Environment Canada Environnement Canada

SPILL TECHNOLOGY NEWSLETTER

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

VOLUME 9 (3-6) ISSN 0381-4459 May - December 1984

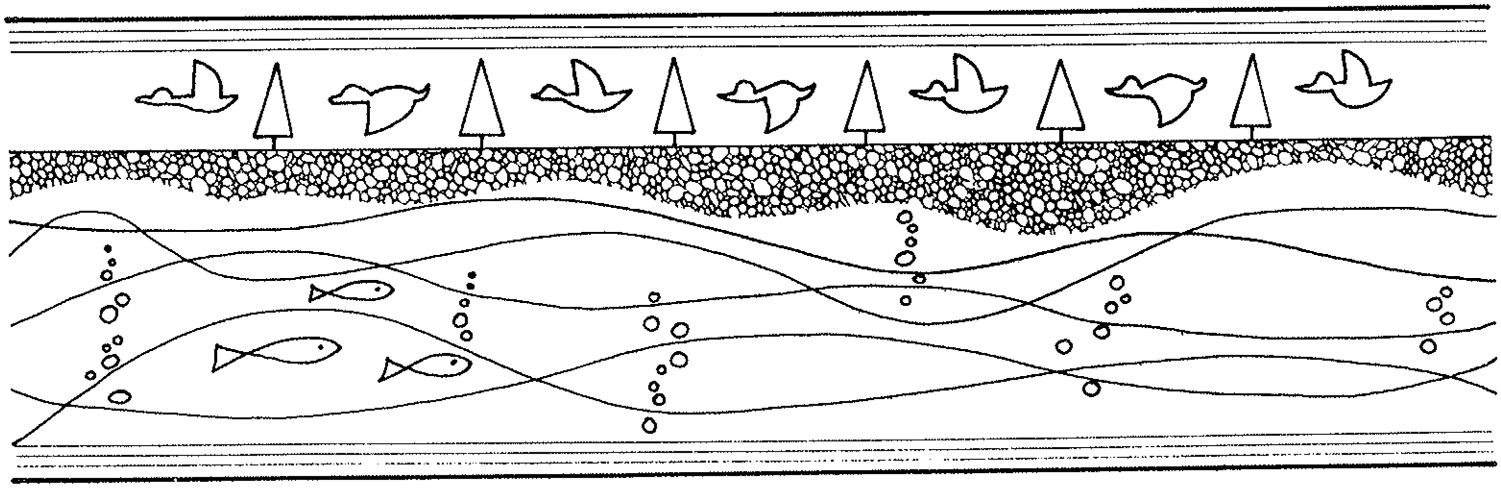

Table of Contents

Disponible en français — voir au verso

Mr. M.F. Fingas and Mr. K.M. Meikle
Technical Editors
Environmental Emergencies Technology Division
Technical Services Branch
Environment Canada - EPS
River Road Labs
Ottawa, Ontario
K1A 1C8

Phone: (613) 998-9622

Mr. Michel Cloutier
Publisher and Coordinator
Technical Services Branch
Environment Canada - EPS
Ottawa, Ontario
K1A 1C8

Phone: (819) 997-3405

The Spill Technology Newsletter was started with modest intentions in 1976 to provide a forum for the exchange of information on oil spill countermeasures and other related matters. We now have over 2,600 subscribers in over 40 countries.

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.

Disponible en français, s'adresser à la:

Section des publications
Division du transfert technologique et de la formation
Service de la protection de l'environnement
Environnement Canada
Ottawa, Ontario
K1A 1C8

et demandez Bulletin de la lutte contre les déversements

INTRODUCTION

The first article of this issue is a review of the testing of the Oil Mop Arctic Skimmer. The second article details the two important criteria for the selection of chemical protection suits; chemical compatibility and configuration. The third article is a brief review of Environmental Protection Service work relating to in-situ combustion.

Readers have, no doubt, noticed that this issue spans 8 months. Production problems and a shortage of articles have put us behind schedule. Thus to catch up, we have combined volume numbers and dates of all issues between May to December 1984. We believe that we have sorted out these problems and that we will be close to schedule in 1985. Any efforts readers can make to help us to that end will be much appreciated.

