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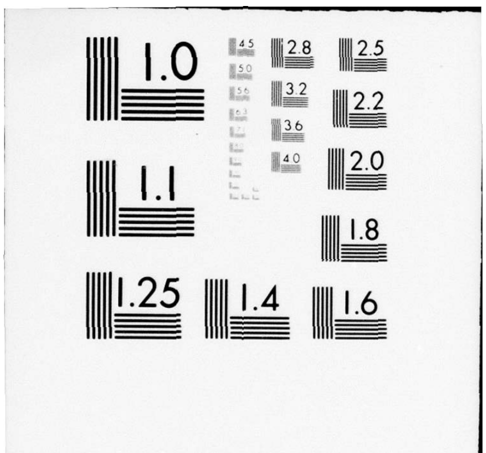

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Report No. CG-WEP-78-3

SUPPLEMENTAL REPORT TO "A PLAN FOR IMPLEMENTING PRESIDENTIAL INITIATIVES CONCERNING OIL POLLUTION"

J. Valenti; J. Leigh; G. Marsh; R. Ross
J. Kuchin; G. Mucci and J. Bellantoni

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SUPPLEMENTAL REPORT TO

(6) "A PLAN FOR IMPLEMENTING PRESIDENTIAL INITIATIVES

CONCERNING OIL POLLUTION RESPONSE". Supplemental Report,

(10) J. Valenti, J. Leigh, G. Marsh, R. Ross,
J. Kuchin, ~~G. Mucci and J. Bellantoni~~

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16. Abstract

The supplemental report is intended to amplify the associated main report "A Plan for Implementing Presidential Initiatives Concerning Oil Pollution Response" and is dependent on it to provide continuity and completeness. Additional details on the following are provided:

1. Site configuration and proposed equipment levels;

2. Support requirements for the proposed configuration including personnel, National Strike Force and shore facility requirements;

3. Alternatives to the proposed configuration as well as equipment and support levels;

4. Pollution prevention; and

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I INTRODUCTION

This supplemental report is intended to amplify the associated main report titled "A Recommended Plan for Implementing Presidential Initiatives Concerning Oil Pollution Response" and is dependent on it to provide continuity and completeness. It is assumed that the reader is familiar with the main report, and desires further details on one or more topics treated therein. Reviewers requiring additional information may refer to the background reports that further support this study effort. The contents of this report are summarized below.

Section II examines the site configuration and proposed equipment levels and explains the assumed capacities of primary response equipment. The basis for establishing the levels of equipment at each site is discussed. The response capability of the proposed configuration is examined based on the stated criteria and on five assumptions concerning the uses of equipment from one or more sites in responding to any particular spill. All equipment items proposed for the inventory are listed together with their assumed unit cost.

Section III discusses the support requirements for the proposed configuration including personnel, the National Strike Force, and shore facility requirements. The need for massive spill contingency planning is discussed. Features desirable in Coast Guard boats, ships, and aircraft to facilitate the support of pollution response operations are summarized. The requirements for acquisition of the proposed equipment inventory over a 3 year period are also examined.

Section IV analyzes alternatives to the proposed configuration as well as equipment and support levels. Current response capability is evaluated in this section, so that the reviewer can assess the alternative of meeting the Presidential goals with current capabilities.

Section V is an elaboration on section 3 of the main report. Expanded discussion of pollution prevention through tanker salvage, oil spill response, and oil spill response in ice infested waters is included. Recommendations for continued developmental work are keyed to this discussion.

Section VI consolidates the discussion of Section V into a proposed 5 year Research and Development Plan, and discusses specific R&D needs as well as projects rejected but not explicitly addressed elsewhere.

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Section VI consolidates the discussion of Section V into a proposed 5 year Research and Development Plan, and discusses specific R&D needs as well as projects rejected but not explicitly addressed elsewhere.

II ANALYSIS OF RECOMMENDED SITING CONFIGURATION AND EQUIPMENT LEVELS

INTRODUCTION. The main report indicates that equipment should be sited at fourteen locations within the contiguous states, as well as in Alaska, Hawaii, and Puerto Rico. As previously indicated these sites were selected because they are believed to be the most probable locations for major pollution incidents. The purpose of this analysis is to indicate how equipment levels were arrived at, and to quantify the pollution response capability of the recommended configuration.

Figure II-1 is a distribution curve of spills greater than 50,000 gallons occurring within the U.S. since 1974. The curve indicates that the greatest volume of spilled oil results from a very few large sills. A closer look at the statistics indicates that on the average one spill of approximately one million gallons can be expected every year. Because of this it was decided that each geographical region of the country should have the ability to clean up a discharge of up to one million gallons in a minimal of time.

An analysis of winter weather conditions in the northeast was undertaken to determine the period of good weather that can typically be counted on to accomplish recovery. The northeast was chosen because there is a higher probability that an incident will occur in this area, and good weather data was available for the area. Recovery was chosen as it is more likely that weather conditions will affect recovery operations than offloading operations. Table II-1 indicates the results of this analysis. From this data it can be shown that the average duration between winter storms during which recovery operations could be undertaken in the northeast will be approximately 70 hours.

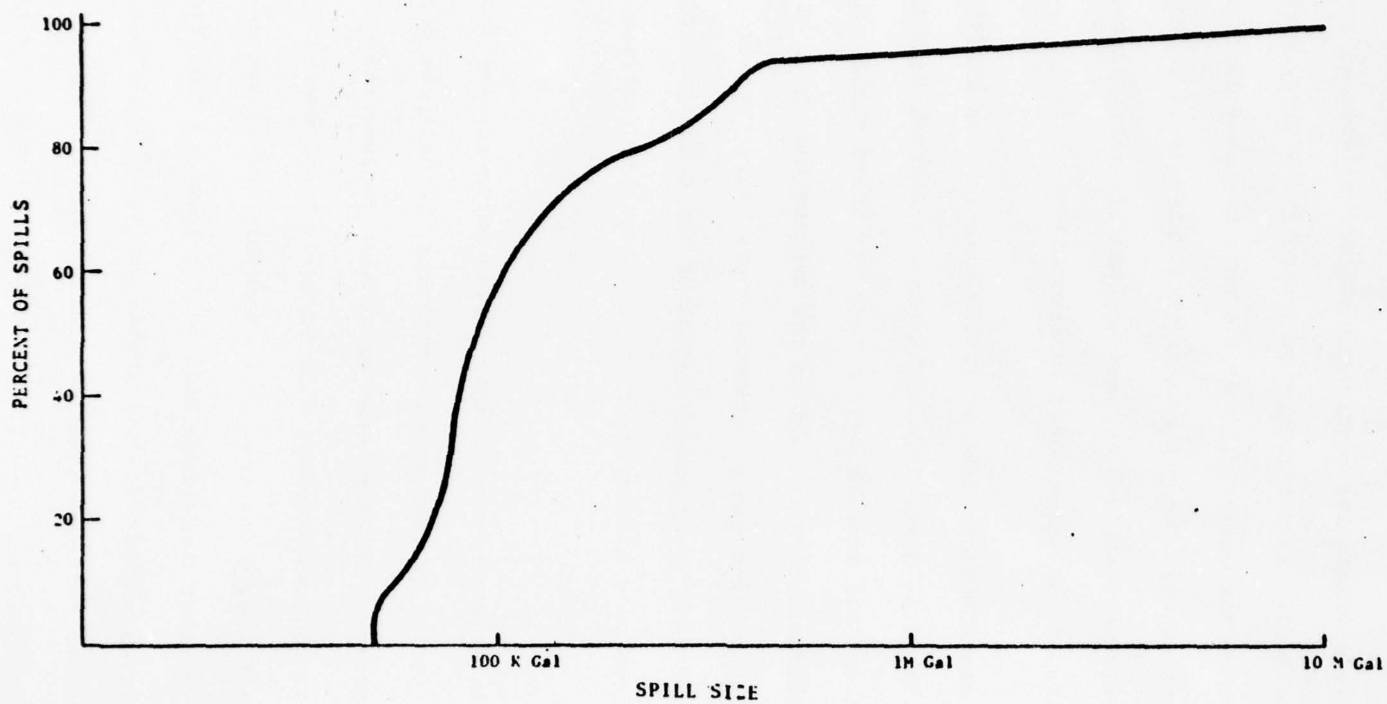


FIGURE II-1 CUMULATIVE OF SPILL SIZE DENSITY FOR SPILLS $\geq$ 50,000 GAL

TABLE II-1 PERSISTENCE OF WAVES <6 FT. HIGH

SEASON	ELAPSED TIME HRS (DA)	TOTAL DURATION HRS (DA)	AVERAGE DURATION HRS	NUMBER OF OCCASIONS	NUMBER > AVE. DURATION	NUMBER < AVE. DURATION	NUMBER >30 HRS. (%)	NUMBER >50 HRS. (%)
PORTLAND, MAINE (43°48'N, 70°6'W)								
JaFeMa	2160 (90 da)	1812 (75 da)	75	24	8	16	15 (62%)	11 (46%)
JuAuSe	2208 (92 da)	2060 (86 da)	188	11	3	8	8 (72%)	7 (64%)
NANTUCKET SHOALS, MA (40°37'N, 69°18'W)								
JaFeMa	2160 (90 da)	1750 (73 da)	83	21	4	17	12 (57%)	8 (38%)
JuAuSe	2208 (92 da)	2098 (87 da)	315	7	2	5	6 (86%)	5 (71%)
CHESAPEAKE, VA (36°59'N, 75°42'W)								
JaFeMa	2160 (90 da)	1662 (69 da)	83	20	7	13	13 (65%)	10 (50%)
JuAuSe	2208 (92 da)	2060 (86 da)	159	13	2	11	11 (85%)	8 (62%)
DIAMOND SHOALS, NC (35°05'N, 75°20'W)								
JaFeMa	2160 (90 da)	1382 (57 da)	40	34	15	19	19 (56%)	10 (29%)
JuAuSe	2208 (92 da)	1877 (78 da)	117	16	3	13	10 (62%)	8 (50%)

Because of this it was decided that the regional goal should be to be able to mount a response to a discharge of up to one million gallons in time to permit the cleanup to be accomplished within 72 hours after cleanup efforts were initiated.

In order to determine equipment levels needed to meet the above stated goal specific equipment, such as the ADAPTS, which is in the current Coast Guard inventory was used. It should be understood however, that it is the total operational capacity (gallons per day offloaded or recovered) in combination with the ready transportability features of the equipment which is being proposed. Developments in the technology and in the marketplace between the time of this report and the time of any implementation will ultimately determine the specific equipment selected.

The capacity of all offloading and recovery equipment is strongly influenced by several specific variables in any operation. In order to carry out the systems analysis required, the Transportation System Center (TSC) made assumptions concerning the performance of the Coast Guard developed ADAPTS and skimming barrier system as outlined below. These assumptions have been utilized throughout their work and they have also been used throughout this report. Offloading, skimming, and storage requirements are addressed below. Other equipment requirements are addressed at the end of this section.

OFFLOADING. The pumping rate of the double stage ADAPTS using a double stage submersible pump varies with oil viscosity and total head. A nominal rate of 1000 gallons per minute (gpm) is assumed even though rates of 1700 gpm are possible for certain oils and temperatures. If two hours per day are allowed for down time for each pump (minor repair and adjustment), hook up, prime mover down time, and 10% of the remaining time is allowed for set up and changing from tank to tank, then 1 ADAPTS will average 1.2 million gallons of oil pumped every 24 hours.

SKIMMING. The skimming barrier (OWOCRS - Open Water Oil Containment and Recovery System) has a recovery capacity of 63,000 gallons per day. This is based on a nominal pumping rate of 600 gpm, and a recovery efficiency estimated at 50%. Allowing an active working day of 10 hours accounts for darkness, changing of receivers, and maintenance. An average oil slick thickness of 0.0125 inches is assumed. A maneuvering efficiency of 35% is also imposed to account for failure to encounter oil uniformly across the entire opening of the skimming barrier due to patchiness of the slick and difficulty in maneuvering the entire system.

TEMPORARY STORAGE. Temporary storage capacity to support offloading is provided for use in the early hours of operation in spill response since barges are not always readily available. This storage capacity is identified as the Dunlop Dracon Type O collapsible barge, which is credited with a nominal capacity of 247,000 gallons in an open ocean situation (85% of total volume capacity). Each Type O barge would provide about four hours of offloading capacity at the nominal rate of 1000 gpm. Thus, one Type O barge is provided in the major high volume regions and two are provided at the air site. Dunlop Type F collapsible barges with a nominal capacity of 42,000 gallons in open ocean conditions have been selected for use with skimming barriers on the basis of their size and towing considerations for support of recovery operations. A day's operation would require about 1.5 barges for a single skimming barrier.

EQUIPMENT LEVELS FOR SITES. As previously mentioned the sites selected by TSC, based on spill potential, were accepted by the Task Force. The latter group however, believed that each site needed to have an ability to deliver equipment over the road, as well as over the water; while TSC suggested that certain sites should only have either a land or water capability. The Task Force also decided that even though land delivery of equipment would provide the most efficient way to deliver equipment, land delivery must be backed up by air delivery, even though the latter mode is severely weight limited.

For the reasons specified above the major equipment levels for the various sites were derived to provide for the recovery of up to one million gallons of oil from open water over a period of 72 hours. Based on the previous analysis of equipment capabilities it can be shown that 6 skimming barrier units would be required to accomplish this goal.

An iterative process was undertaken to ascertain the number of recovery units which should be placed at each location to assure that the above goal could be met with only the use of regionally available resources. Table II-2 is the result of this process. Equipment available within a region from the commerical, private sectors and other government agencies were considered in arriving at these figures. The results are considered to address the potential spill threat at each location, while accounting for equipment available at adjacent sites within the region.

TABLE II-2 RECOMMENDED MAJOR EQUIPMENT LEVELS

Site Name	Skimming Units (1)	Offloading Units (2)
EAST COAST		
Boston	4/6	1/1
New York	3/5	1/1
Philadelphia	3/9	2/1
Portsmouth	6/9	1/0
GULF COAST		
Clearwater	3/5	1/2
Pascagoula	2/3	1/0
New Orleans	4/6	1/1
Sabine	2/3	1/0
Galveston	4/6	1/1
Port Aransas	2/3	1/0
WEST COAST		
Los Angeles	3/6	1/1
San Francisco	4/5	1/1
Seattle	3/5	1/1
Kodiak	2/3	1/0
GREAT LAKES, HAWAII, PUERTO RICO		
Chicago	1/2	1/0
Barbers Point	1/2	1/0
San Juan	1/2	1/0
TOTAL	47/74	18/10

Notes to Table:

(1) OWOCRS (skimmer-barrier)/Type F flexible barge.

(2) ADAPTS double stage pump/Type O flexible barge.

A unit of offloading equipment has such a high (over one million gallons) daily capacity that only one unit was recommended for all locations, except Philadelphia, where two units were recommended.

SITE CONFIGURATION CAPABILITY. Several analyses were performed to attempt to quantify the levels of success that the proposed site configuration would have if equipped with the major response equipment suggested. The criteria used for making the analyses were:

- Average response time
- Fraction of spills responded to in 6 hours or less
- Fraction of oil ports reached in 6 hours or less
- Fraction of historic spills reached in 6 hours or less

An effort was also made to determine the average fraction of oil that could be recovered from open water spill in 72 hours for various stockpile levels of equipment.

RESPONSE TIME MEASURES. The response time measures calculated for the recommended site configuration are given in Table II-3. It was assumed that at the combined land-water sites, the equipment was preloaded on tractor trailers adjacent to a launching area, and that when the spill occurred within 36 n. mi. of the site the equipment was transferred to a waiting sled for towing to the spill. The transfer time was estimated to be 30 minutes. The numbers in parentheses correspond to what the response time would be if equipment were already packed on sleds or vessels. A mean over the road speed of 37.8 mph was used for truck deliveries.

TABLE II-3 RESPONSE TIME MEASURES FOR RECOMMENDED CONFIGURATION

Site	Type	Avg. Spill/Yr	Avg. Response (hours)
EAST COAST			
Boston	L	1.133	4.01
Boston	W	0.301	1.95 (1.45)
New York	L	0.371	4.63
New York	W	1.786	1.84 (1.34)
Philadelphia	L	0.285	4.17
Philadelphia	W	5.067	1.85 (1.35)
Portsmouth/Norfolk	L	0.207	4.62
Portsmouth/Norfolk	W	0.406	2.38 (1.85)
GULF COAST			
Clearwater	L	0.038	4.09
Clearwater	W	0.089	2.07 (1.57)
Clearwater	A	0.995	5.26
Pascagoula	L	0.033	3.85
Pascagoula	W	1.120	2.24 (1.74)
New Orleans	L	1.078	3.62
New Orleans	W	2.705	1.83 (1.33)
Sabine	L	0.416	3.07
Sabine	W	0.880	2.20 (1.70)
Galveston	L	0.753	2.85
Galveston	W	0.275	2.16 (1.66)
Port Aransas	L	0.016	5.19
Port Aransas	W	0.742	1.24 (0.74)
WEST COAST			
Los Angeles	L	0.419	4.01
Los Angeles	W	1.189	1.91 (1.41)
San Francisco	L	0.086	3.61
San Francisco	W	1.150	2.33 (1.83)
Seattle	L	0.700	2.71
Seattle	W	0.300	2.42 (1.92)
Valdez/Anchorage	W	3.190	1.84
GREAT LAKES, HAWAII, PUERTO RICO			
Chicago	L	0.009	5.25
Chicago	W	0.135	2.04 (1.54)
Barbers Point	L	0.009	5.81
Barbers Point	W	0.177	1.88 (1.38)
San Juan	L	0.012	4.21
San Juan	W	0.082	1.83 (1.33)
TOTAL		26.176	2.53 (2.17)

TABLE II-3 (CONT'D)

INTERVAL	% OF OIL PORTS	% OF SPILLS
0.0 to 1.0 hr.	0.0	0.0
1.0 to 2.0	21.0	64.5
2.0 to 3.0	14.7	13.5
3.0 to 4.0	20.0	9.2
4.0 to 6.0	26.0	12.3
6.0 to 8.0	13.7	0.5
8.0 to 10.0	4.7	0.0
over 10.0	0.0	0.0

Percent of 1974-77 spills (greater than 50,000 gallons) within six hours of proposed sites = 90.0%. Percent of 1974-77 spills between 10,000 and 50,000 within six hours of the proposed equipment site locations = 88.5%.

The spill response times shown in Table II-3 are based on expected open water spills of heavy and crude oils in 1985. A nominal spill rate of 1.0/yr was assumed for Seattle, approximately twice the rate based on 1976 throughput. This accounts for possible increases in traffic resulting from Trans Alaskan Pipeline activities.

The mean value response time for the configuration can be shown to be 2.2 hours if some equipment is sled mounted, and the remainder is kept on tractor trailers. If all of the equipment is trailer mounted the mean response time becomes 2.5 hours. Calculations further indicate that 99.5% of responses to spills can be made in less than six hours. As a check, historical data shows that 89% of all spills greater than 10,000 gallons occurred within six hours of the proposed equipment sit locations. This accounts for 90% of all oil spilled in the coastal regions between 1974 and 1977. Another indication of the general coverage provided by the proposed configuration is given by the fact that 82% of the oil ports within the U.S. having an annual throughput of 1,000 tons (308,000 gallons) or more are located within six hours of the proposed sites. None of the remaining 18% are more than ten hours away. These data seem to indicate that the statistically derived 99.5% figure may be optimistic. Nevertheless, it also seems fair to indicate that at least 90% of expected future spills over 50,000 gallons should occur within six hours of the proposed site.

It is possible to plot past spills and locate sites so as to optimize the coverage to past spill locations. One can in fact achieve approximately 95% coverage of all past spills within six hours by using this method and the same number of sites that appear in the preferred configuration.

This would, however, result in more than a 50% increase in the average response time of the configuration. It also requires that equipment locations be widely dispersed. The selection of a configuration to minimize response time to the specific geographical areas of highest spill potential rather than to cover wide geographic areas should result in a greater volume of oil being recovered and is therefore preferred.

<u>SITE CAPABILITY LEVELS</u>. It is necessary to evaluate the overall response capability of the proposed site configuration before evaluating the capability of the system to respond to the various size spills. This is demonstrated in Table II-4, which indicates that the total 72 hour capability of the system for recovery is to collect 8,883,000 gallons of oil with 3,139,000 gallons of temporary storage available. For off-loading the total 72 hour capability is to offload 59,400,000 gallons, with 2,470,000 gallons of temporary storage available.

It is not considered reasonable to expect equipment to be delivered from Hawaii, San Juan, and Alaska when responding to incidents within the contiguous states. Available equipment levels should therefore be estimated from levels of equipment within the contiguous states (skimming 8.1M gallons, with 2.9M gallons storage, and offloading 49.5M gallons with 2.5M gallons storage).

TABLE II-4 RECOVERY CAPABILITIES OF RECOMMENDED EQUIPMENT DEVELOPMENT

Site Name	Site Type	72 Hour Capability (gallons) Skimming (000's)	Offloading (000's)
EAST COAST			
Boston	LW	756/258	3,300/247
New York	LW	567/215	3,300/247
Philadelphia	LW	1,134/387	6,600/247
Portsmouth	LW	378/86	3,300/0
GULF COAST			
Clearwater	LW, A	567/215	3,300/494
Pascagoula	LW	378/129	3,300/0
New Orleans	LW	756/258	3,300/247
Sabine	LW	378/129	3,300/0
Galveston	LW	756/258	3,300/247
Port Aransas	LW	378/129	3,300/0
WEST COAST			
Los Angeles	LW	567/258	3,300/247
San Francisco	LW, A	756/215	3,300/247
Seattle	LW	567/215	3,300/247
Kodiak	A	378/129	3,300/0
GREAT LAKES, HAWAII, PUERTO RICO			
Chicago	LW	189/86	3,300/0
Barbers Point	LW	189/86	3,300/0
San Juan	LW	189/86	3,300/0
TOTALS		8,883/3,139	59,400/2,470
CONTIGUOUS TOTALS		8,127/2,878	49,500/2,470

ASSISTANCE LEVELS. The recovery fraction defined above depends on the amount of assistance rendered site-to-site. Four levels of assistance were examined.

LEVEL 0, NO ASSISTANCE. In this case each site responds alone to those spills to which it is the closest in time via the mode(s) available at the site. For example, in some cases a spill location will be closest in time to the Clearwater, Florida air site, although it may be closer in distance to some other site.

LEVEL 1, LOCAL ASSISTANCE FROM IMMEDIATELY ADJACENT SITES. It is expected that for many spills adjacent sites will send assistance. For these purposes, Chicago, Seattle, Barbers Point, San Juan, and Alaska are not considered to be adjacent to any other site. Also, it is assumed in this case that Clearwater air will not assist any site except the Clearwater land/water. This does not preclude Clearwater from servicing spills at ports to which it is closer in time than any other site.

In calculating the recovery capability delivered by an assisting site, allowance was made for delivery of the equipment more than six hours after receipt of the On-Scene Coordinator's request. The amount of recovery capability received from another site was multiplied by the fraction of the 72 hour recovery period remaining at the time of arrival of the equipment. For calculation purposes the time of arrival was calculated on the assumption that the equipment was delivered by appropriate transport option to the equipment storage site of the region in which the spill occurred.

The recovery period was taken to commence at the 6th hour and extend to the 78th hour. Equipment arriving within the first 6 hours, therefore, was assumed to provide its full 72 hour capability, while equipment arriving at the 42nd hour was assumed to provide only one-half of its nominal 72 hour capability. Equipment arriving at the 78th hour or after was considered to provide no capability at all.

In the case of local assistance the adjacent sites are generally close enough so that the assistance coefficients just described are all close to unity. These coefficients are given in Table II-5.

TABLE II-5 LOCAL ASSISTANCF

Spill Site	Symbol	Assisting/Assistance Site/Coefficient
EAST COAST		
Boston	BO	NY/0.99
New York	NY	PH/1.00, BO/0.99
Philadelphia	PH	NY/1.00, PN/0.98
Portsmouth/Norfolk	PN	PH/0.98
GULF COAST		
Clearwater Land	CL	CA/1.00
Pascagoula	PG	NO/1.00
New Orleans	NO	PG/1.00, SA/0.98
Sabine	SA	NO/0.98, GA/1.00
Galveston	GA	SA/1.00, PA/1.00
Port Aransas	PA	GA/1.00
WEST COAST		
Los Angeles	LA	SF/0.93
San Francisco	SF	LA/0.93
Seattle	SE	
GREAT LAKES, HAWAII, PUERTO RICO		
Chicago	CH	
Barbers Point	BP	
San Juan	SJ	

NOTE: (1) CA = Clearwater air.

LEVEL 2, LOCAL ASSISTANCE FROM IMMEDIATELY ADJACENT SITES WITH AIR ASSISTANCE. In this case it is assumed that, in addition to the local assistance of Level 1, Clearwater provides assistance by air to all sites except Seattle, Los Angeles, San Francisco, Barbers Point and Alaska. The assistance coefficients employed for this case are given in Table II-6. It should be noted that all the assistance coefficients are above 0.90, except for the assistance from Clearwater air to San Juan.

LEVEL 3, COASTAL AND AIR ASSISTANCE. This case assumes that sites within 750 n. mi. of each other render mutual assistance, and that Clearwater air provides assistance to all sites except those on the West Coast and Hawaii. This essentially forms groups of mutually assisting sites along the East, Gulf and West Coasts. Because of the larger travel time some of the coefficients that result are as low as 0.75.

In this scheme, assistance from San Francisco to Seattle has a coefficient 0.77 via land and about 0.99 via air. Thus the total 72 hour capability available at Seattle is 1,004,000 gallons with the land assistance and 1,128,000 gallons with air assistance from San Francisco.

The complete set of assistance coefficients employed for coastal and air assistance is given in Table II-7. Once again it is seen that almost all the coefficients are greater than 0.75, indicating that, with land transport, equipment movement along the coasts is quite efficient.

TABLE II-6 LOCAL AND AIR ASSISTANCE

Spill Site Symbol	Assisting/Assistance Site(s)/Coefficients
BO	NY/0.99, CA/0.96
NY	PH/1.00, BO/0.99, CA/0.97
PH	NY/1.00, PN/0.98, CA/0.98
PN	PH/0.98, CA/0.99
CL	CA/1.00
PG	NO/1.00, CA/1.00
NO	PG/1.00, SA/0.98, CA/1.00
SA	NO/0.98, GA/1.00, CA/0.99
GA	SA/1.00, PA/1.00, CA/0.99
PA	GA/1.00, CA/0.98
LA	SF/0.93
SF	LA/0.93
SE	
CH	CA/0.97
BP	
SJ	CA/0.55

NOTES: (1) See Table II-5 for site named corresponding to symbols.

TABLE II-7 COASTAL AND AIR ASSISTANCE

Spill Site	Assisting/Assistance Sites(s)/Coefficients
BO	PH/0.94, NY/0.98, PN/0.85, CA/0.96
NY	PH/1.00, BO/0.98, PN/0.93, CA/0.97, CH/0.75
PH	NY/1.00, BO/0.94, PN/0.96, CA/0.98, CH/0.77
PN	PH/0.96, NY/0.93, BO/0.85, CA/0.99, CH/0.76
CL	NO/0.85, PG/0.89, SA/0.75, CA/1.00
PG	NO/1.00, GA/0.87, SA/0.91, PA/0.81, CL/0.89, CA/1.00
NO	GA/0.92, PG/1.00, SA/0.96, PA/0.86, CL/0.85, CA/1.00
SA	NO/0.96, GA/1.00, PG/0.91, PA/0.96, CL/0.75, CA/0.99
GA	NO/0.92, PG/0.87, SA/1.00, PA/1.00, CA/0.99
PA	NO/0.86, GA/1.00, PG/0.81, SA/0.96, CA/0.98
LA	SF/0.88
SF	LA/0.88, SE/0.77
SE	SF/0.77
CH	PH/0.77, NY/0.75, PN/0.76, CA/0.97
BP	
SJ	CA/0.55

NOTE: See Table II-5 for site names corresponding to symbols.

LEVEL 4, ALL SITES AND AIR ASSISTANCE. The assistance potential on a national scale from all sites without recourse to DOD aircraft was computed, using the same decision rules as for Level 3 assistance, but without the 750 n. mi. constraint on distances. Almost every site in the country renders and receives substantial amounts of assistance from one or more sites, with some coefficients as low as 0.01. (The coefficients are not tabulated here).

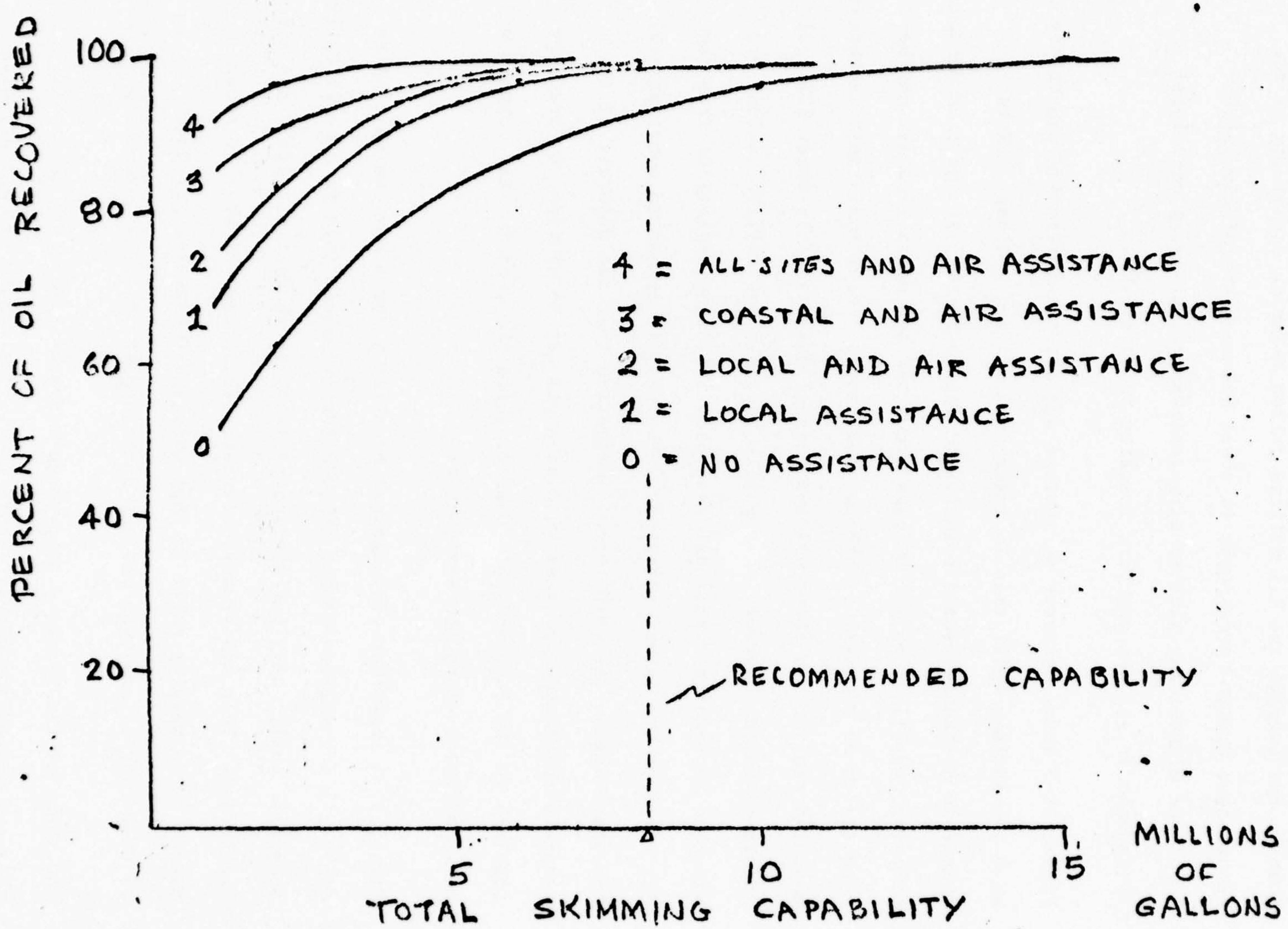
MAXIMUM NON-MASSIVE SPILL. In deriving the recommended configuration it was assumed that the maximum non-massive spill is one million gallons. The effect of this assumption on the calculated percent of oil recovered should be explored. It is expected that for a given recovery capability, the percent recovery will increase as the maximum spill size decreases. Accordingly, maximum spill sizes of eight million and thirty million gallons were also tried with different levels of assistance.

RESULTS. The percent of oil recovered was calculated as a function of total skimming capability, for different levels of assistance. The relative distribution of skimming capability shown in Table II-2 was retained, while the total contiguous capability (shown as 8,127,000 gallons in Table II-4) was varied from 2,000,000 gallons to 80,000,000 gallons. Skimming capability was chosen as the independent variable because it is far more expensive per gallon than offloading. Also it requires more elaborate logistics than offloading.

Figure II-2 shows recovery percentage on the vertical axis vs skimming capability on the horizontal axis, with assistance level as parameter.

FIGURE II-2, RECOVERY VS CAPABILITY

MAXIMUM SPILL = 1 MILLION GALLONS



The maximum spill size is taken to be 1 million gallons. It is seen that on the average the 8.1 million gallon skimming capability of the recommended system corresponds to about 93% recovery of the spilled oil, even without any site-to-site assistance. Allowing only local assistance brings the recovery fraction to about .99.

Figure II-3 shows recovery percentage against total skimming capability when the maximum spill size is taken as 8 million gallons. (Note change in horizontal scale relative to Figure II-2). At the recommended skimming capability on the average about 59% of the spilled oil can be expected to be recovered, with no assistance. Local assistance increases expected recovery to about 69% and coastal assistance to about 82%. It should be noted, however, that spills beyond a few million gallons are expected to require a national response, including assistance from the Air Force to the extent necessary. The results appear to substantiate the statement in the main report indicating that the majority of the required assistance for massive discharges can be provided by tractor-trailers on the East and Gulf Coasts, while the need for air support will be significant along the West Coast.

Figure II-4 shows recovery against capability for a maximum spill size of 30 million gallons (about 100,000 tons). Since this is unequivically a massive spill, only one assistance level is shown: all sites and air assistance. This assistance, however, falls short of what is recommended for a massive spill in that only the Clearwater Air Base (4 C130 B'S) is employed and the USAF support is not allowed for.