FIELD TESTS OF THE OIL MOP ARCTIC SKIMMER

Submitted by: F. Laperrière
Environmental Emergencies Technology Division
Environmental Protection Service

Skimmers were developed to operate in the Arctic near shifting ice areas but under relatively calm sea and weather conditions. Because they were to be deployed from a work base or ship, remote control was necessary.

One of the collection principles chosen for the development of these skimmers was the oleophilic rope mop. A catamaran design was chosen in order to allow an initial oil/water separation using the zero relative velocity principle and to operate in debris and ice. Oil Mop Pollution Control developed a large production type skimmer based on the testing results of a smaller scale unit under controlled sea and spill conditions (EPS 4-EC-81-4, EPA-600/9-81-007).

The large scale Oil Mop Skimmer is made of aluminum plates with high density foam in the hulls. Its dimensions are 6 m long, 2.5 m wide, 1.2 m high (0.5 m draught included) and its weight is about 2,300 kg. A WD2-1,000 Wisconsin Diesel engine (20 HP at 2,800 rpm) coupled with an Abex Denison hydraulic pump supply power to two high density rubber wringer rollers (0.25 m diameter) driving three rope mops of 0.3 m diameter and 9.1 m long. The transfer of the oil is accomplished using a 7.6 cm Granco positive displacement rotary pump. The maximum delivery distance is 25 m and the maximum pumping height is 3 m. A remote control which can operate at 60 m permits the adjustment of the skimmer and the mop speed as well as the discharge pump rate. An indicator light mounted on the skimmer flashes at each revolution of the wringers.

The skimmer is primarily designed to recover oil within a containment boom (boom attachments are provided at both ends of each hull) but two 3HP outboards provide additional manoeuvrability when used without booms. Oil herding spray pipes mounted on the bow can be used to direct the oil towards the skimmer. Extension of mops outside the hulls with floating tail pulleys is possible for the recovery of very light products.

It was tested for its manoeuvrability in Hamilton Harbour, Ontario and for its oil skimming performance in a settling pond at the Imperial Oil asphalt plant in London, Ontario. During its manoeuvrability assessment a loss of power of the engine prevented the recovery components of the system to reach their maximum operating conditions while being propelled. It was also noticed that in windy conditions its manoeuvrability was difficult.

During its oil skimming performance tests, malfunctions of the radio control systems negated the proper evaluation of skimming efficiency. Used with a towing system and booms, in its primary design mode, the prototype recovery unit works efficiently. The skimmer is thus expected to reach high pick up and recovery efficiency as well as high oil recovery rate.

Further mechanical improvements on this oleophilic mop skimmer were postponed until winter tests are completed at the OHMSETT facility.

References:

An Evaluation of Oil Pumps and Skimmers, Report EPS 4-EC-81-4, Environment Canada, 1981.

Summary of U.S. Environmental Protection Agency's OHMSETT Testing 1974-79, G.F. Smith, et al., EPA USA 1981.

THE SELECTION OF CHEMICAL PROTECTION SUITS FOR SPILL EMERGENCIES

Submitted by: Mervin F. Fingas
Environmental Emergencies Technology Division
Environmental Protection Service
Ottawa, Ontario

and

J.T. Vanchuk
MSA Canada Inc.
Downsview, Ontario

Introduction

The selection of chemical protection suits by response teams has been a subject of much recent discussion. The authors believe that the many irrelevant details presented to would-be purchasers has lead to confusion among first responders, especially hazardous materials teams of fire departments; the result is that by-and-large they have not purchased chemical protection suits.

The current "wisdom" on these protection devices is largely to blame. For example the following are well known axioms,

1. "There is no such thing as impermeable rubber or plastic", and
2. "No one clothing material will be a barrier to all chemicals".

While strictly speaking these axioms are true, they have only served to frighten those involved in chemical spill response. Let's examine each of these axioms in terms of the spill response situation. The first item leaves the implication that there is no form of protection. What this statement actually means is that most materials are permeable to a certain extent. This is true, but what the person responding to spills requires is a minimum protection of 30 to 60 minutes or whatever his SCBA (Self-contained Breathing Apparatus) will provide. He will probably not refill his tank and re-enter the contaminated area. Thus for the spill response application what is required is a minimum of 30 minutes protection from breakthrough.