The shape of the recovery percentage curve is similar to the spill volume distribution curve, Figure II-1. The Figure shows that, with

FIGURE II-3, RECOVERY VS CAPABILITY

MAXIMUM SPILL = 8 MILLION GALLONS

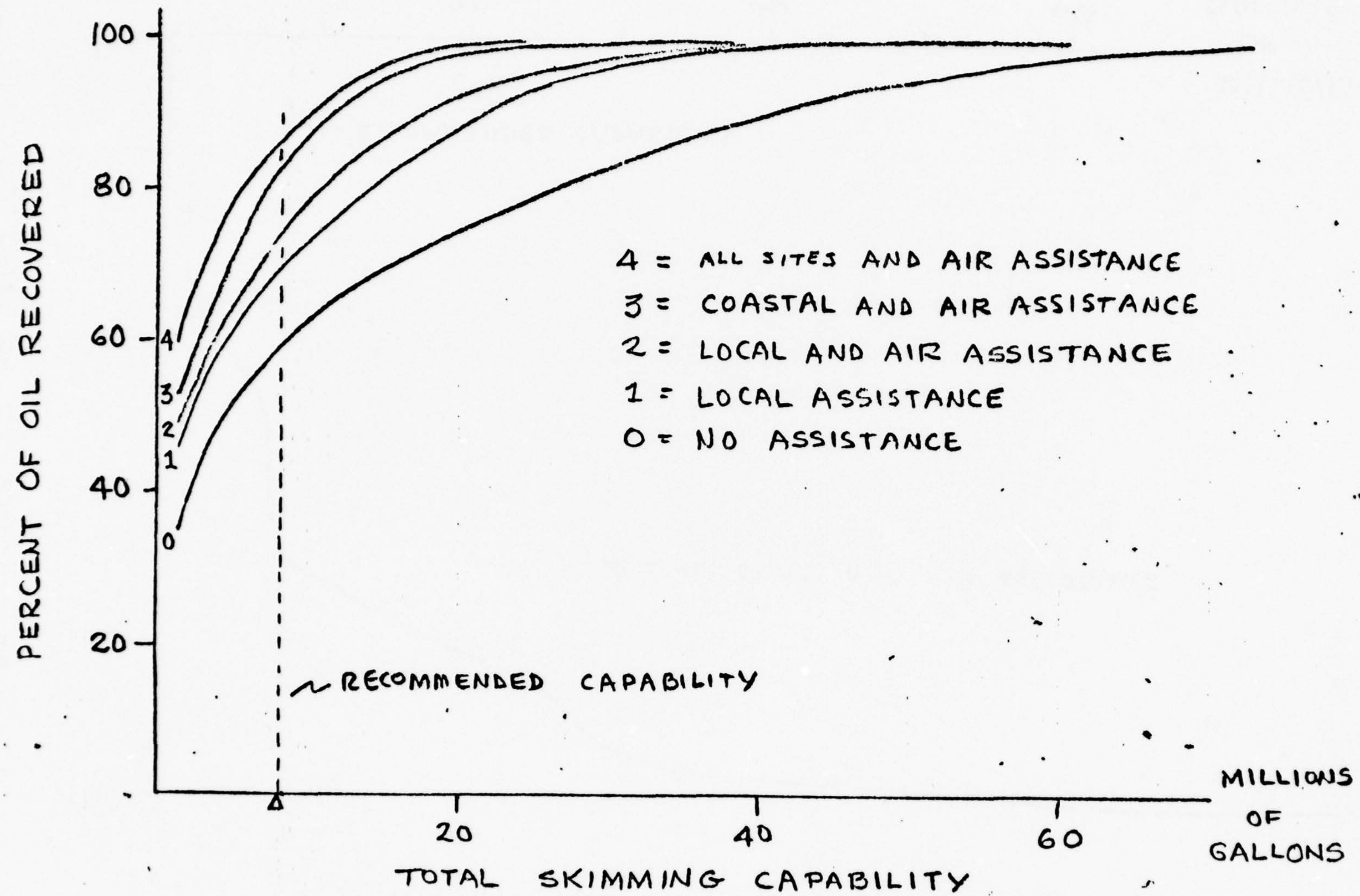
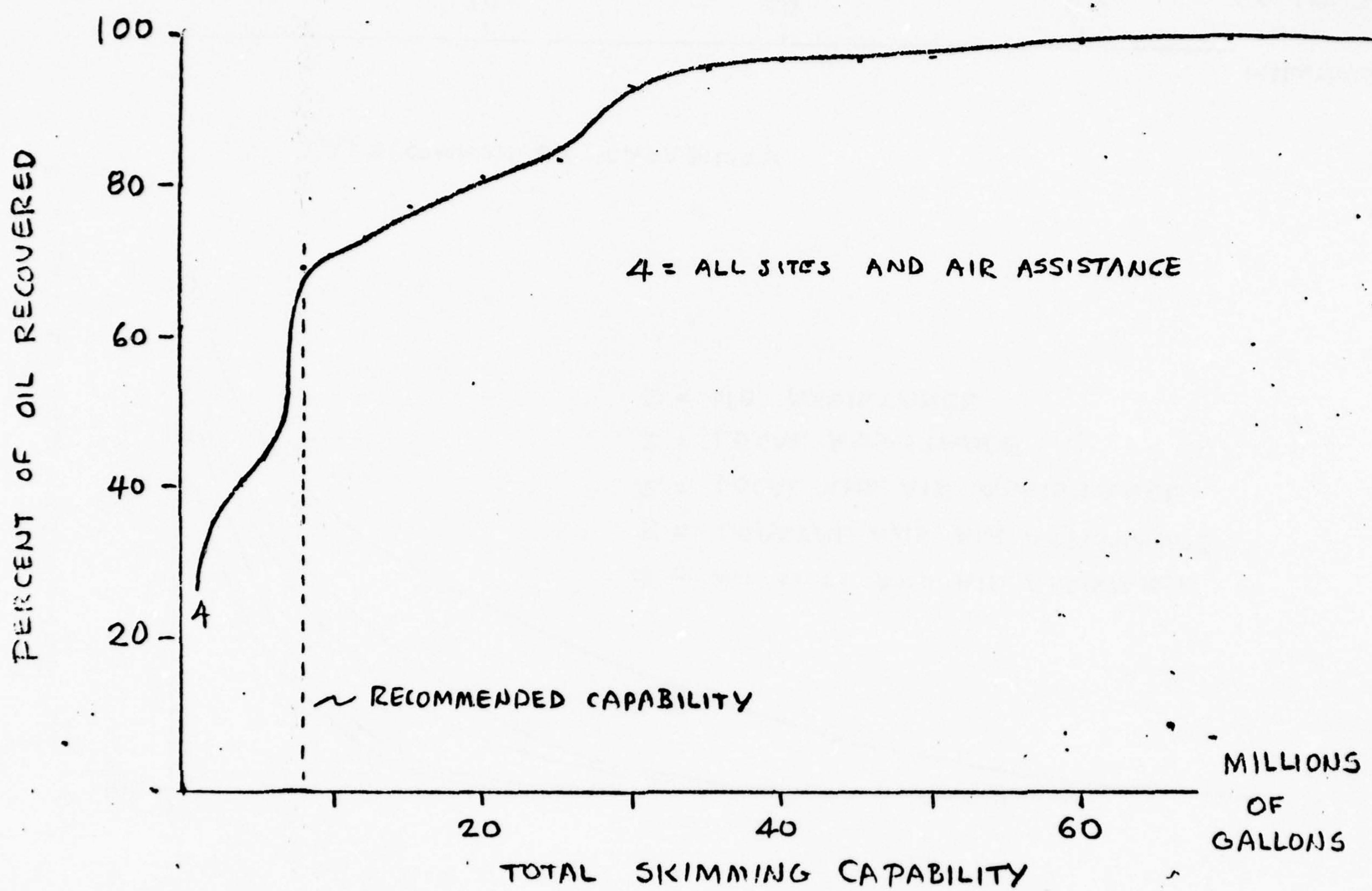


FIGURE II-4 RECOVERY VS CAPABILITY

MAXIMUM SPILL = 30 MILLION GALLONS



level 4 assistance, the recommended skimming capability corresponds to about 68% oil recovery. As stated in the main report spills of this size should involve crude oil rather than product. Because of the evaporation rates of crude oils and expected dispersion, it is very unlikely that more than 50% of a massive discharge of crude oil would be available for recovery. The recommended level of equipment is therefore considered to be sufficiently high to meet the threat posed by such a discharge.

Alaska, Hawaii, and Puerto Rico have been given little attention in this analysis. This is due to the fact that the Task Force concluded that large airlifts using DOD facilities would be the only feasible way to respond to a massive discharge in these areas. The only alternative would be to maintain large stockpiles in these locations, solely to meet the massive spill threat. Such actions are not considered reasonable because the probability of a massive discharge occurring at any one location is sufficiently low that it is unreasonable to maintain inventories of equipment solely to offset this threat. Further, it is very likely that the needed air support can be provided by the Air Force if and when it is required.

OTHER EQUIPMENT REQUIREMENTS

FAST CURRENT. Fast current oil recovery skimmers will be required in locations where a spill threat exists and currents can be expected to routinely exceed two knots. The skimmer identified for this purpose is the zero relative velocity (ZRV) unit currently in the prototype construction, test, and evaluation stage. The unit is a self-propelled catamaran and is expected to serve as a harbor skimmer, as well as function in currents up to eight knots.

HARBOR SKIMMING. Additional harbor skimming capability has been included in those locations in which the National Inventory of response equipment indicated an insufficient harbor skimming capability existed. Several commercially available systems can meet this requirement. One of the larger type self-propelled units is included in the proposed inventory to meet this need.

TRACTOR TRAILERS. Land transport flatbed trailers are necessary for the rapid transport of equipment. It is proposed that the equipment be stored on these flatbed trailers ready for immediate dispatch. Air transportable trailers are also required for the rapid mobilization of equipment into aircraft. The latter are lowboy trailers that can be directly loaded into C130 and C141 aircraft. They eliminate the interface problems between flatbed trailers and aircraft cargo decks. Air transportable trailers will be located at Clearwater, San Francisco, and Kodiak. The air transportable trailers are currently being manufactured under a Coast Guard contract. Tractors for both types of trailers are provided based on the total amount of equipment at the site, with a maximum of two tractors at any one site.

FAST SURFACE DELIVERY SLEDS. Water transport to the spill location will be provided by the Fast Surface Delivery Sled and supplemented by any buoy tender which may be available at the time of the pollution incident. The sled can be towed by a wide variety of cutters. A maximum of three sleds is provided at any site, with lesser amounts being provided depending on the amount of equipment at the site. The sled provides the assurance that a minimal number of water transport vehicles will be available for transport of equipment to the spill site.

MISCELLANEOUS EQUIPMENT. The following support equipment is proposed for each site: mobile, highway capable crane of approximately 20 ton capacity; zodiac inflatable boat; command post, built around a step-van type vehicle; passenger van; 20 ft. boat and trailer; OWOCRS handling system, for cleaning and repacking of the OWOCRS; a four wheel drive truck; and, a small equipment trailer.

The mobile crane provides the ability to unload the trailers and deploy the various equipment at any waterfront facility with adequate water depth for the support vessels and with adequate road access for heavy loads. This is expected to greatly enhance the timeliness of the operation be allowing a widely expanded choice of debarkation sites and by insuring the availability of a reliable lift capability and operator.

Table II-8 lists all equipment (except cold weather items) required at each site to outfit the proposed response system (after hardware in existing Coast Guard inventory or contracted for is accounted for). Cost estimates are unit acquisition costs, in 1978 dollars. $30.1M is required to procure the needed hardware. Support costs are addressed elsewhere in this document.

Maintenance of pollution control equipment is considered to be 2½% of total acquisition cost per year. This figure includes allowance for routine maintenance costs directly associated with the operation of the equipment, i.e. bag and boom cleaning. An additional 2½% of total acquisition cost must be allocated for damage occurring during operation of the equipment. Thus, anticipated annual maintenance costs for this pollution hardware are $1.9M.

TABLE II-8 TOTAL EQUIPMENT REQUIREMENTS

Hardware	Unit Cost	Total Amount	Total Cost	Existing Hardware	Total for New Acquisition
Van	10,000	16	160,000	0	160,000
4 WD Drive	10,000	16	160,000	0	160,000
Trailered boat	10,000	16	160,000	0	160,000
Forklift, 6K lb	10,000	16	160,000	0	160,000
Equipment Trailer	2,000	16	320,000	0	320,000
Zodiac	4,000	17	680,000	0	680,000
Mobile crane	125,000	17	2,125,000	0	2,125,000
Harbor Skim	250,000	5	1,250,000	0	1,250,000
ZRV	800,000	11	8,800,000	1	8,000,000
Sled	80,000	37	2,960,000	12	2,000,000
ADAPTS	60,000	18	1,080,000	18	0
Bag-O	236,000	10	2,360,000	3	1,652,000
Command Post	15,000	17	255,000	0	255,000
OWOCRS	150,000	47	7,050,000	26*	3,150,000
Moor System	2,500	44	110,000	16	70,000
Hand System	55,000	17	935,000	3	770,000
Bag F	86,000	76	6,536,000	6	6,020,000
Prime Mover	31,000	47	1,457,000	0	1,457,000
Flatbed Trailer	12,000	53	636,000	0	636,000
Tractor	45,000	24	1,080,000	0	1,080,000
Air Trailer	12,000	16	192,000	16	0
Air Dolly	4,000	16	64,000	16	0
	Total System Cost:		38,530,000	Total Acq. Cost:	30,105,000

*26 OWOCRS will be funded by FY 79, of which only 3 have already been converted to OWOCRS. Remaining 10 will be converted, and 10 new ones purchased in FY 79.

COLD WEATHER CONSIDERATIONS. Sub-arctic response equipment will be required at three locations; Kodiak, Chicago and Philadelphia. This equipment will supplement the harbor and open water capability at these locations so as to permit a response effort to be mounted in cold weather climates, and ice infested waters. The equipment is intended to meet regional rather than local needs. One suite of equipment is proposed for each site and will permit 10,000 gallons of oil to be recovered per day. Table II-9 is a list of the equipment in the sub-arctic package. Each equipment suite costs $884K. An additional $50K will be needed to purchase special equipment for diving in sub-arctic waters. Maintenance is estimated at 5% ($135K) per year of acquisition costs.

TABLE II-9

EQUIPMENT REQUIRED TO ACHIEVE A 10,000 GAL/DAY SUB-ARCTIC RESPONSE CAPABILITY AT ONE SITE

Sub-system	Item	No req's	Specification	Cost
Surveillance	Surface markers	200	Buoyant, disposable	4K
Containment	Conventional heavy duty boom suitable for use in ice fields	2500 ft	Inflatable cold weather type	50K
Recovery	Arctic boat skimmer	1	Cold weather oil recovery system	450K
	Oil mop	2	Mark II-4H	1K
	Crane barge	1	Clamshell or dragline on 4,000 yd^3 barge	NOT PURCHASED BY CG
	Skimmer heads	4		4K
	Vacuum trucks	4		NOT PURCHASED BY CG
Storage	Tank barge	2	1-10,000 bbl, 1-15,000 bbl	NOT PURCHASED BY CG
	Bladder tanks-1,000 gal	4	1000 gal	
Transfer	ADAPTS pumping	1	1000 gpm at 32 ft disch head	Already in inventory
	Portable pumps	2	200 gpm, 10 ft suct, 150 ft disch, self priming	5K
	Steam generator	2	9MBTUH ea	300K
	Hoses	20	50 X 6"	10K
Logistics	Tugs, C-130, Helicopter icebreaker, small boat			Already in inventory
Other	Special clothing	50 sets	Low temp oil resistent	25K
	Portable shelter	1	8 man portable shelter	10K
	Portable heater	2	100,000 BTU	1K
	Portable generator	2	3KW	15K
	Emergency personnel locater beacon	15	EPIRB	3K
	Ice kit-chain saw	3	4' bar saw, 6' X 9" auger bit	6K
				884K

III SUPPORT REQUIREMENTS

Site Personnel Requirements. The TSC report did not contain an analysis of personnel requirements. The Task Force's computation of site personnel requirements was based on the belief that a six hour response could not be mounted unless a minimum level 24 hour watch was maintained at each equipment site. The watch personnel would be responsible for mobilizing the equipment and putting it into operation at the scene of the incident.

A four (4) person watch configuration (used for the larger sites) is considered to be the minimum number of personnel required to marshal and deploy site equipment efficiently and to provide operating expertise for deployment and use of equipment. This size group will need to be complimented when deploying a skimming barrier. However, since support boats/cutters will also be needed, additional personnel should be available for this purpose.

In order to provide some personnel savings, sites with one or two skimming barriers were reduced to a 3 man watch. This represents a compromise between the number of personnel needed and the fact that these sites are less likely to have to respond to the larger spills. To man a "4 man" watch requires 16 personnel (based on 2,250 man hrs/may yr). Adding 1 SK, an enlisted supervisor, 1 staff officer and adjusting for the 17% general detail factor yields the total personnel strength of 22. For a "3 man" watch, the total is 17.

The 3 fast current recovery unit (ZVR) sites would not be manned on a full time basis. Four new personnel are provided, two for maintenance of equipment and two operators, to each of these sites. In the event of a discharge, it is intended that the host unit will deploy and place the vessel in operation while simultaneously requesting assistance from the National Strike Force.

Personnel to man sites total to 333; with 9, 22 man sites; 7, 17 man sites; 3, 4 man ZRV sites; and 1*, 4 man sites.

Although the new personnel are being provided to insure a rapid response to the larger sized discharges, they will also be available to respond to smaller discharges of oil, perform routine equipment maintenance, and will provide a nucleus for developing an expertise in chemical response within each Emergency Port Task Force. The latter field being one where we are only just beginning to become involved in.