The second axiom, that of the fact that "no one clothing material is a barrier to all chemicals" has caused a lot of difficulties. As noted, this is true, but the probability that a spill response team will have to deal with some of the materials listed on compatibility charts is so low as to be unreal. This thesis will be developed further in the next section of this paper. Suffice it to say here, that the axiom has convinced responders that they must purchase a number of suits before considering themselves prepared. To date the usual reaction has been to purchase nothing.

One additional item will be dealt with in this paper, that of suit configuration. Manufacturers are currently supplying totally encapsulating suits with SCBA's worn either inside or outside. After the material compatibility confusion, this problem ranks second. Competing manufacturers have, in the authors' opinion, confused the issue to the point where few users understand the advantages or disadvantages of one configuration versus the other. The third section of this paper deals with this topic.

Chemical Compatibility

As noted above, the authors believe that most spill responders can choose one material that will provide them with protection for most spills. We will illustrate that by using the material spill data base known as NATES or National Analysis of Trends in Emergency Systems (Beach 1978). This data base currently lists over 20,000 spills which have been reported in the years 1972-1983. The sample we shall use is that of the chemical spills between 1972 and 1980. These spills number about 600, and the remaining thousands that are not chemical spills are oils, petroleum, mining materials, etc. Readers wishing to know more about these spills are advised to consult the above noted reference.

The most frequent chemical spills during this sample period are listed in Table 1. We noted at the outset that spills of certain chemicals are frequent; others infrequent. This is simply due to production volume and method of handling. We have found that there is a strong correlation between production volume and spill frequency. According to our records, some of the products listed in compatibility tables have never been spilled in Canada. This is not surprising, observing that the same materials are usually not made in commercial quantities here.

We have prepared a compatibility chart of the 25 chemicals most frequently spilled in Canada with some common materials used for protective clothing construction (Schwope 1983, Friel 1980, Buchan 1981, Fingas 1984). This chart appears as Table 2 with the ratings defined in Table 3.

The findings are summarized as follows:

1. For the 25 most common spilled chemicals in Canada materials were compatible for every situation where a chemical protection suit might be required, this includes butyl rubber, neoprene and polyvinyl chloride. (Note: even though compatibility was determined, the protection may not be required in short-term situations because of the low penetration rate of the material through the skin).
2. For these same chemicals, an additional 4 materials were identified that were not tested for or showed rapid permeation of one chemical. These materials included natural rubber, nitrile, chlorinated polyethylene and viton.
3. The events involving the 25 materials accounts for 81% of the number of spills that occurred in Canada during the sample period.

TABLE 1

Chemical Substance	Number of Spills	Amount (metric tons)
PCBs	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	Unknown
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	Unknown
Xylenes	2	Unknown
Sodium chloride	2	Unknown
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

NATES data summary: August 1972 to September 1980, excluding one-time events.

TABLE 2 COMPATIBILITY OF PROTECTIVE CLOTHING MATERIALS WITH COMMONLY SPILLED MATERIALS[1]

			Material[3]														
Material	Number of Spills[2]	Cumulative Probability of Spillage (%)	butyl rubber	natural rubber	neoprene	neoprene/SBR	neoprene/NR	nitrile	nitrile/PVC	polyethylene	CPE	polyurethane	polyvinyl alcohol	polyvinyl chloride	SBR	viton	
PCB's	102	17	A	A	A	-	-	A	-	A	D-	-	A	D-	-	A	
Sulphuric Acid	44	24	B-	B-	B	-	-	B	D-	D-	B-	D-	D-	B	-	B	
Natural Gas	41	31	B-	-	B-	D-	-	-	-	-	B-	D-	D-	B-	B-	-	taken as hydrogen sulphide
Sulphur	39	37															not taken, PC not necessary
Sodium Hydroxide	35	43	B-	A-	A-	B-	-	A-	-	B-	B-	B-	-	A-	-	B-	
Fenitrothion	33	49															a pesticide, oil carrier most will function
Hydrochloric Acid	32	54	B-	A-	A-	-	-	B	D-	B-	A	D-	D-	B	-	B	
Ammonia	26	58	B-	B-	B-	-	-	B-	-	-	-	-	-	B-	-	B-	
Chlorine	17	61	D-	C-	C-	-	-	D-	-	-	B-	-	-	B-	-	B-	
Potassium Chloride	14	63															PC not necessary
Latex	13	65															PC not necessary
Hydrogen Sulfide	13	67															see natural gas
Matacil	12	69															pesticide, oil carrier most will function
Phosphorus	11	71															PC not necessary under most circumstances
Styrene	10	73	C-	C-	C-	D-	-	D	C	C	D-	B-	B	C	D-	A	
Ammonium Nitrate	8	74															PC not necessary
Dimecron	8	76															most PC will handle oil carrier
Mercury	7	77															PC not necessary in most circumstances
Methanol	6	78	A-	B	B	B-	-	A	B-	B-	B-	B-	C	C	B-	A	
Cyanides	5	79															PC not necessary in most circumstances
Benzene	4	79	C	C	C	C-	C	C	C-	C	C	C	B	C	D-	B	
Calcium Oxide	4	80															PC not necessary
Ethylene Glycol	4	81	B-	A	A	D-	B	A	B-	A	B-	A-	B	A	B-	B-	
Copper Sulfate	4	81															
Phenol	4	81	A-	B	A	B	B	C	D-	B	B-	D	C	C	D-	D-	
Average Rating			B-	B-	B-	-	-	B-	-	-	C	-	-	B-	-	B-	
Complete Coverage			yes	1 short	yes	-	-	1 short	-	-	1 short	-	-	yes	-	1 short	

1. Data from "Guidelines for the Selection of Chemical Clothing"
2. Based on historical information from the NATES data base, from 1972 to 1980, 606 "chemical" spills were recorded in period and about 14 000 others
3. Abbreviations: SBR - styrene butadiene rubber, NR - natural rubber, PVC - polyvinyl chloride, CPE - chlorinated polyethylene, PC - protective clothing

TABLE 3

RATING SCHEME USED IN ASSESSING CLOTHING MATERIALS[1]

Rating Scheme	Performance Data or Recommendations
A	Breakthrough times greater than one hour reported by two or more testers and A or B ratings from three or more vendors
A-	Vendor recommendations as above only
B	Some data suggesting breakthrough times of approximately an hour or more and A or B ratings from vendors with no C or D ratings
B-	Vendor recommendations as above only
C	Breakthrough times less than one hour reported by two or more testers and C or D ratings from three or more vendors
C-	Vendor recommendations as above only
D	Some data suggesting breakthrough times of one hour are not likely and C or D ratings from less than three vendors
D-	Vendor recommendations as above only
-	No testing reported or rapid breakthrough occurs

1. Rating scheme essentially that reported in "Guidelines for the Selection of Chemical Protective Clothing"

Table 3 shows that if one selects one of the three materials (butyl rubber, neoprene or polyvinyl chloride) there will be a very small probability that a different material would be required. One should also examine the other attributes of the material. This has been done as illustrated in Table 4. Only PVC has a serious difficulty that of flexibility in cold weather.

In conclusion, the authors recommend that before selecting a suit material the compatibility with expected spill materials be examined. The national spill data shows that one material will suffice for a high percentage of potential spills.

Configuration

Having overcome the barrier of selecting a material in terms of chemical compatibility and general properties a prospective purchaser is faced with the difficulty of choosing between suits where the SCBA is worn inside or where it is worn outside the suit. Various manufacturers have made the choice difficult by presenting their product as the only option. The advantages and disadvantages of each configuration are listed in Tables 5 and 6 (Vanchuk 1984), and summarized in Table 7. The authors conclude that a suit with the SCBA worn outside is more advantageous, primarily because it is far superior for both safety and wearer comfort.