Impact on National Strike Force. There may be some question upon review of the main report as to what the role of the National Strike Force (NSF) would be once Emergency Port Task Forces (EPTFs) called for in the proposed response network are put in place.

The number of personnel to be assigned to each EPTF is only sufficient to provide a 24 hour watch to insure that equipment can be transported to the scene of an incident upon notification of need. These people will also initiate response action. Supplementary personnel would be needed to sustain the operation and must either be drawn from the MSO or an alternate source. If these personnel are to come from the MSO for any period of time, it will no longer be possible for that command to maintain a continuous watch or respond to other events occurring within the area. It is therefore considered necessary to continue the National

*Kodiak only delivers equipment by air and is therefore only assigned maintenance personnel.

Strike Force for the purpose of supplementing the EPTFs during extended response efforts. As a rule, it is expected that EPTFs will need to be supplemented by members of the NSF whenever a response effort is expected to extend beyond a period of two days.

The National Strike Force will also be needed to respond to pollution incidents in the areas where EPTFs have not been established. In addition, periodic training and evaluation of EPTFs and MSOs without EPTFs must be accomplished. Use of the NSF for accomplishing this is also considered appropriate.

As a result of the added training duties of the NSF as well as the establishment of an open water recovery capability, the workload of the NSF should increase rather than decrease with the establishment of the proposed response structure.

Six additional personnel should be added to the National Strike Force to allow for anticipated increases in requirements to provide training and evaluate other units, to provide personnel to supplement field response efforts, and to accomplish required planning for responding to massive pollution incidents.

The need for planning the response to a massive spill also appears to be a task which is better suited to be addressed by the National Strike Force than by any one Federal On-Scene Coordinator. The NSF should therefore be tasked with maintaining a plan for response to massive incidents. A synopsis of these and other anticipated functions of the NSF is included as Figure III-1.

The spill threat analysis performed by the Transportation Systems Center (TSC) indicates that the majority of major discharges are expected to occur on the east coast in the vicinity of Philadelphia, and on the gulf coast in the vicinity of New Orleans.

The process used for determining locations for siting equipment and the amounts of equipment to be placed at each location was intended to reduce the amount of time required to mount a response effort to spills occurring at the most probable locations for major pollution incidents. It would likewise seem that the Strike Teams for each coast should be located so as to minimize the time required to respond to incidents occurring at the most probable locations for major events. Further, the present locations of the Atlantic and Gulf Strike Teams are not sufficiently close to major airports to permit the teams to take full advantage of commercially available air transport.

It is therefore recommended that the Atlantic and Gulf Strike Teams be relocated to the general areas of greatest spill potential on their respective coasts, Philadelphia and New Orleans. The spill threats on the west coast are not considered sufficiently concentrated to indicate that a shift in the location of Pacific Strike Team from San Francisco is merited. $1.2 M is required to move the Atlantic and Gulf Strike Teams.

The need for a rapid response which will ensure a prompt evaluation of the condition of a stricken vessel was stressed in several of the studies accomplished in support of this effort. While all members of the Task Force agree that the Coast Guard should look to the U.S. Navy Supervisor of Salvage for support in salvaging vessels, there is an urgent need for performing a rapid assessment of the situation to determine what the alternatives are to avoiding the discharge of all or the majority of the cargo. The National Strike Force appears to be the logical group to make the rapid assessment. To do so requires that the Teams develop and maintain a high level of expertise in diving, and some expertise in salvage operations.

Past experiences have led the Task Force to conclude that it is unrealistic to expect each team of the Strike Force to maintain an expertise in response to discharges of oil and hazardous chemicals, as well as a high level of proficiency in diving. Further, the growing awareness of the widespread problem of chemical wastes will result in an added emphasis in this area in the near future. When this is compounded with the added work load that the oil response program will generate if the initiatives are implemented, it will become even more difficult for any team to maintain an expertise in all areas. It is therefore recommended that the National Strike Force be reorganized so that there is a team on each coast having the general responsibilities outlined in Figure III-1, but without diving capability and one additional team that will provide all diving and salvage expertise required to support response efforts, maintain the necessary liaison with the Supervisor of Salvage, and provide for NSF participation in research and development efforts performed in cooperation with the Supervisor of Salvage. To accomplish this, 25 new billets must be added to the NSF.

One additional change is required to establish a more effective NSF. A change is needed because the present mechanisms for exercising administrative and operational control over the strike teams are in need of improvement in:

a. Identifying and documenting operational techniques for deploying response equipment.

b. Developing future operational equipment needs of the NSF.

c. Insuring that individual strike teams are maintaining adequate levels of expertise in response techniques.

d. Evaluating training being provided to MSOs by strike teams.

e. Coordinating training and planning between teams so that the NSF can function as the nucleus from which to respond to a spill of massive proportions.

To improve this situation, it is recommended that CO and XO NSF billets be established, and the NSF become a Headquarter's Unit. It is not envisioned that either billet would be operational in the sense that the CO of each strike team would still respond to render advice and assistance to OSCs, as they do now. However, CO and XO NSF would oversee these efforts to determine how to improve the status quo as well as accomplish the types of things indicated above and in Figure III-1. They would also coordinate efforts requiring the expertise of more than one team. Direct engineering support for the strike teams would continue to be provided by Headquarters (EOE).

DUTIES OF THE NATIONAL STRIKE FORCE

1. Supply personnel to supplement EPTFs in MSO response efforts.
2. Supply personnel to provide advice and assistance to OSCs during pollution incidents.
3. Develop and improve operational response techniques and procedures.
4. Train and evaluate capabilities of Emergency Port Task Force.
5. Develop strategies and perform appropriate coordination for dealing with responses to massive spills.
6. Assess need for regional/national contracts to provide services in support of pollution response program.
7. Coordinate requests for equipment shifts between regions to meet response requirements.
8. Support Pollution Response R&D program.

Figure III-1

NATIONAL STRIKE FORCE

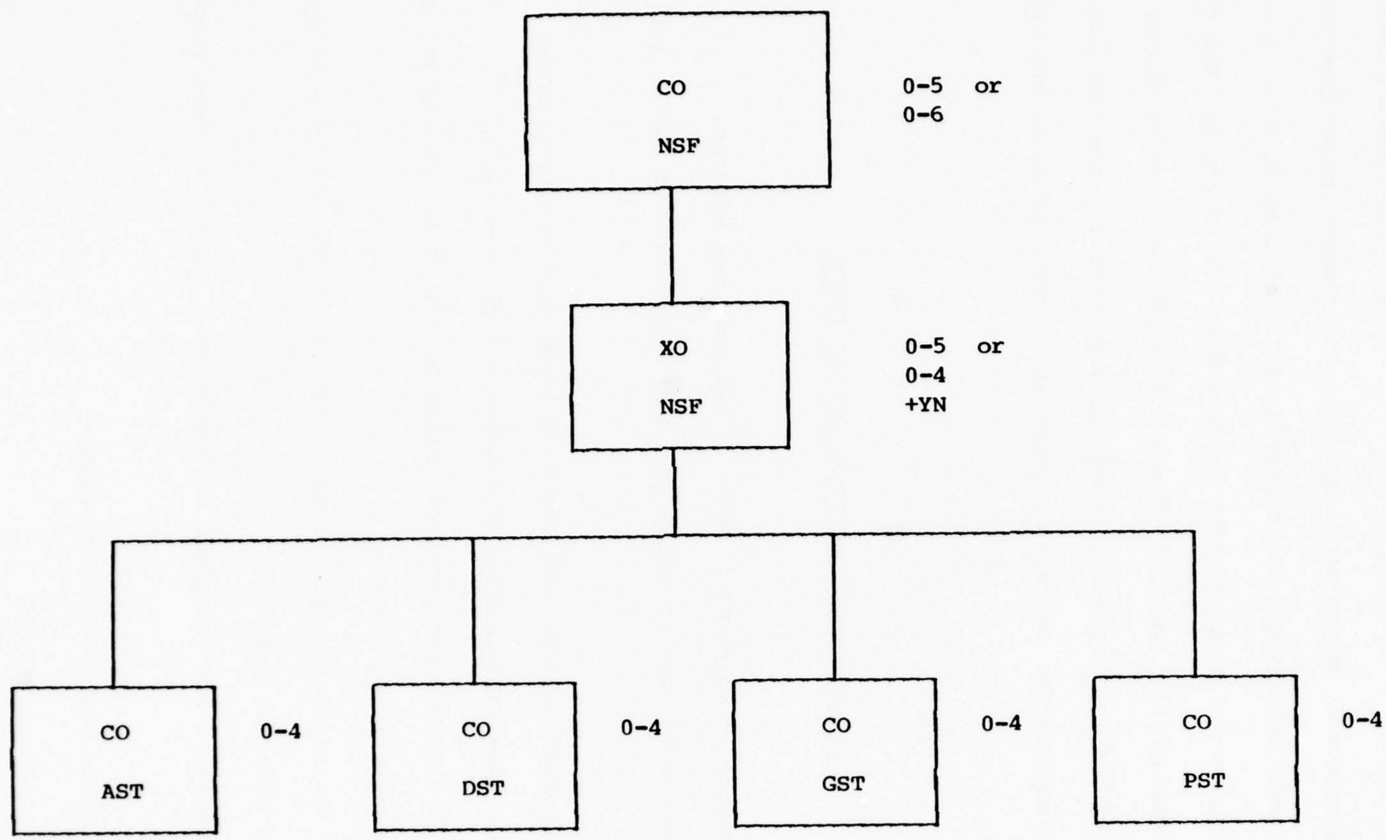


Figure III-2

Support Personnel Requirements. Additions are also needed to the various support staffs in order to be able to implement the response goals stated in the Presidential Initiatives. The areas that will require augmentation are as follows: At the Headquarters level, G-EOE, G-ECV, G-DOE, G-FCP, and G-WEP will each require additional manning. Engineering and Contracting will require a temporary augmentation (AC&I positions) to accomplish the initial buy and then follow-on permanent OE personnel to manage and support the response system. The 3 year time frame for completion of the project dictates the AC&I manning requirements. To establish and equip the sites in 3 years G-EOE, G-ECV, and G-FCP would require seven, fourteen, and four, AC&I personnel respectively. At the completion of the 3 year time frame, G-EOE would require four OE positions, G-ECV one, and G-FCP two. G-DOE would require an increase of ten R&D positions throughout the R&D effort. G-WEP would require two OE positions as soon as the project was undertaken.

At the district level, the most significant impact will be on the engineering support staff as the equipment inventories will require a continuing maintenance support effort. To provide for this district EOE billets, should be established as follows: First - 1; Third - 2; Fifth - 1; Seventh - 1; Eighth - 2; Ninth - 1; Eleventh - 1; Twelfth - 1; Thirteenth - 1; Seventeenth - 1. (12 total).

The establishment of the Emergency Port Task Force will also require that a more advanced level of hands-on pollution response training be accomplished at the Marine Safety School in Yorktown. The estimated annual impact will be to train 180 personnel for a two week period. This will require six additional instructors, a one time $300,000 training equipment purchase, a maintenance/storage facility at $125,000 and two personnel to maintain the equipment.

An additional support consideration is the need to develop and implement a maintenance/inventory system similar to SICP to provide for support of the extensive pollution equipment which will be purchased. Two personnel will be required for this program.

Impact on Shore Facilities. The shore facilities necessary to support this equipment and the associated personnel were developed in a three step process.

1. A functional facility model was developed based on operating criteria.
2. The model was costed by assigning costs to the various functional elements.
3. The specified equipment locations were compared to the model to identify probable facility deficiencies and related costs. The total of these deficiencies identifies funds which are required to provide facilities for the program.

Shore facilities planning for the Coast Guard is by necessity a decentralized field effort. Dollar figures and concepts presented in this report must therefore be considered subject to modification based on local site condition and field operating situation. Where possible, utilization of existing multi-use facilities will be made to minimize essential costs.

The operation and use of the facility in actual spill situations will represent only a fraction of the time available. Primarily, equipment will be on a standby, well maintained, ready to go status at the shore facility.

The characteristics of these shore facilities will have significant impact in terms of response time, reliability of equipment, training and morale of operating personnel.

The primary operating criteria used in developing the shore facilities model included:

waterfront location

3-4 man continuous watch

½ - 1 hr "launch" response

boom cleanup area

helipad

equipment stored "ready to go" on flatbed trailers - outside storage

spill equipment maintained in house

vehicle/crane maintenance by contract.

The typical facility is schematically shown on Figure III-3. Equipment is stored on flatbed trailers "ready to go" for land transport. A highway capable mobile crane is provided for loading and launching needs at the facililty, or offloading trailers at debarkation points. Sleds are not highway transportable, and therefore are stored dockside and must be launched and towed to the debarkation point. A continuous watch is provided in order to respond by land or water in the short time from allowed. Waterfront facilities are required at sites, as all sites are capable of responding with a minimum suite of equipment via land or water, and sleds must be launched via water. Additional costs were developed for billeting (i.e., family housing, BEQ, subsistence and quarters) based on the prevailing situation at each location. Community services were considered at locations where personnel increases represent a significant percentage of the existing Coast Guard population. Total shore facilities AC&I costs are $11.5M, with a recurring OE expense of $450K.

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FIGURE III-3

TYPE X RESPONSE FACILITY

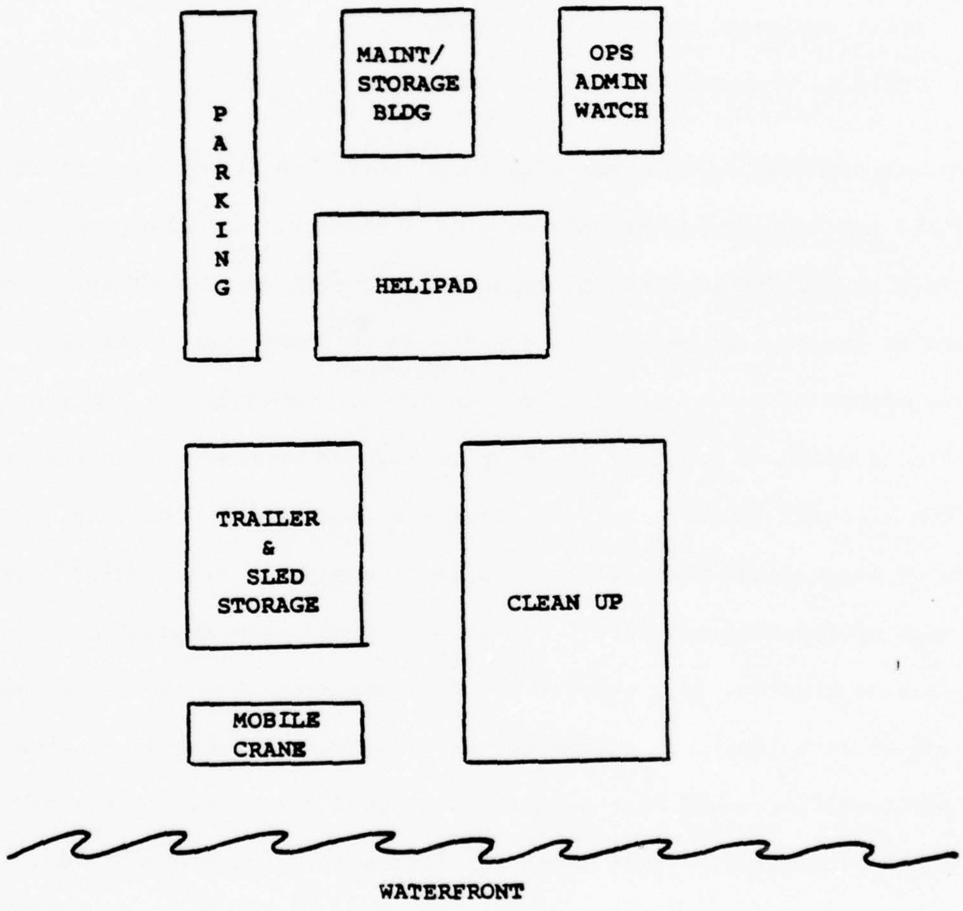

TABLE III-1

FUNCTIONAL SHORE FACILITY REQUIREMENTS

LOCATION	Site Acquisition	Storage Pad	Clean up Facility & Site Utilities	Waterfront Improvement	Helipad	OPS/Admin Watchstand Berthing	Maint/Storage Building	Parking	Addn'l Family Housing: Own	Addn'l Family Housing: Lease	BEQ	% Increase in Population	Community Services	
Philadelphia	1	1	1	1	1	1	1	1	0	6	0	15		
New York	0	1.3	1.3	0	0	0	1.3	0	0	6	13	1		Includes ferry trip to mobilize by highway geographic cost factor of 1.3 used
New Orleans	1	1	1	1	1	1	1	1	0	6	0	9		
Sabine	0	1	1	0	1	1	1	0	0	10	11	50	50K	Due to population impact funds for some type of Community Service added
Portsmouth	0	1	1	0	1	0	1	1	0	5	0	4		
San Francisco	0	1.2	1.2	0	1.2	0	0	0	0	0	10	3		TRACEN Alameda assumed site 1.2 geographic cost factor used
Galveston	0	1	1	0	0	0	1	0	0	12	0	10		
Pascagoula	1	1	1	1	1	1	1	1	0	5	11	100	50K	Population doubled, impact funds for Community Services added
Port Aransas	1	1	1	1	1	1	1	1	12	0	13	50	50K	Due to population impact funds for some type of Community Services added
Los Angeles	1	1	1	1	1	1	1	1	0	6	0	10		
Boston	1	1	1	1	1	1	1	1	0	6	10	2		
Seattle	0	1	1	0	1	0	0	0	2	4	0	3		
Chicago	0	1	1	0	0	1	1	0	0	5	0	20		
Clearwater/St. Pete	0	0	1	0	0	1	1	0	0	0	9	5		
Alaska	0	0	2.5	0	0	0	0	0	1200	0	520 K	2		Assumes SUPRTCEN Kodiak geographic cost factor is 2.5
Hawaii	0	1.4	1.4	0	0	1.4	1.4	0	0	0	0	4		Geographic cost factor is 1.4
Puerto Rico	0	0	1.6	0	0	1.6	1.6	0	0	0	264 K	13		
Total Elements	6	14.9	20	6	10.2	12	15.3	8.6	-	71	77*		3	
"Unit" Cost per Element	200K	10K	110K	150K	30K	30K	125K	25K	60 K	1.2K	15K		50K	
Cost for Element	1200K	150K	2200 K	900K	310K	360K	1810K	215 K	2040 K	35K OE	1940 K		150K	Total AC&I = 11,445K (includes outfitting @ 10K/site)

Annual OE = 450K   OE 30 & 43

Lease Housing = 85K

NOTE: Elimination of functional element will not necessarily provide equivalent savings.
Changes in functional needs will require reevaluation of entire model.