Conclusion

A potential purchaser of a chemical protection suit for spill situations can simplify his decision. Butyl rubber, neoprene and polyvinyl chloride offer sufficient protection for most of the top 25 chemicals spilled in Canada. PVC could be a problem because of its poor cold weather flexibility. The outside SCBA configuration has the most advantages and fewest disadvantages. For the typical Canadian spill situation, a butyl rubber or neoprene suit with externally-worn SCBA is the recommended choice. Users of the protection equipment are urged to be prepared with a verified list of materials for which their suit material is useful.

TABLE 4 OVERALL ASSESSMENT OF PROTECTIVE MATERIALS FOR COMMONLY SPILLED MATERIALS

	Material		
	Butyl Rubber	Neoprene	Polyvinyl Chloride
Breakthrough protection for most common spills	1	1	1
Flexible in cold weather	1	2	3
Resistance to abrasion, cuts, and punctures	2	1	1
Resistance to heat, ozone and UV	1	1	2

Rating System:
1. good, sufficient
2. fair, barely sufficient
3. poor, movement difficult

TABLE 5 ASSESSMENT OF WEARING BREATHING APPARATUS INSIDE THE PROTECTIVE SUIT

Advantages	Disadvantages
1. SCBA is protected against contaminants.	1. Wearer does not have ready access to vital controls of the SCBA, namely the by-pass or purge valve.
2. NIOSH certification of the SCBA is maintained.	2. Wearer must learn to use new procedures to reach the by-pass or purge valve by removing his arm from the glove and sleeve, retract it into the body of the suit and operate the by-pass valve.
	3. Above procedure is possible only by making sleeves with "bat wings" under the arms to permit retracting the arm and hand into the suit. Additional material adds to bulk and weight of suit.
	4. In the event the by-pass or purge valve must be used to restore flow of air into the facepiece during emergency conditions in a highly toxic or corrosive atmosphere, consider the following: A) The emotional state of the wearer (no flow of air). B) The level of training required for the wearer to remain calm (with no supply of air) until he can withdraw his hand from the glove and retract his arm from the sleeve into the suit and open the by-pass or purge valve. C) Time required to accomplish action (B) when clothed for cold weather or low temperature operations (heavy underwear, sweaters or parkas worn inside

TABLE 5 ASSESSMENT OF WEARING BREATHING APPARATUS INSIDE THE PROTECTIVE SUIT (Cont'd)

Advantages	Disadvantages
	the suit). How does one train wearer not to panic and hold his breath during the time it takes to restore the air flow?
	D) If a "buddy" is present and similarly dressed, how much help can the "buddy" extend under these conditions?
	E) It is highly likely the wearer or the "buddy" would break the integrity of the suit (open the zipper or cut the fabric) to open the by-pass or purge valve to restore the air flow.
	5. Wearer cannot help himself using the arm-retraction procedure if he is injured or trapped.
	A) If the wearer is injured and must be moved to a fresh air base, the integrity of the suit and SCBA must be maintained. How is this accomplished when wearing a 30 or 60 minute SCBA? Subtract the time of entry, exit time, time for diagnosing type of injury and obtaining additional help of a stretcher team outfitted similarly to the injured person, preparing him for movement, placing him in stretcher and actual removal to fresh air base. Picture three scenarios involving the malfunction of an SCBA:
	- railway embankment, wrecked rail cars, winter, snow,

TABLE 5 ASSESSMENT OF WEARING BREATHING APPARATUS INSIDE THE PROTECTIVE SUIT (Cont'd)

Advantages	Disadvantages
	darkness, toxic or corrosive atmospheres. - chemical process area, working one or two levels above ground, only access is a caged ladder, toxic or corrosive atmosphere. - confined space with all the ramifications.
	B) Moving an injured person safely without aggravating the injury while he is wearing an SCBA inside a total encapsulating suit before his air supply is exhausted, is a challenge that may not be successfully overcome.
	6. Normal viewing (by the wearer) of the SCBA gauges is impossible.
	7. Moist, exhaled air from facepiece may fog lens of chemical suit.
	8. Vision may be distorted because the wearer has to look through the lens of the SCBA and the lens of the chemical suit.
	9. Field of vision is reduced (when needed most).
	10. Effective working time in a toxic or corrosive atmosphere will be reduced because wearer must return to fresh air base to exchange air cylinders for full ones.
	11. Each trip to replace air cylinders on SCBA worn inside the chemical suit results in the following:

TABLE 5 ASSESSMENT OF WEARING BREATHING APPARATUS INSIDE THE PROTECTIVE SUIT (Cont'd)

Advantages	Disadvantages
	A) Potential contamination or injury of support team.
	B) Support team must be outfitted similarly to the working team in order to decontaminate the wearers' suits prior to opening them to replace the air cylinders (the proper decontaminating agent may not be available)
	C) Potential contamination of the safe, fresh air base, rendering it unsafe for subsequent use and requiring the creation of a new fresh air base.
	D) A logistics problem quickly develops under the aforementioned conditions.
	12. Use of a dual-purpose SCBA is difficult. Consider the following:
	A) The quick disconnect fitting on the remote airline (an adapter hose and fitting required to penetrate the wall of the suit) would be difficult to "break" so that air from the cylinder on the SCBA would flow automatically to the wearer on inhalation.
	B) Even though the quick disconnect fitting were enlarged so that the wearer could operate it through the wall of the suit, the wearer would be without air for the time it took to accomplish this action.

TABLE 5 ASSESSMENT OF WEARING BREATHING APPARATUS INSIDE THE PROTECTIVE SUIT (Cont'd)

Advantages	Disadvantages
	C) Some dual-purpose SCBAs require the cylinder valve (on wearer's back) to be closed when using air from a remote source, then opened manually should the remote air supply be interrupted. Accomplishing this by attempting to locate and open the valve on the SCBA cylinder worn inside the suit may prove to be somewhat difficult.
	D) The wearers of chemical suits would likely be wearing cover gloves over the butyl rubber gloves (which have low cut and abrasion resistance) and covered with a contaminant that may be greasy and slippery. Accomplishing the action in A), B), and C) is highly unlikely.
	13. When the wearer realizes that he cannot get any air until he "breaks" the quick disconnect or opens the cylinder valve, he will resort to his by-pass or purge valve and encounter all or most of the associated problems indicated in points #1 to #5.
	14. Difficult to use the SCBA and chemical suit with the standard protective firefighting turn-out coats, pants, boots, helmets, etc.
	15. Necessitates using SCBA in a non-approved manner.
	16. Good, clear communication by radio or telephone is seriously impeded.

TABLE 5 ASSESSMENT OF WEARING BREATHING APPARATUS INSIDE THE PROTECTIVE SUIT (Cont'd)

Advantages	Disadvantages
	17. Consider a haz-mat team handling an emergency that is corrosive, radioactive, or involving highly toxic bacteria. Could cylinder changes be made or new SCBA donned without risk of contaminating the wearer or the inside of his suit if it encapsulates the SCBA? Decontaminate him first? Will the right decontamination agent be available on site?

TABLE 6 ASSESSMENT OF WEARING BREATHING APPARATUS OUTSIDE THE PROTECTIVE SUIT

Advantages	Disadvantages
1. The wearer has quick ready access to all the controls of the SCBA, including the by-pass or purge valve.	1. SCBA is exposed to toxic, corrosive atmospheres and may require replacement of some parts.
2. The wearer can use the standard operating instructions (as furnished by manufacturer) in operating the SCBA. There is no necessity to learn a separate procedure for the SCBA when used with a chemical protection suit.	2. The NIOSH certification for the SCBA may be void, depending upon the method of attaching the SCBA facepiece to the chemical suit.
3. The suit is lightweight and less bulky and easier to wear when "bat wings" are not incorporated as part of the suit.	3. If point no. 2 is a fact, then the owner of the suit may have to apply for a variance to the regulatory authority having jurisdiction.
4. If the wearer's air supply is interrupted, he has fast, ready access to the by-pass or purge valve without the possibility of: A) Emotional upset, bordering on panic. B) Having to remember special training on how to reach the by-pass or purge valve. C) Being encumbered by heavy clothing used to protect against low temperatures. D) Being forced to go without air for a period longer than that which a person could hold their breath while attempting to activate the by-pass or purge valve.	
5. The wearer's "buddy" has full access to the controls of the wearer's SCBA in the event the wearer has any difficulty in their operation.	