* + Outside CONUS

Massive Spill Response Planning. The analyses developed in the Transportation Systems Center (TSC) report for studying massive spill response requirements point out the importance of preplanning the response to such an incident.

Detailed contingency planning thus far has been left to each Federal On-Scene Coordinator (OSC). Each OSC has in turn developed a plan to varying degrees of sophistication for responding to pollution incidents in his area of responsibility. The sum total of these plans would not prove to be useful in responding to a massive spill, for a massive spill response will require that equipment and personnel be called in from around the country over a very short period of time. For this reason, planning the response for a massive discharge should be performed on a national level.

To be useful, the plan must outline where equipment will be taken from; develop the strategies to be followed for moving equipment; indicate the amounts of and times when equipment and personnel will be required for responding to the various sized threats; and the contacts through which resources of the various governmental agencies, and private and commercial concerns can be accessed.

Should the 6 hour response and 100,000 ton goals be implemented, the proposed reorganization of the National Strike Force (NSF) will provide a mechanism for maintaining plans for responding to massive spills. It should also provide the nucleus staff for launching such an effort whenever the plan is implemented. Each OSC would be familiar with the plan. Once deciding that such a situation existed, the OSC would notify the commanding officer of the NSF who would initiate the response effort to the extent directed. CO NSF would then travel to the scene with a staff to direct the logistical aspects of the response and provide advice to the OSC as to how to plan strategies for launching the response effort.

It is equally important that the plan be periodically tested. To accomplish this, it will be necessary to develop detailed scenarios for drills which will mobilize sufficient amounts of equipment and personnel and exercise standby service contracts to the extent necessary to determine the effectiveness of the plan and point out its weaknesses. Drills of this sort are considered to be as essential as the planning effort itself.

The development of a massive spill plan is considered to be an 18 man month effort. Annual funding required to support massive spill drills is estimated at $300,000.

The National Inventory System was discussed in the introduction to the main report. As previously indicated, the system was established to determine the amount of response equipment available in the commercial, private, and governmental sectors. This information system is ideal for rapidly accessing large amounts of equipment for mounting responses to the larger non-massive and massive discharges. It is therefore considered necessary to maintain the system for both uses. The system will require $60K annually to operate and maintain.

Characteristics Necessary for Future Coast Guard Aircraft and Cutters to Support the Marine Environmental Protection Program. The main report indicates that a number of Coast Guard cutters, small boats, and aircraft will need to be modified and that future procurements will have to incorporate those characteristics required to support the marine environmental protection program if adquate numbers of support platforms are to be available to mount responses to the larger sized spills. The following is a brief summary of the characteristics that are needed in the various support modes.

A. Transport Aircraft

1. As a minimum, have the cargo carrying capability of HC130H. (Carry a payload of up to 40,000 lbs over 1,000 n.mi., and 22,000 lbs over 3,400 n.mi.)

2. The interior of the aircraft to be capable of being reconfigured to receive a maximum pollution response load in a minimum of time.

3. Have the necessary hardware, as a part of the normal configuration of the airframe, to permit a dispersant rig package to be mounted in the aircraft in a minimum of time.

B. Helicopters

1. Be of sufficient size to permit the aircraft to carry one complete ADAPTS unit internally (6,000 lbs load, 200 ft^3), deliver it a distance of 50 miles, have sufficient fuel to stay loaded on scene for ½ hour, winch down the load, and return to the debarkation point empty.

2. Interior design to permit rapid reconfiguration for receipt of a maximum response load.

3. Have the necessary hardware fixed to the airframe to permit a dispersant package to be rapidly mounted on the craft.

4. If at all possible to be able to tow a Fast Surface Delivery Sled under sea state 3 conditions. Further, the airframe should be designed to be configured for towing in a minimum of time.

C. Cutters Capable of Operation in up to Ten Foot Seas

1. Have the capability to move at low speeds (1 to 1½ knots) for long periods of time with good control. This capability is needed for skimming operations associated with spill recovery operations.

2. Be prefitted with necessary hardware to permit use of the vessel as a Vessel of Opportunity Skimmer (VOSS), and for spreading dispersants.

3. Large, open fantail, with low freeboard, tow rail, or stern roller, with lift capability, possibly an A-frame on stern.

D. Small Boats/Cutters 30' and greater

1. Have capability to move at low speeds (1 to 1½ knots) for long periods of time with good control.

2. Be operable in up to seven foot seas.

Impact on Utilization of Coast Guard Cutters and Small Boats. The need for ready access to support vessels has been addressed in the main report. As is suggested in that document because of the widespread geographical availability of small boats and cutters in the Coast Guard, the service is considered to be the largest single source of floating platforms available to support offloading and oil recovery operations.

In order to insure that this mission is performed in an efficient and effective manner, training is required at all units having boats greater than or equal to 30' in length and for all cutters. While it is not possible to predict which boats and cutters will be required to provide support during actual incidents, it is possible to estimate the total number of ship support days that will be required.

In order to maintain proficiency, each floating unit expected to be utilized in support of the pollution response mission should be required to conduct a training exercise in handling booms, skimmers, and portable oil storage bags once each quarter. In addition, each unit should participate in a larger scale regional exercise of approximately 3 days duration annually. The expected added training load is estimated at 7 days for each participating small boat and cutter.

In determining the actual operational requirements for ship support, the following assumptions have been made:

a. Spill rates will occur at the levels predicted in the main report.

b. New techniques in offloading will permit ten distressed vessels to be offloaded each year. Each operation will require on the average, three support vessels for five days.

c. The capabilities of recovery equipment specified in the main report are valid.

d. One-half of all spills greater than 50,000 gallons will require Federal response actions. On the average, 4 support vessels will be required for 5 days for each incident.

e. One-fifth of all spills between 10,000 and 50,000 gallons will require Federal response actions. On the average, 4 support vessels will be required for 3 days for each incident.

f. One spill of approximately one million gallons will occur each year, requiring 12 support vessels for approximately 7 days.

This equates to an expected need for approximately 614 operation ship/small boat support days. It is anticipated that approximately 2/3 of the required operating time can be provided by small boats, while the other 1/3 will require cutter committment. As indicated in the previous section, modifications will be required to some classes of small boats and cutters before they can be effectively used in support of this program. Another possible impact on cutter time is the need for providing platforms for surveillance in selected areas out to approximately 200 miles, as called for by the Clean Water Act Amendments to the Federal Water Pollution Control Act, and the recent Outer Continental Shelf Lands Act Amendments. This requirement is being addressed elsewhere. Vessels on patrol should be equipped with appropriate response equipment should surveillance patrols be established.

Equipment Acquisition Plan. This plan represents a three year undertaking for the acquisition and implementation of the recommended response system. Acquisition funds in the amount of $32.8M are required to procure response equipment to achieve the recommended response capability. Because of the inability of the Coast Guard Operating Expense appropriation to absorb such funding levels, funding is required through the Acquisition, Construction and Improvement (AC&I) appropriation.

Essentially, each of the individual hardware types would be the subject of a separate procurement contract of which there are approximately 30. It is estimated that final delivery to the field of each equipment item can be accomplished in 1-3 years from the date of individual acquisition project initiation. Thus, those acquisitions requiring larger lead times for specification development and/or hardware manufacturing would be undertaken first, with those of shorter duration being accomplished in succeeding steps. Funding over the three years would be required in the following increments:

BY	:	$ 7.3M
BY + 1	:	15.9M
BY + 2	:	9.6M
TOTAL	:	$32.8M

Vehicles would be purchased (or leased) through the General Services Administration while the remaining systems would be the subject of commercial procurement contracts initiated and administered at the Headquarters level.

Delivery of hardware would be staged over the individual contract periods and coordinated such that some equipment would be delivered and become operational at some of the staging sites quite early in the three year acquisition period.

Undertaking of the acquisition plan is manpower dependent in that a certain level of man hours are required to initiate and sustain each acquisition project. While the majority of the manpower resources are required prior to each individual contract award, the phased plan requires a sustained level of resources over the three year period. These manpower resources are required at the Headquarters level (Offices of Engineering and Comptroller) and represent the tasks which must be accomplished prior to award and during the course of each contract. Included among these tasks are preparation of purchase specifications, logistics and support planning, contract administration, and delivery acceptance. The manpower resource requirements are dependent to the largest degree on the number of individual contracts required and only marginally affected by the number of equipment items or the dollar level of the individual procurement contracts. In order to accomplish the three year implementation objective, concurrent efforts on many of the contracts would be required. As previously stated, the project man hour requirements dictate a need for seven AC&I billets or positions for the Office of Engineering (project engineer) and four for the Office of Comptroller (contract negotiator/administrator) for the three year period of the response system implementation.

IV ALTERNATIVE SITING, EQUIPMENT, AND PERSONNEL LEVELS

GENERAL. This section discusses various alternatives that were considered by the Task Force in determining the preferred site configuration, and equipment and manning levels. The alternative of maintaining the status quo is also discussed.

TSC SITING CONFIGURATION. The siting configuration recommended by TSC was essentially accepted by the Task Force. The one exception taken was that TSC recommended that certain sites have only a water or land response capability. This was not concurred with for the following reasons. While it is true that the specific site for which the recommendations were made might well be able to accommodate their primary threat from a one mode operation, their ability to assist neighboring sites would be limited. Further, unless a site has an over the road capability, the equiment at that location would be of little use in responses requiring national mobilization. It was therefore decided that all sites should have the ability to deliver equipment by land and water. Further, because of the distance between adjacent sites on the West Coast, it was decided that the San Francisco site should have the capability to deliver supplemental response equipment by air.

POSSIBLE MODIFICATIONS TO PREFERRED SITE LOCATIONS. Reducing the number of sites will have the effect of increasing the expected average response time and/or the potential for not being able to deliver response equipment within six hours of notification. If sites were to be reduced, the first candidates based on spill potential would be

Puerto Rico, then Hawaii, and Chicago. Hawaii and Puerto Rico are remotely located from the remainder of the response network and would therefore have to be supplied with equipment by aircraft. There would therefore be an extended period before even limited equipment could be brought in, as air transport even by C-130 is extremely weight limited (see below). Likewise, having no equipment in the Great Lakes area will result in similar problems.

The next three candidates for elimination, based on low potential would be Portsmouth, Virginia; Seattle, Washington; and Port Aransas, Texas. Elimination of any of these result in the lack of any immediate response capability in three environmentally sensitive areas: Chesapeake Bay, Puget Sound, and Corpus Christi/Padre Island. These actions are not considered acceptable. Since the elimination of the immediate response capability in areas of higher spill potential is also not desirable, a reduction in the number of sites recommended in the preferred configuration is considered undesirable.

The alternative of placing all equipment at a limited number of sites, namely the locations of C-130 aircraft, was investigated and rejected because of response time and load limitations. An analysis of average response time for one aircraft load indicates that the six hour response criteria would not be met on the average of one in every five occasions if an all aircraft response posture were established. Further when one looks at the load limitations of the C-130 aircraft, if can be concluded that:

a) The 130H aircraft can deliver an offloading capability in one plane load to a range of 3400 n. mi. The 130B aircraft can only do so to 1000 n. mi.

b) Neither aircraft can provide the equipment required to mount a recovery operation in one plane load.

The all aircraft alternative is therefore not considered viable if the stated Presidential Initiative goals are to be met.

If a reduction in sites is considered desirable, three candidates, listed in the order in which the eliminations should be made would be: Port Aransas, Chicago and Pascaguola. The objections to eliminating the first two sites have already been made. The third, Pascaguola, has a spill potential comparable to San Francisco, and Los Angeles. Its potential is in fact only exceeded by New York, New Orleans, and Philadelphia. Pascagoula was primarily selected because it is believed that its elimination can be absorbed by the response system easier than the elimination of the other locations previously mentioned. If it were to be eliminated, the area would then be serviced by New Orleans. This would effectively double the load at New Orleans from what it would be in the proposed configuration. In addition to losing immediate coverage of a major oil port and to the Florida panhandle, a significant workload is placed on an already extremely busy area. A further consideration is the fact that should LOOP fail to operate within the same time frame considered in the TSC study, a significant increase in traffic will occur in the Gulf Coast area because of the large number of lightering vessels that will be required to service supertankers.

Because of the fact that the site configuration recommended provides for a six hour response to 99.5% of the most probable locations for major discharges, little is to be gained by adding more sites to the configuration. If it is considered desirable to add additional sites, it is recommended that one be placed at Cleveland to provide more direct coverage of the Great Lakes.

TSC RECOMMENDED EQUIPMENT LEVELS. The equipment levels recommended by TSC called for establishing a nationwide capability to recover thirty million gallons of oil from the open water and forty million gallons from harbor environments. The capital investment involved in procuring this equipment alone would be approximately $120M. The recommended levels of equipment were rejected because they did not account for the fact that most open water equipment can be used in harbors. Thus, there is no need to duplicate dedicated capabilities. The TSC equipment levels also did not account for assistance being rendered from adjacent sites when one site in a geographical region is responding to one of the larger sized (but not massive) spills. Additionally, their equipment levels included separate inventories of identical offloading and recovery equipment for geographically colocated land and water response sites.

POSSIBLE MODIFICATIONS TO PREFERRED EQUIPMENT LEVELS. Reducing the amount of equipment in the proposed configuration will reduce the ability to respond to both non-massive and massive discharges. Since it can be shown that a small number of large spills account for a significant amount of the volume of oil discharged it is not reasonable to establish too low of a regional capability to respond to these incidents. Spills in excess of one million gallons have in fact occurred in the U.S. coastal regions on nine occasions over the past ten years. On the other hand, spills greater than 5 million gallons have only occurred on the average of once every five years during the same time period. Thus, it is considered that the ability to mount a response to a discharge of a million gallons rather quickly is desirable. Likewise, the frequency with which spills greater than a few million gallons appear, place them in a category where a national rather than a regional response seems appropriate.

As shown by Figures II-2 thru II-4 in Section II, the levels of equipment proposed will accomplish the non-massive response goals while providing what the Task Force believes to be the highest practical equipment inventories for responding to a massive spill.

From the viewpoint of the massive spill, it would appear that a reduction below the 230 tons per hour* removal capability that the preferred alternative should provide is unwarranted. This is because a review of historical tanker accidents indicates that mean outflow rates of from 200

*The 230 tons per hour level is based on utilizing 27 of the 43 recovery units in inventory within the lower forty-eight states. This leaves one recovery unit at each site to deal with other discharges, and assumes four units will be inoperative for various reasons. If no units were kept in reserve, a recovery rate of 332 tons per hour could be realized from the equipment, provided sufficient operational support vessels could be found and operated simultaneously in a spill.

to 600 tons per hour can be expected from the largest of massive spills. A further point to be considered, is that massive spills of the largest kind will involve crude oil. When one considers expected evaporation and mixing rates, it is unlikely that greater than fifty percent of the amount discharged during any massive crude spill will ever be recovered. For this reason, a recovery potential equivalent to or greater than the largest outflow rate observed thus far is not considered likely to prove useful. Further, the operational logistics of mounting the massive discharge response must be recognized in setting an upper limit for response inventories.

The offloading capability which will meet each region's non-massive requirements amounts to one unit per region, except for Philadelphia, where the number is two. The total inventory of these units also meets the massive potential spill requirements of eleven offloading units. A further reduction or addition to this number is not justifiable since, any reduction would result in no open water pumping capability in some areas.

As previously indicated, a national inventory of pollution response equipment was conducted in conjunction with the study efforts to determine the extent to which response equipment was available within each region of high spill potential. The conclusion of this effort was that considerable ability exists within the U.S. to recover oil once it has impacted the shoreline. Further, large amounts of harbor boom are available. Little harbor skimming capability appears to exist throughout the country. In addition, virtually no open water capability exists anywhere outside the Federal government. Consideration was given to the availability of commercial equipment in determining the need for establishing levels for Federal equipment at each site location.

SITE PERSONNEL REQUIREMENTS. As indicated in Section III, the Task Force's computation of site personnel requirements was based on the belief that a six hour response could not be mounted unless a minimum level, 24 hour watch was maintained at each equipment site. The watch personnel would be responsible for mobilizing equipment and delivering it to the scene.