TABLE 6 ASSESSMENT OF WEARING BREATHING APPARATUS OUTSIDE THE PROTECTIVE SUIT (Cont'd)

Advantages	Disadvantages
6. There is no necessity to break the integrity of the suit by opening the zipper or cutting into the suit to reach the controls of the SCBA.	
7. By using only dual-purpose SCBA with remote air supply, virtually an unlimited service time is available with the following benefits: A) Injured people can have their injuries properly diagnosed, be prepared properly for movement reducing the possibility of further aggravating their injuries. B) If they are trapped or cannot be moved readily to fresh air, they have access to an unlimited supply of breathing air from remote locations up to 300 feet.	
8. The wearer can easily view the air pressure gauge.	
9. Lens fogging is virtually eliminated when a properly fitted nosecup is used with the facepiece.	
10. Vision is clear and undistorted through the facepiece lens.	
11. Normal field of vision is maintained.	
12. Working time in a toxic or corrosive atmosphere can be extended for several hours by using the dual-purpose SCBA with up to 300 feet of airline hose attached to a remote supply of compressed breathing air.	

TABLE 6 ASSESSMENT OF WEARING BREATHING APPARATUS OUTSIDE THE PROTECTIVE SUIT (Cont'd)

Advantages	Disadvantages
13. The foregoing approach to handling airborne contaminants is safer and more efficient because: A) No necessity for the wearer to return to well-equipped base every 30 or 60 minutes to replace the spent cylinder. B) Lower frequency of exposure of the support team to the contaminated person helps maintain their integrity. C) Reduced potential for possible contamination of the fresh air base.	
14. Standard protective firefighting coats, pants, boots, helmets, etc. can be used when necessary.	
15. Good, clear communication by radio, telephone or person-to-person is possible by using the appropriate approved voice amplifiers.	
16. The SCBA can be used safely in the NIOSH approved manner.	

TABLE 7 SUMMARY OF THE ISSUES RELATED TO SCBA INSIDE OR OUTSIDE THE PROTECTIVE SUIT

Issue	SCBA Inside	SCBA Outside
1. regulations, certification	SCBA not used according to regulation	SCBA certification may be voided, a variance may be required
2. safety	in an emergency wearer is in a precarious situation	-
3. changing air bottles	very difficult, can cause contamination	-
4. equipment protection	-	SCBA may be contaminated
5. ease of use	difficult, heavier, clumsier	comfortable and light, good access to controls
6. communication and vision	difficult	relatively easy

References

Beach, R.A., 1978. Information Systems Used in Environmental Emergencies. Spill Technology Newsletter, V3, N5, pp. 283-287.

Schwope, A.D., Costas, P.P., Jackson, J.O. and Weitzman, O.J., 1983. Guidelines for the Selection of Chemical Protective Clothing, Environmental Protection Agency, Washington, D.C.

Friel, J.V., McGoff, M.J., and Rodgers, S.J. 1980. Material Development Study for a Hazardous Chemical Protective Clothing Outfit, United States Coast Guard, Washington, D.C.

Buchan, Lawton, Parent Ltd. 1981. A Study of Self-Contained Breathing Apparatus and Totally-Encapsulated Chemical Protection Suits, Environmental Protection Service, Ottawa, Ontario.

Fingas, M. 1984. "The Development of Improved Countermeasures for Chemical Spills in Canada," Proceedings of the 1984 Hazardous Material Spills Conference, Government Industries, Inc., Rockville, Maryland.

Vanchuk, J.T. 1984. "Personal Protection Equipment at Spill Incidents". Presented at 70th Annual Maritime Fire Chiefs Convention, Gander, Newfoundland.

IN-SITU BURNING OF UNCONTAINED OIL SLICKS

Submitted by: F. Laperrière, Project Engineer
Environmental Emergencies Technology Division
Environmental Protection Service

In the mid-seventies in-situ combustion of oil spills was identified as a potential offshore removal technique. It was only in the early eighties (COOSRA, McKinley Bay, spring 1982; S.L. Ross Environmental, 1982, 1983) that research and development was oriented towards this one-step removal process on open water and in partial ice cover conditions. This development was largely initiated because of the limitations of the containment and removal techniques offshore and/or in ice conditions. Rapid weathering and spreading of the oil released from a damaged tanker combined with a response time of 10 to 24 hrs from a land base and of sea condition limitations, prevent containment and mechanical removal. In-situ burning was thus identified as a potential onboard countermeasure for a major oil spill from a vessel in Arctic waters.

The project funded by EPS was to study the combustibility of thick oil slicks on open water. The importance and effects of the air inflow during combustion of the uncontained slick were to be studied. An entrainment of air sufficient to maintain a 1 mm thick slick and also sustain the combustion was expected.

The study was executed in 4 phases. The first one was the development of a model describing in-situ burning of oil slicks considering; oil spreading on water, flame spreading on oil, combustion rate under certain conditions of wind velocities, temperature and delays of ignition of the oil. The 3 other phases involved experiments on a small, a medium and a large scale, quantifying parameters and providing data to calibrate the model.

The small scale testing was designed to measure oil and flame spreading in one dimension. It was conducted in a wind/burning tunnel using a water trough 3 m long by 10 cm wide. An Alberta Sweet Mix Blend crude oil (weathered to simulate an exposure to a 10 m/s wind for 1, 4, 8 hrs at 10°C) and a fresh diesel were used to investigate oil and flame spreading upwind and downwind with different wind speeds and water temperatures.

It was found that at this scale there was no difference between the flame speed whether the oil had spread or not. Comparing the results to Fay's model oil spreading predictions, an oil viscosity effect (not originally considered in the model) was noticed.

The medium scale testing was conducted in 2 dimensions, the parameters affecting the combustion efficiency: oil and flame spreading, and air influx. The combustion efficiency and regression burning rate were measured. It was executed in a 10 m x 10 m outdoor tank using a metal ring of 1 m and 2 m diameter with different volumes of oil reaching a thickness up to 4 cm. No delayed ignition was tried. The oil was released only once the flames had covered the entire area inside the ring. Under those conditions it was noticed that the flames were spreading as quickly as the oil. The combustion efficiencies found were about 50-60% compared to 60-80% as predicted by the model. The regression rate for the thicker slick was not a direct function of the initial slick thickness. The air entrained velocity couldn't be measured in this mid-scale test due to windy conditions. It was thus addressed in the large scale testing.

The large scale experiment was to assess the time dependent effects on the combustion efficiency of an uncontained oil slick. Ignition delay and other effects on oil and flame spreading were to be evaluated as well as fire induced air and water inflow. The testing was executed in an old settling pond in Prudhoe Bay in a joint project with SOHIO Alaska Petroleum Company. A smaller number of tests than planned were done due to ice formation on the pond. Ignition with and without delay was tried and a contained burn was also done in order to measure inflow air and water velocities. A volume of 2 m^3 of degased Prudhoe Bay crude in a 6 m diameter ring (7 cm thick) was used for each burn. The results are being analysed at the moment but we can say that delayed ignition had an effect on the flame spreading and thus on the combustion efficiency. An increase of the air movement towards the fire was noticed but effects on the water surface were not obvious. A complete report on this study will be available in 1985.

References:

S.L. Ross Environmental Research Ltd; 1982a. Oil Spill Countermeasures for a Major Spill from a Vessel in Arctic Waters, Report for Environment Canada, Ottawa.

S.L. Ross Environmental Research Ltd; 1982b. Potential Large Oil Spills Offshore Canada and Possible Response Strategies, Report for Environment Canada, Ottawa.

S.L. Ross Environmental Research Ltd; 1983a. Igniter Requirements for a Major Spill from a Vessel in Canadian Arctic Waters, Report for Environment Canada, Ottawa.

S.L. Ross Environmental Research Ltd; 1983b. A Study of On-Board Self-Help Oil Spill Countermeasures for Arctic Tankers, Report for Environment Canada, Ottawa.