ALTERNATIVE PERSONNEL REQUIREMENTS. Any reduction in watch personnel will reduce the potential for responding within six hours of notification. Reductions are therefore not recommended, unless the six hour response goal is changed. Reductions in administrative personnel will add to an already heavy administrative load at each unit and are also not recommended. Possible ways to reduce the number of personnel required include the following. The possible reductions are listed in the order of priority that it is felt they should be considered.

1) Based on spill threat as weighted against cost, Chicago, San Juan, and Honolulu have a small equipment inventory as well as a limited potential for large discharges. First reductions could be made here. Manning could be reduced to equipment maintenance levels (two personnel per site), with the intent that normally assigned personnel would be given pagers and placed in an on call status at home, to return as soon as possible when paged. A minimum of three personnel would be required to

be in the status each day during non-working hours. Such actions would not guarantee a six hour response in these areas, and would add to the current workload in the sense that personnel would be assuming a standby status during some of their off duty time. A reduction of 44 personnel could however be realized.

2) Elimination of the staff officer, and/or supervisor is a possible way to reduce from 19 to 38 billets. The administrative workload at MSOs and COTPs is already significant. If new tasks are added, appropriate numbers of administrative personnel should also be included.

3) Reducing the watch at the large sites, from four to three men would permit two trucks and a mobile crane to be gotten underway. This is considered to provide for immediate mobilization of sufficient amounts of equipment. It does not however, provide an adequate number of personnel with operational expertise at the scene. The MSO/COTP would then be required to place one person from existing personnel on an at home standby status to deploy to the scene when called. This should not delay the delivery of equipment but might delay the time needed to place the equipment in operation. It again will add to the existing workload at the MSO/COTPs involved. This action would result in a reduction of 45 personnel. Conversely, the lesser sites could be reduced from three to a two man 24 hour watch. The results and impact on these MSO/COTPs would be the same as for the larger sites. The potential personnel reduction would be 28 personnel.

4) The minimum level of needed personnel would be to only provide persons to perform equipment maintenance. Under this concept sites with

two or more skimming barriers would receive four people, while those with one would receive two people. Deployment of equipment would have to be accomplished with existing resources at each MSO/COTP. The National Strike Force would be called immediately to carryout all response operations. To accomplish this would require that the National Strike Force be able to provide a larger number of personnel more rapidly when called upon. Approximately 85 maintenance personnel would be required and an additional 72 NSF personnel are also estimated as being needed. Personnel requirements would therefore total to 157 versus 333. It is estimated that on the average, this would lengthen response times along the Atlantic and Gulf Coasts by approximately five hours. The increase along the Pacific Coast is estimated to be about eight hours. It is therefore not considered possible to meet the six hour goal in this manner.

5) Another alternative considered was to have regional contracts with trucking firms for delivering response equipment. The cost of hiring trucks and civilian drivers on a 24 hour call was believed to be cost prohibitive. This alternative would also fail to meet the need of having four qualified response personnel at the scene to deploy and operate equipment.

CURRENT RESPONSE CAPABILITY. As mentioned in the beginning of Section IV one of the alternatives which must be considered in the analysis, is to maintain the status quo with regard to the national response capability.

The purpose of the following is to examine that posssibility by attempting to quantify the capability of the current response network to respond within six hours of notification, as well as to a spill of massive proportions.

CURRENT EQUIPMENT LEVELS. Table IV-1 is a listing of major response equipment currently in the Coast Guard inventory, on order, or for which funding is anticipated during FY 79. Equipment actually available is indicated in each column, while the levels after planned procurements are received, are shown in parenthesis. The listing does not include 40 small (5-20 gpm) portable harbor oil recovery units and harbor boom which is located at Coast Guard units in major port areas. These and other small harbor equipment identified by the national inventory, provide a limited local capability which should not be considered in the analysis of our ability to respond to a major spill, primarily because of the logistics of using this equipment and also because it is not designed for open water use.

TABLE IV-1 PRESENT AND CURRENTLY PLANNED MAJOR POLLUTION RESPONSE EQUIPMENT

	Bay St. Louis MS	Elizabeth City	San Francisco
ADAPTS	4	7	7
OWORS/BARRIER*		1	1
OWOCS/Skimming Barrier*	0 (6)	0 (10)	0 (10)
Type O Barge	0 (1)	0 (1)	0 (1)
Type F Barge	0 (2)	0 (2)	0 (2)
Air Transportable Trailers**	0 (4)	0 (6)	0 (6)
Type D2 Barge	0 (2)	0 (2)	0 (2)
Viscous Oil Pumping System	0 (1)	0 (1)	0 (1)
MEP Equipment Mobilizer**	1	1	1

Notes and Definitions:

ADAPTS - Air Deliverable Anti-Pollution Transfer System (offloading pumping system).

OWORS - Open Water Oil Recovery System (Lockheed Skimmer).

OWOCS - Open Water Oil Containment System (Open Water Barrier).

OWOCS/Skimming Barrier - Open Water Barrier with Skimming capability, also termed Open Water Oil Containment and Recovery System (OWOCRS).

*At this moment only one OWORS is operational. No OWOCS/Skimming Barriers exist as a complete system. By April 1979 it is expected that two OWORS and three OWOCS/Skimming Barriers will be operational. If currently proposed FY 79 funding is provided, 13 OWOCS will be converted to OWOCS/Skimming Barriers, and 10 new OWOCS/Skimming Barriers will be purchased in FY 79.

**The listed trailers and mobilizers provide for movement to and loading of aircraft at originating Air Stations as well as unloading of aircraft and transport of equipment from air fields at destinations near debarkation points.

Table IV-2 indicates the total current offloading and spill recovery capacity. Calculations have been based on the assumptions for individual offloading and recovery units discussed in Section II. The levels after planned procurements are received are shown in parenthesis.

The OWORS/Barrier (Lockheed Skimmer with open water barrier) is listed in Table IV-1 as a single system for the purpose of this analysis because the highest recovery capability of the OWORS only exists when used in conjunction with the open water barrier (OWOCS). In actuality, the barrier is a skimming barrier when provided with the accessories of prime mover, hoses, and pumping system and can serve the same purpose as the OWORS/Barrier.

The OWORS can achieve recovery rates of up to 1,250 gallons per minute in calm water in oil at least 4 inches thick of the proper viscosity (400-500 centistokes). At 1 knot, the barrier can collect 300 gallons per minute in an average slick thickness of .0125 inches. At such a slick thickness, the OWORS with a barrier has a recovery rate equal to the Skimming Barrier. At slick thicknesses above 0.0125 inches, the OWORS recovery rate is still 300 gallons/minute, while that of the OWORS with barrier continues to increase with slick thickness up to about 1,250 gallons per minute.

The Viscous Oil Pumping System has a rated capacity of upwards of 1000 gpm. This pumping capability has not been included in the following analysis as an addition to the existing ADAPTS capability because the purpose of acquiring the Viscous Oil Pumping Systems was for use when ADAPTS would not work well (highly viscous oils) rather than as an additional pumping capability for all purposes. Because its size is physically larger than ADAPTS, its mobilization requirements are greater and it would not be selected over ADAPTS for normal pumping operations or used at all when sufficient numbers of ADAPTS were available.

It should be noted that the present inventory includes no emergency storage capacity. This capacity must be obtained on a case-by-case basis in order to be able to conduct any offloading or spill recovery operation.

TABLE IV-2

CAPABILITY OF PRESENT EQUIPMENT

	Bay St. Louis	Elizabeth City	San Francisco	TOTALS
OFFLOADING				
Pumping	4.8M	8.4M	8.4M	21.6M gallons per 24 hours
Storage	0 (247K)	0 (247K)	0 (247K)	0 (741,000) gals.
SKIMMING				
Removal*	0 (378K)	0 (693K)	63K (693K)	63K (1.764M) gals. per 24 hours
Storage	0 (86K)	0 (86K)	0 (86K)	0 (258,000) gals.

*At the moment, the total removal capability is 63,000 gallons per day. By April 1979, the capability should be 315,000 gallons per day.

Table IV-3 tabulates the total offloading and recovery capacities of the equipment level recommended in the main report, based on the stated assumptions.

TABLE IV-3

PROPOSED POLLUTION RESPONSE CAPABILITIES

NO.	Equipment	Gallons/24 Hrs.	Gallons Storage	Comparison
18	ADAPTS	16.5×10^6		Same
10	Type O Barge		2.5×10^6	333%
47	Skimming Barrier	2.7×10^6		181%
76	Type F Barge		2.9×10^6	1267%

The last column of this table compares the proposed equipment levels to that which will be available after planned procurements, through (FY 79) are accomplished.

The ZRV and harbor recovery units included in the proposed inventory are not included in this comparison, since they are not intended for use in open water.

<u>SIX HOUR RESPONSE</u>. The above discussion quantifies the types and amount of response equipment that currently planned funding levels are expected to provide. The purpose of this portion of the section is to determine how much of this equipment can be expected to be delivered and with what degree of assurance one can expect it to be delivered. Although a detailed analysis of this question is contained later in the section, a summary of the results follows.

Considering the use of Coast Guard aircraft only, a detailed analysis of historical aircraft availability data yields the following results:

- o On the average, two aircraft can respond to either the East or West Coast spill response debarkation areas in less than 6 hours, and to the Gulf Coast areas in less than 6.5 hours, with a 90% or better reliability (probability of occurrence).

- o If one uses a response time of 8 hours, on the average, 4 aircraft can respond to the East or Gulf Coasts, but only 2 to the West Coast with a 90% or better probability. Again, on the average, 4 aircraft can respond to the West Coast within 6 hours (5.6 hours) but with only a 20% reliability. In all cases for more than 4 aircraft, the response times are greater than 9 hours and reliabilities less than 65%.

It can thus be concluded that a Coast Guard 6 hour response capability with current resources and operating profiles is limited to two C-130 aircraft. There is little basis from past experience to expect to improve on this via the routine utilization of DOD aircraft. This transport capacity translates to a single complete skimming barrier and 2 Type F collapsible storage containers which will provide for 63,000 gallons/day spilled recovery. Similarly, two offloading systems having an offloading pumping capacity of 2.4 million gallons per day could be provided.

As indicated in the main report it can be concluded that even if these load limts were acceptable, a six hour response can not be met with an all air response using Coast Guard transport aircraft.

MASSIVE SPILL RESPONSE. Based on the above analysis, it appears that the present inventory provides for an adequate number of portable offloading pumps to meet a potential massive spill threat provided adequate offloading vessels and DOD aircraft can be arranged for. Until April 1979, we have virtually no massive spill recovery capability. By April 1979, we should have the capability to recover 1016 tons of oil per day (315,000 gallons). Provided expected FY 79 funds are made available, our recovery capability will be raised to the 5500 tons per day level (1,764,000 gallons) when FY 79 procurements are delivered.

DETAILS OF AIR DELIVERY CAPABILITY ANALYSIS. The ability of the Coast Guard C-130 aircraft to deliver pollution response equipment to the debarkation port of an oil spill depends on:

1) aircraft availability;

2) aircraft payload;

3) equipment weight and size; and

4) total air/land response times and levels.

Each of these factors was investigated in detail as part of this analysis. The site configuration examined, consisted of three air sites with four aircraft per site: 4 C-130Bs at Elizabeth City, 3 C-130Bs and 1 C-130E at Clearwater, and 4 C-130Hs at San Francisco. It is assumed that the larger equipment (skimming barrier, ADAPTS, Type O and F Barges) are preloaded on 33 ft. drop trailers that can, in turn, be loaded into the C-130. The remaining equipment is assumed to be carried on pallets that can be used with aircraft compatible mobilizers or trailers. It is further assumed that in the event of a spill close to the air base, the equipment will be trailered over the road to the debarkation port, using trailers and/or mobilizers. It is also assumed for this particular analysis, that the Gulf Coast equipment is sited with the aircraft at Clearwater rather than New Orleans or Bay St. Louis, This permitted the results of the analysis to be utilized in evaluating the preferred site. The results however, are more optimistic than the situation that currently exists with the equipment at Bay St. Louis and the aircraft at Clearwater.

The probability that 1, 2, 3, or 4 aircraft will be available at any given time at each of the three Coast Guard air stations at which they are located was determined.

Two categories were considered:

Category I - The probability that an aircraft is available for pollution response is proportional to the annual hours reported in status other than NOR or SAR for each aircraft type and air station.

Category II - The probability of availability is proportional to the annual hours reported in status other than NOR, SAR, or any other Coast Guard mission, for each aircraft type and air station.

The results are summarized in Table IV-4. Table IV-4 gives the probability of availability of the specified number of aircraft at any one time. In order to use these data, it is necessary to assume that only one request is made for aircraft for pollution response when a spill occurs. This assumption avoids the problem of determining how many C-130 aircraft would be available in an extended period of time, for which mission duration data are needed. Since a six hour response is the major concern, it is likely that only those aircraft would be effective that were available at the time the OSC request is received for assistance, i.e. at the start of the six hour period. Therefore the data in Table IV-4 will be taken to represent the total C-130 availability for six hour pollution response. For the same reason (i.e. need for rapid response) the Category II probabilities will be used, since they represent what is immediately available without recall from SAR or any other missions.

TABLE IV-4

AVAILABILITY OF USCG C-130 AIRCRAFT

	Elizabeth City	Clearwater	San Francisco
Number of Aircraft Stationed			
C-130B	4	3	0
C-130E	0	1	0
C-130H	0	0	4
Probability of Availability-Category I			
None	.0200	.0443	.0045
1 or more	.9800	.9557	.9955
2 or more	.8473	.7464	.9440
3 or more	.5170	.3764	.7230
4	.1516	.0857	.3015
Probability of Availability-Category II			
None	.0355	.0590	.0104
1 or more	.9645	.9410	.9896
2 or more	.7794	.6980	.9012
3 or more	.4174	.3231	.6180
4	.1026	.0661	.2150

EQUIPMENT PHYSICAL CHARACTERISTICS. The physical characteristics of equipment in transport mode assumed for calculation purposes are as follows (per unit data):

	lbs.	cu. ft.
ADAPTS	6,000	200.
OWOCS/Skimming Barrier	19,000	1100.
Type O Barge	13,700	738.
Type F Barge	3,720	270.

AIRCRAFT LOAD PLAN. The amount of equipment that can be carried by the C-130B or C-130H depends on the loading plan as well as on the weights and sizes above. In particular, the air-based equipment must be land transportable at the destination and at the origin. To accomplish this, the OWOCS/Skimming Barrier would be mounted on a 33 ft. drop trailer, of 8 ft. width. The trailer weight is approximately 5,000 lb., and can be loaded onto a C-130B or H which has a cargo compartment length of 40 ft., plus an 8 ft. ramp. Similarly, the Type O Barge or two Type F Barges may be loaded onto aircraft loadable trailers or mobilizers. A common operating weight for the C-130H is 90,000 lbs. An operating weight of 85,000 lbs. is allowed for the C-140B. These two operating weights will be assumed in the following. Nominal loading plans for the C-130s are as follows, with each numbered load plan representing a single aircraft.

C-130B - Skimming

		weight lb	range n.mi.
Load plan 1.	OWOCS	16,000	
	Trailer	5,000	
		21,000	1,200
Load plan 2.	Pumps & Floats	700	
	Prime mover	1,200	
	Type F Barge	8,000	
	Hose (600') & connector	600	
	Fuel Cell	460	
	Discharge Hose	720	
	Trailer	5,000	
		16,680	1,900
Load plan 3.	Type F Barge	8,000	
	Type F Barge	8,000	
	Trailer	5,000	
		21,000	1,200

Skimming could commence after the arrival of loads #1 and #2. Subsequent loads would add storage capacity. It should be noticed that the range is limited by load plans 1 and 3.

C-130B - Offloading (pumping)

		weight lb	range n.mi.
Load plan 4.	3 ADAPTS	18,000	
	Trailer	5,000	
		23,000	900
Load plan 5.	2 ADAPTS	12,000	
	Trailer	5,000	
		17,000	1,800
Load plan 6.	Type O Barge	13,000	
	Discharge hose	720	
	Trailer	5,000	
		18,720	1,700

By using a mobilizer it is possible to place 4 ADAPTS in an aircraft on pallets at a total weight of 22,269 lbs. Accordingly, an alternate to load plan 4 would be:

Load plan 7.	4 ADAPTS	22,300	1,000

C-130H - Skimming

		weight lb	range n.mi.
Load plan 8.	OWOCS	16,000	
	Trailer	5,000	
	Pumps & Float	700	
	Prime Mover	1,200	
	Hose & Connectors	600	
	Fuel Cell	460	
	Discharge Hose	720	
		24,680	3,300

C-130H - Skimming (Con't)

		weight lb	range n.mi.
Load plan 9.	Type F Barge	16,000	
	Trailer	5,000	
		21,000	3,300

The C-130H is volume limited in some cases, because the payload is much more than the C-130B while the size is essentially the same.

If the above loads are distributed more evenly, so as to maximize the range, the C-130H still has a 3,300 n. mi. range and 2 aircraft-loads are still needed to start skimming. If the Type F Barges can be handled without aid of the trailer, then one has:

Load plan 10.	Type F Barges on pallet with discharge hose (3)	27,000	3,100
Load plan 11.	Type F Barges and hose on pallet (4)	36,000	1,800

C-130H - Offloading (pumping)

		weight lb	range n.mi.
Load plan 12.	2 ADAPTS	12,000	
	Type O Barge	13,000	
	Discharge hose	720	
	Trailer	5,000	
		30,720	2,600
Load plan 13.	1 ADAPTS	6,000	
	Type O Barge	13,000	
	Discharge hose	720	
	Trailer	5,000	
		24,720	3,300

It can be seen from these figures that the C-130B can cover up to about 1,500 n. mi., which would reach most East Coast ports from Elizabeth City or Clearwater. The C-130Hs at San Francisco, however, can cover the East Coast as well as the West Coast with some load plans.

RESPONSE TIME. The average response times from Clearwater, Elizabeth City, and San Francisco are shown in Table IV-5. It should be noted that the response times of Table IV-5 includes the time required to unload the equipment at the destination airport and to truck it over the road to the debarkation port. The land mode is used for spills near the air stations, i.e., for which the truck response time from the air station is less than the air/land response time from the same air station. Water mode from Honolulu and San Juan is used for spills near Hawaii and Puerto Rico.

TABLE IV-5

POLLUTION RESPONSE TIMES FROM USCG AIR STATIONS

	AVERAGE RESPONSE TIME (HOURS)	AVERAGE SPILL POTENTIAL (SPILLS/YR)
Clearwater, AIR	5.95	8.71
Clearwater, LAND	2.68	0.13
	5.90	8.84
Elizabeth City, AIR	5.29	9.55
Elizabeth City, LAND	3.15	0.45
	5.19	10.00
San Francisco, AIR	5.62	2.14
San Francisco, LAND	2.20	1.23
	4.37	3.37
Barbers Point, WATER	1.54	0.18
San Juan, WATER	1.96	0.09

Response in interval	0-1	.0%
	1-2	4.1
	2-3	3.9
	3-4	0.5
	4-6	71.9
	6-8	19.9
	above 8 hrs	0.0
		100.0

These response times apply to the first aircraft load or loads from the air station closest to the spill. Because additional trailer-based equipment may be stationed at the air station, over and above the low-bed trailers that fit into the C-130s, the land response times will apply to any amount of equipment, but since it is not presently planned to add C-130s to augment the USCG fleet, it is important to determine what amount of equipment and what delivery times the present complement of C-130s can achieve.

To do so, it will be assumed that spills on the East and Gulf Coasts are responded to by aircraft from all three air stations, but that spills on the West Coast are responded to only by the aircraft at San Francisco. The response time for spills in one region by aircraft in another were found to be as given in Table IV-6.

Table IV-6

REGION OF SPILL

	Clearwater	Elizabeth City	San Francisco
Region of Response	Hours	Hours	Hours
Clearwater	5.95	7.20	
Elizabeth City	7.20	5.29	
San Francisco	10.63	10.26	5.62

The diagonal elements of this Table are regional air responses of Table IV-5, obtained by taking the spill-weighted response times for all spills in the air response region of the site. The off-diagonal elements represent the spill-weighted response from one region to a spill in another region. In the case of San Francisco's response to East and Gulf Coast regions, however, the times shown are simply the response times from San Francisco to Philadelphia, and to New Orleans, respectively.

RESPONSE LEVELS. The next question is the amount of equipment that can respond. It is seen from the preceding load plans that a full skimming response requires 2 C-130B aircraft loads or 2 C-130H loads. The difference is that the C-130B is limited to 1,200 n. mi. Also, the B-version equipment includes only one Type F Barge, while the H-version equipment has two.

It is also seen from the load plans that a full offloading response requires 2 C-130Bs but only 1 C-130H. Again, there is substantial differences in range achievable (1,700 n. mi. as opposed to 3,300 n. mi.).

The load plans on which the above observations are based, and which shall be assumed in what follows, are summarized here:

	Skimming	Offloading
C-130B	1st aircraft: Load plan 1	Load plan 5
	2nd aircraft: Load plan 2	Load plan 6
C-130H	1st aircraft: Load plan 8	Load plan 13
	2nd aircraft: Load plan 9	Load plan 13

Aircraft will be assumed to be dispatched in pairs from each air station, for simplicity and because in most cases two aircraft are required to achieve an offloading or skimming capability at the destination.

Table IV-7 shows the delivery capability possible from each of the three sites, assuming the load plans above. The aircraft respond from the air station listed in the first line of the Table, with probability shown next to Category I and Category II. The probability of exactly 2 or 3 aircraft responding is obtained from Table IV-4 by subtracting the probability of 4 aircraft responding from the probability or 2 or more responding. From the ranges shown in the load plans, it can be assumed that the C-130Bs and C-130Hs respond to spills on the East and Gulf Coasts, but that only the C-130Hs respond to spills on the West Coast. The major exceptions to this are the upper part of Maine and the upper peninsula of Michigan, which cannot be reached by the C-130Bs from Clearwater and Elizabeth City, respectively.

All 27 combinations of aircraft availability in pairs from the three sites are listed in Table IV-8 along with the probability of the combination as obtained from Category II of Table IV-1. The equipment levels are also shown, assuming the load plans listed above. All subsequent results are obtained from Table IV-8 and the response time matrix tabulated previously.

It can be seen from Table IV-8 that the most likely single (probability .296), response, is 2 aircraft from each station, but overall, this will not be the most likely response. Also, it is seen that it is more likely that no aircraft at all will respond than that all twelve will respond.

TABLE IV-7

DELIVERY CAPABILITIES OF THREE AIR SITES

FROM:	Clearwater	Elizabeth City	San Francisco
Skimming Response-Level I			
# Aircraft	2	2	2
Skimmers/OWOCS	1	1	1
Type F Barge	1	1	2
Category I availability	.66	.70	.64
Category II availability	.63	.68	.69
Skimming Response-Level II			
# Aircraft	4	4	4
Skimmers/OWOCS	2	2	2
Type F Barge	2	2	4
Category I availability	.09	.15	.30
Category II availability	.07	.10	.22
Offloading Response-Level I			
# Aircraft	2	2	2
ADAPTS Sets	2	2	2
Type O Barges	1	1	2
Category I availability	.66	.70	.64
Category II availability	.63	.68	.69
Offloading Response-Level II			
# Aircraft	4	4	4
ADAPTS Sets	4	4	4
Type O Barge	2	2	4
Category I availability	.09	.15	.30
Category II availability	.07	.10	.22

TABLE IV-8

POSSIBLE AIR RESPONSES AND THEIR PROBABILITIES

Responding Air Station(s) and Aircraft			Probability of Response (Category II)	Response level to East & Gulf Coasts		West Coast	
CW	EC	SF	(1)	Offloading (2)	Skimming (3)	Offloading (2)	Skimming (3)
0	0	0	.007	0/0	0/0	0/0	0/0
2	0	0	.014	2/1	1/1	0/0	0/0
4	0	0	.001	4/2	2/2	0/0	0/0
0	2	0	.020	2/1	1/1	0/0	0/0
2	2	0	.043	4/2	2/2	0/0	0/0
4	2	0	.004	6/3	3/3	0/0	0/0
0	4	0	.003	4/2	2/2	0/0	0/0
2	4	0	.007	6/3	3/3	0/0	0/0
4	4	0	.001	8/4	4/4	0/0	0/0
0	0	2	.046	2/2	1/2	2/2	1/2
2	0	2	.095	4/3	2/3	2/2	1/2
4	0	2	.010	6/4	3/4	2/2	1/2
0	2	2	.140	4/3	2/3	2/2	1/2
2	2	2	.296	6/4	3/4	2/2	1/2
4	2	2	.034	8/5	4/5	2/2	1/2
0	4	2	.024	6/4	3/4	2/2	1/2
2	4	2	.045	8/5	4/5	2/2	1/2
4	4	2	.005	10/6	5/6	2/2	1/2
0	0	4	.004	4/4	2/4	4/4	2/4
2	0	4	.030	6/5	3/5	4/4	2/4
4	0	4	.003	8/6	4/6	4/4	2/4
0	2	4	.044	6/5	3/5	4/4	2/4
2	2	4	.092	8/6	4/6	4/4	2/4
4	2	4	.010	10/7	5/7	4/4	2/4
0	4	4	.007	8/6	4/6	4/4	2/4
2	4	4	.014	10/7	5/7	4/4	2/4
4	4	4	.001	12/8	6/8	4/4	2/4

(1) Based on Category II aircraft availability probabilities.

(2) ADAPTS Type O Barge.

(3) Skimming Barriers/Type F Barges.

Since at least one barrier and one Type F Barge, or one ADAPTS and one Type O Barge are required before any oil recovery or offloading can commence, it is useful to know what probabilities attach to delivery of specified minimum conbinations of equipment. These probabilities are shown in Table IV-9. The Table applies either to offloading or to skimming deliveries, but not to both simultaneously. The dashed lines mark off the equipment amounts that will be delivered with 90% probability or more. A "Recovery Unit" in the Table refers to 2 ADAPTS or to a Skimming Barrier, while a "Storage Unit" refers to a Type O Barge or Type F Barge, for offloading or skimming. Thus, it is seen that there is a 91% probability of aircraft availability for delivery of 4 ADAPTS and 2 Type O Barges, or of 2 Skimming Barriers and 2 Type F Barges, to the East or Gulf Coasts. For the West Coast, the 90% probability level corresponds to 2 ADAPTS and 2 Type O Barges, or to 1 Skimming Barrier and 2 Type F Barges.

The average response times achievable by present air delivery are shown in Table IV-10. The response times depend on the location of the spill (Gulf, East or West Coast ports), the minimum number N of aircraft required to respond, and the site from which the aircraft originate. The aircraft are assumed to be available in pairs, for simplicity, because two aircraft are required in most cases to deliver a useful skimming or offloading capability. The required N aircraft may have to come from more than one site. The probabilities shown are the probabilities that the Nth aircraft will come from the site shown at the head of the column. The average response time from all sites is the most important indication of achievable response time. These times are less than six hours only for 2-aircraft responses to the East or West Coasts, and for the 4-aircraft response to West Coast ports which has a probability of only .205. Therefore, only a 2-aircraft response to the East and West Coasts can be relied on (probability of 90% or more) in less than six hours, while 2-aircraft response to the Gulf Coast requires 6.5 hours with a probability of 90% or more.

TABLE IV-9

PROBABILITY OF AIR DELIVERY OF GIVEN EQUIPMENT COMBINATIONS (1)

East and Gulf Coasts

Number of Recovery Units	Number of Storage Units 0	1	2	3	4	5	6	7	8
0	1.00	.99	.96	.87	.62	.29	.13	.03	.00
1	.99	.99	.96	.87	.62	.29	.13	.03	.00
2	.91	.91	.91	.87	.62	.29	.13	.03	.00
3	.63	.63	.63	.63	.62	.29	.13	.03	.00
4	.21	.21	.21	.21	.21	.21	.13	.03	.00
5	.03	.03	.03	.03	.03	.03	.03	.03	.00
6	.001	.00	.00	.00	.00	.00	.00	.00	.00

West Coast

Number of Recovery Units	Number of Storage Units 0	2	4
0	1.00	.90	.20
1	.90	.90	.20
2	.20	.20	.20

(1) Probability of aircraft being available to deliver at least the number of units indicated.

(2) The Tables apply either to offloading or to skimming equipment delivery, but not to both, as follows:

	Offloading		Skimming
1 Recovery Unit =	2 ADAPTS	or	1 Skimming Barrier
1 Storage Unit =	1 Type O Barge	or	1 Type F Barge

TABLE IV-10

AVERAGE RESPONSE TIMES AND PROBABILITIES FOR AT LEAST N AIRCRAFT

Average Response Time(1)/Probability(2)

Response to Gulf Coast Ports

	From Clearwater	From Elizabeth City	From San Francisco	Average from all Sites
N = 2	5.95/.705	7.20/.238	10.63/.050	6.49/.993
4	5.95/.069	7.20/.531	10.63/.313	8.28/.913
6	5.95/.000	7.20/.121	10.63/.506	9.97/.627
8	5.95/.000	7.20/.007	10.63/.205	10.52/.212
10	5.95/.000	7/20/.000	10.63/.030	10.63/.030
12	5.95/.000	7.20/.000	10.63/.001	10.63/.001

Response to East Coast Ports

	From Clearwater	From Elizabeth City	From San Francisco	Average from all Sites
N = 2	7.20/.153	5.29/.790	10.26/.050	5.83/.993
4	7.20/.493	5.29/.092	10.26/.313	8.07/.898
6	7.20/.121	5.29/.000	10.26/.506	9.67/.627
8	7.20/.007	5.29/.000	10.26/.205	10.16/.212
10	7.20/.007	5.29/.000	10.26/.030	10.16/.030
12	7.20/.007	5.29/.000	10.26/.001	10.16/.001

Response to West Coast Ports

	From Clearwater	From Elizabeth City	From San Francisco	Average from all Sites
N = 2	- 1 -	- 1 -	5.62/.900	5.62/.900
4	- 1 -	- 1 -	5.62/.900	5.62/.205

(1) Average time elapsed, in hours, from receipt of OSC request to arrival of Nth aircraft.

(2) Probability that Nth aircraft will arrive from site(s) indicated. There is a finite probability in all cases that N or more aircraft will not be available, equal to 1 minus the probability shown in the last column.

ALTERNATIVE TIME FRAMES. Due to the extensive planning and procurements involved, it is judged that the recommended period of time for implementation of the proposed response system cannot be less than three years.

The acquisition period could be lengthened to occur over any period of time. Because of the importance of placing a system into being which is capable of providing a rapid and effective response as soon as possible, it is recommended that the implementation period not be extended beyond five years.

Besides adding two years to the time frame over which the system would become operational, this alternative would reduce the AC&I position requirements from 7 to 4 for the Office of Engineering and from 4 to 2 for the Office of Comptroller because fewer acquisition projects would have to be accomplished concurrently. Funding for AC&I equipment acquisitions over the five year period would be required in the following increments:

BY	:	$ 1.8M
BY + 1	:	$ 10.9M
BY + 2	:	$ 9.3M
BY + 3	:	$ 5.7M
BY + 4	:	$ 5.1M
TOTAL	:	$ 32.8M

Although all dollar figures in this report are quoted as 1978 dollars, it should be noted that stretching the acquisition period over the additional years will also increase the acquisition costs because of inflation.

V RESPONSE OPERATIONS

INTRODUCTION. This section discusses response operations in greater detail than is contained in Section 3 of the main report, but generally treats the same topics. The focus is on the operational aspect of the response with only limited attention given to the logistical aspects. Tank vessel salvage, oil spill recovery or treatment, and oil spill response in ice infested waters are discussed. The state-of-the-art is indicated. Recommendations for continued development efforts are made as are comments on certain concepts considered in the background studies which the Task Force judges do not warrant being pursued.

POLLUTION PREVENTION AND AMELIORATION. There were 82 reported "potential pollution incidents" of greater than 50,000 gallons during the period of January 1974 to July 1977 involving a total of 886,400 tons of oil. Preventing the release of these massive quantities of oil to the waterways has the three-fold benefit or preserving the resource (the oil, and possible the vessel), of reducing the overall impact on the environment, and of eliminating the specific impact of each "avoided spill".

GENERAL. A tanker which is stranded presents an imminent threat of partial or total failure of the ship's hull, with the attendant loss of most or all of her cargo. Any action which could be taken to prevent this hull failure offers great promise in preventing the occurrence, or in minimizing the size,

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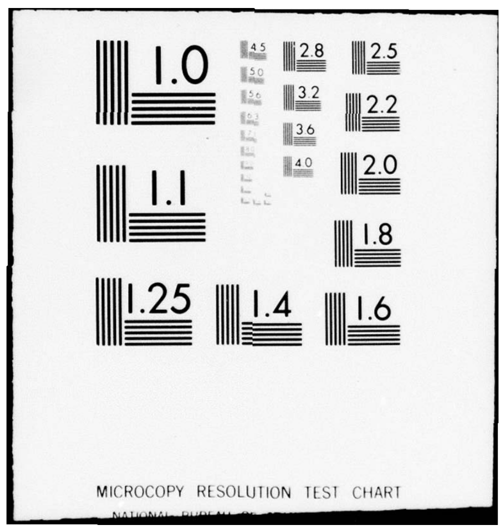
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MICROCOPY RESOLUTION TEST CHART

of an oil spill. Thus, even from a "pollution response" perspective, a tanker stranding must be immediately recognized and dealt with as a tanker salvage situation.

The first priority in developing an improved capability in pollution response should thus be directed to improving capabilities in tanker salvage operations. (The obvious desirability of insuring adequate vessel construction, manning, operations, and maintenance standards as the first line of defense against the occurrence of oil spills is beyond the scope of the "pollution response" program and this report, but is being aggressively addressed by the Coast Guard Office of Merchant Marine Safety).

It should be noted that the National Oil and Hazardous Substances Contingency Plan recognizes the legal responsibility of the U.S. Navy Supervisor of Salvage to provide the salvage expertise required to cope with a pollution incident and the Navy is fully committed to providing this service.

The status of the ship's machinery is a vital consideration in these incidents. Other important considerations are: the specifics of the stranding situation; the conditions of the water and the bottom surrounding the tanker; the present and developing situation with regard to the ship's hull; the anticipated weather conditions in the next several hours and next few days, and the potential availability and timeliness of various forms of outside assistance.

OFFLOADING. The preferred approach to the salvage process is the controlled offloading to a lightering ship or barge. The timely availability of lightering capacity is considered to be the most severe limitation in offloading. The Coast Guard is placing collapsible bags in sizes up to 247,000 gallons in inventory for emergency, first response, use. However, these bags are too small to rely on beyond the first few hours of operation. The unit cost of these bags is about $236,000. The establishment of local or regional contracts with commercial operators to insure the availability of an ocean going barge and tug within an established time frame after notification is considered to be the most promising approach to providing this essential storage capacity. (Availability as used here means that the tug and barge would be ready to proceed together to the scene as directed by the On-Scene Coordinator). Preliminary investigations have indicated that such arrangements would be possible in some of the "high risk" port areas, but not necessarily in all areas. Where such contracts cannot be obtained, it may be necessary to provide lightering capacity in the form of government leased or owned vessels. This would involve cost associated with maintenance, mooring, and security, along with capital cost. The latter cost may be essentially avoided by utilization of tank vessels from the reserve fleet maintained by the Maritime Administration.

Table V-1 is a listing of the tank vessels in the fleet on 1 August 1978.

TABLE V-1

U.S. MARITIME ADMINISTRATION

NATIONAL DEFENSE RESERVE FLEET

Type	Name	Location	Capacity
T-3	Aucilla	James River, VA	137,000 bbls
T-3	Sabine	"	138,000 bbls
T-3	Chikaskia	"	130,000 bbls
T-2	Tallulah	"	141,000 bbls
T-2	Saugatuck	"	141,000 bbls
T-3	Niobrara	Beaumont, Texas	134,000 bbls
T-2	Cache	"	141,000 bbls
T-2A	Monogahela	"	132,000 bbls
T-2A	Merrimack	"	132,000 bbls
T-2	Soubarissen	"	141,000 bbls
T-2	Schuylkill	"	141,000 bbls
T1-M	Peconic	"	31,000 bbls
	Trasverse	"	
	Transuperior	"	
T1-M	Chattahoochee	Suisun Bay, California	30,000 bbls
T1-M	Alatna	"	30,000 bbls
T-2	Chepachet	"	141,000 bbls
T-2	Mission Santa Ynez	"	141,000 bbls
T-2A	Tappahannock	"	132,000 bbls
T-2A	Kennebec	"	132,000 bbls

A detailed survey of these vessels would be required to determine their state of repair before they could be seriously considered for this purpose. More detailed study is needed of both of these approaches in providing the required lightering capacity and early implementation of the selected approach is recommended.

In the event that the ship's pumps are not usable for offloading because of loss of power, flooding of the pumproom or other causes, then lightweight, rapidly transportable pumps, prime movers, and hose systems such as the Coast Guard developed ADAPTS, and similar commercial systems are readily available. Portable pumping systems of this type have seen extensive pollution prevention service in the last few years. However, even with a large number of these pumps being used on a 100,000 DWT tanker, it would take a considerable amount of continuous operation to offload the tanker. Furthermore, while these pumps have a capacity on the order of 1,000 to 2,000 gpm at moderate temperatures for a nominal crude oil, pumping capacity for a residual fuel oil and many crudes at low temperatures can be one to two orders of magnitude lower. (The loss of operation of a tanker cargo heating system often leads to such conditions in winter months in our northern waters). The development of booster pumps, improved portable emergency cargo heating systems, and improved offloading transfer hoses is recommended to improve upon our current emergency pumping capability.

The proper positioning, control, and mooring of the lightering vessel as well as the stabilization of the stranded tanker itself in heavy weather conditions is a significant consideration in undertaking such an operation. It is recommended that the need for improved mooring systems and techniques for this application be examined in conjunction with the Supervisor of Salvage.

A possible future alternative to offloading to a lightering vessel is the use of high capacity oil burners (flares) to dispose of the cargo as it is pumped off the vessel. Such flares could be mounted on a barge as a disposal platform. However, current flaring equipment designed for exploratory drilling platform use has insufficient capacity to match offloading pumping capacity. In addition, high heat generation and attendant safety problems as well as other technical limitations remain to be resolved. Continued research and development is recommended since all work up till now has been directed toward other goals and does not provide an adequate basis for evaluation of this concept.

JETTISONING. The rapid freeing of a stranded tanker may be essential to avoid extensive damage due to the forces of storm winds, waves, and shifting currents. This situation could arise when lightering capacity as discussed earlier cannot be brought to the scene in advance of a heavy storm known to be approaching. If the vessel's machinery is still functional, but she is unable to free herself at high tide, it may be necessary to jettison a limited amount of cargo to refloat and free the vessel. This approach must be given appropriate consideration as a possible course of action to prevent the total loss of the ship and her cargo to the sea.

The proper equipment and data must be available to assess the vessel's situation in making this or any other salvage decision. While all of the required data are routinely produced during the design and construction of a tank vessel, there is currently no standardized format for the presentation of the data. In addition, there are no regulations or agreements which insure that the data will be available in a timely manner. It is therefore recommended that an agreement be sought through the Inter-governmental Maritime Consultative Organization (IMCO) to require the availability of the vessel's general arrangement drawings, tank capacity data, and curves of form (displacement and other curves) in a central repository.

BALLASTING. If freeing of a stranded tanker cannot be accomplished for any reason (loss of ship's power and pumps, unacceptable conditions, etc.) it may be important to stablize the ship pending later offloading and salvage operations. Stablizing the position of the ship is important to prevent hull damage and possible breakup due to dragging over the ocean floor, or excessive and abnormally located bending loads placed on the hull by virtue of the combined and changing forces of the wind, waves, current, and grounding reaction, during heavy weather conditions. Flooding of available spaces low in the ship would be a possible effective approach. The installation of high holding capacity emergency mooring systems (beach gear) would also be of value. Flooding of the tanker would require high capacity water pumps, or the use of shaped explosive charges, magnetically attached to appropriate positions on the interior or exterior of the hull. Ship and tank condition assessment tools and information as previously discussed are essential. All of the components mentioned are within the state-of-the-art, requiring only adaptation to the specific operational and logistic requirements of this program. It is doubtful at this stage that sufficiently large mooring systems could be transported to a stricken tanker except by surface vessel. Similarly, it appears that proper installation of sufficient numbers of such mooring systems (individual legs) during heavy weather will frequently not be feasible. Again, detailed consultation with the Supervisor of Salvage is intended for the purpose of identifying those concepts or systems which warrant development for this application.

SPILLED OIL RESPONSE

MECHANICAL RECOVERY. Once an oil spill has occurred, the objective of response is to minimize the environmental damage by limiting the spread of the oil and by removing the oil from the water. To date, there have been few successful large scale operations of this nature. Frequently the oil is "lost" or redistributed into the air and water through natural evaporation and dispersion or it reaches shore and is removed by labor intensive land based operations.

In open water areas, the problems of conducting response operations are considerably magnified by high sea states and adverse weather conditions. As stated in the main report, it is possible that spilled oil will not exist in a recoverable slick above wave heights of 10-12 feet. At the opposite end of the spectrum, present state-of-the-art equipment can operate with varying levels of effectiveness in up to sea state 3 with possible extension of capabilities up to sea state 4 by refining techniques and equipment. In order for a skimmer to be effective, it must follow the motion of the seas, and thus the oil slick. Although a number of skimmers are designed to withstand the rigors of open ocean use, many fail to operate effectively in the relatively low but steep waves which are present in the higher sea states.

There are a number of commercially available oil recovery skimmers which use different concepts for the removal of oil from the water. These skimmers can generally be divided into two groups in terms of their mode of operational application; (1) those that recover oil from a thickened pool created by a large boom with which they work; and, (2) those that act on an open uncontrolled slick.

Of those that operate with a boom, precise control of the boom and the skimmer is of great importance to successful operation. Ancillary equipment such as oil transfer hoses, and oil storage capacity must be considered if insufficient storage capacity is provided on the skimmer. Currents or speeds of advance of greater than about 1½ knots will result in large losses of oil past the system, further complicating the overall control problem. In order to reduce the complexity of the approach described above, the Coast Guard has developed a skimming barrier design which incorporates the oil removal function into the barrier itself. This design is considered to represent the state-of-the-art.

The skimming barrier is a direct modification of the Open Water Oil Containment System (OWOCS) currently in the Coast Guard inventory. Each OWOCS barrier itself is 612 feet long with a four foot high vertical curtain. Floatation is provided by CO2 automatically inflated pontoons attached to the back side of the barrier every six feet. To convert the OWOCS to the skimming barrier, six weir openings are installed at the center or apex of the barrier and small sumps are fitted to the back side of the barrier at each of these locations. Emanating from each sump, is a four inch flexible discharge hose which leads to a pump float positioned approximately 10 feet behind the barrier. The pump float itself measures approximately five feet by eight feet with a very small freeboard. Mounted on the float are three double diaphram pumps. The outlets of the three pumps are manifolded into a single six inch flexible hose of the appropriate length to reach a receiving vessel, barge or towed floating container. Hydraulic power to the pumps is provided by an ADAPTS prime mover through one inch hydraulic hose. Pressure requirements of the pump drive motors, require that the hydraulic hoses and thus the prime mover vessel platform be kept within 300 feet of the pump float (and thus the apex of the barrier). If a floating rubber container is used for receiving the recovered oil/water mixture, the ADAPTS support vessel (or another independent vessel) must be capable of towing the container.

While three of the existing 15 OWOCSs are currently being modified into skimming barriers, the system has some inherent limits and there are some technical gaps which remain to be solved. The system is limited to effective operation in sea state 3 (and possibly sea state 4), and in such sea states may recover a large proportion of water with the oil. Thus an oil-water separator to reduce the storage and transportation requirements for the recovered fluid is desirable. This development effort is presently underway and should be continued.

While the operational concept discussed above has been partially demonstrated in developmental testing and limited training exercises, fully developed and documented operational procedures remain to be established. As can be appreciated, the coordination of two or three vessels, the barrier, a storage container and a pump float is a difficult task. Present deployment techniques are also limiting since they require the use of small boats and swimmers to connect the pumping system to the barrier in the water.

Despite the limitations discussed above, the skimming barrier is believed to represent the most promising concept for open water recovery of spilled oil. It should be noted that the system is also usable in some harbor or protected water situations where sufficient vessel maneuvering room and water depth might exist. It could also be moored across the opening to a small bay or inlet. The good wave conformance of the barrier itself, coupled with its inherently large sweep width, provides a recovery concept which is effective yet relatively low cost. In order to increase its potential effectiveness, some thought is also being given to attaching an additional barrier section to each of the 612 foot skimming barrier section. Connection problems and the desired characteristics of the side sections require detailed examination. However, the concept has the advantage of greatly increasing the sweep width (and thus potential oil recovery rate). This will also improve vessel maneuverability by separating the tow vessels by larger distances.

Unit acquisition costs for the elements of the skimming barrier system are approximately:

Barrier	$ 100K
Skimming modifications	15K
Pumping system	20K
Prime mover	30K
Hoses & support equipment	10K

Most of the skimmers currently available for open water use are of the independent type. Some are self-propelled and of a sophistication comparable to a vessel. The non-self-propelled type require a seaworthy support vessel for control and maneuvering. None of the existing independent type skimmers have sufficient on-board tankage to sustain a recovery operation for more than a very few hours or minutes in some cases. Thus, these skimmers must also be provided with towed containers, barges, or sufficient storage capacity on a primary support vessel. Two non-propelled skimmers are currently in the Coast Guard Strike Force inventory. Termed the Open Water Oil Recovery System, they were designed, developed, and constructed under contract in a program which was started in 1970. The original prototype unit is now being repaired and modified while an operational unit was delivered in late 1977. The acquisition cost of these systems is approximately $800K per unit.

One of the main obstacles to effective use of independent type skimmers in open water is the fact that they have a very small (usually less than 20 feet) sweep width, and thus a relatively low potential encounter rate with respect to spilled oil. Thus in most instances, effective use of independent skimmers in open waters requires that they be used in conjunction with an open water barrier which herds or concentrates the oil so as to improve the efficiency of the skimmer. This is the operational concept for the Coast Guard recovery system discussed above. In such operations, the independent skimmers can be viewed as simply wave following pumping systems. When compared to the skimming barrier concept, they are in fact very complex and costly pumping systems which share nearly all of the skimming barrier shortcomings because of the required use of a barrier with them.

VESSEL OF OPPORTUNITY SKIMMING SYSTEM (VOSS). A concept which shows promise for oil recovery in higher sea states is the vessel of opportunity skimming system (VOSS) wherein a portable skimming device is used on various vessels of opportunity. The VOSS concept would thus incorporate the desirable features of the seaworthy platform (vessel of opportunity) and the ready mobility and flexibility of the skimmer package.

Preferably, the skimming device would be totally self-contained with its own source of power and handling systems. It should also be able to be used effectively from a wide variety of vessels such as offshore supply boats, fishing vessels, small tankers, offshore barges, tugs, or government owned (Coast Guard, Navy, etc.) vessels.

Because of the probable nature of the skimming device itself, it may be necessary to pre-adapt vessels with which it might be used. If such is the case, it may be necessary to primarily rely on Coast Guard and certain other government owned vessels to ensure the timely availability of the required vessels. In order for a vessel to be suitable for such use, it must be seaworthy in sea state 4 and above, which implies vessels of at least 100 feet and possibly larger. The vessel must have an open deck area of considerable dimensions (one system nearing completion of development is 35 feet long) for arranging the various components of the skimming devices such as prime mover, pumps, handling equipment, and hose manifolds. Since nearly every skimming concept operates best at slow speeds, the vessel must be capable of operating continuously at slow speeds in the range of 1-3 knots, and retaining considerable maneuverability at such speeds in varying sea conditions. On-board storage for recovered oil/water would be desirable, although not usually available in most candidate vessels. Since placing portable temporary tankage aboard is generally not feasible due to possible free surface areas with large weights of fluid above the vessel's center of gravity, the vessel must also be able to tow a barge or portable container.

Although it is not possible to fully analyze the availability of appropriate vessels until the full design details of the skimming device are completed, it is very likely that Coast Guard 210 foot WMECs and 180 foot WLBs will be suitable platforms for this purpose.

Several skimming concepts may be feasible. Studies to date indicate that a rope-type sorbent system appears to offer the best possibility for providing a wave-conforming, lightweight, and flexible skimming system. Additionally, the recyclable sorbent concept offers promise because of its inherent compliance with the water surface and high potential recovery efficiency. At this point, such devices are in the conceptual design or prototype development stage. Because of its potential for rapid mobilization and relatively low cost, the concept is recommended for pursuit by the Coast Guard as a developmental program.

<u>DEDICATED VESSEL.</u> The dedicated skimmer vessel system would in theory be the ultimate concept for open water recovery of oil in the highest sea state in which a slick might exist. Such a vessel could also be used for harbor oil recovery operations, depending upon the characteristics of the harbor area. The vessel would be a large, self-contained, manned vessel with a primary mission of oil spill response. Any of a number of recovery device concepts could be used, and on-board storage capacity for recovered oil could be incorporated, although other storage capability might still be required for periodic offloading. The vessel would have considerable space for on-board mounting of other oil spill response hardware such as booms, pumps, salvage gear, dispersant application hardware, and diving support equipment. Command and control equipment for coordinating on-scene oil spill response operations and towing capability for storage containers or barges could be incorporated in the design.

Reference (3) indicates that such a vessel should be at least 160 feet long to be able to effectively operate in the higher sea states. Design of the vessel itself would be compromise between the fastest possible transit speed to an oil spill, the need for a stable platform, and having sufficient accommodations for the variety of related spill response hardware which would be required. To meet such requirements, the hull would likely be of the catamaran type, with the most desirable possibly being a Small Waterplane Area Twin Hull (SWATH) configuration for which current technology exists. The skimming mechanisms would have the least relative motion to the oil/water surface if it were placed near the center of pitch, although the heave and roll characteristics of the vessel would also have to be considered. The maximum speed of such a vessel would likely be in the range of 30 knots with a cruising speed of 20 knots in a seaway. Slow speed maneuvering capabilities would also have to be incorporated to facilitate effective use in oil spill recovery capabilities such as search, rescue, surveillance, buoy tending, fire-fighting, etc., but consideration would have to be given to the overall oil spill response posture at any given time if the vessel were used extensively for other purposes in wide geographical areas - i.e. it may not be in the right place when needed for fast response to an oil spill.

Despite the favorable possibilities for dedicated skimmer vessels, the concept has some critical and overiding shortcomings. The most significant considerations are the limited range of operation, and the fact that the device will have a relatively small sweep width as compared to a skimming barrier. Both of these constraints can only be overcome by procuring a large number of these vessels, at a substantial cost. Furthermore, no such dedicated skimmer vessels exist at this time. They would therefore have to be the subject of a total development effort. Such an effort is estimated to require eight years at a cost of $5 - 10M, not including prototype construction and testing. Unit acquisition costs are roughly estimated to be in the range of $12 - 15M, with a production schedule of approximately two units per year. The personnel costs for the crew of about 50 and the required recurring vessel maintenance costs would further increase the costs of such a program. The possible existence of an upper limit of an oil slick at sea state 5 or 6 as previously discussed coupled with the high developmental risks, long acquisition time, and high life cycle costs of dedicated skimmer vessels lead the Task Force to recommend that their development not be pursued for Coast Guard use.

In addition to the critical need for large oil storage capacity on scene similar to that discussed earlier for tanker lightering operations, there is a similar need for provision of very low speed towing and maneuvering capability in all Coast Guard ships and boats intended to operate in open water conditions. As indicated by the Massive Spill Section of the main report, all the reasonably available vessel resources of the Coast Guard will be required to cope with very large spills regardless of the recovery concept employed. The limited number of Coast Guard ships and boats which can be expected to be available would in fact indicate that "standby status" contracts should be arranged with existing fishing vessels, offshore supply vessels, or similar fleets where they are known to have the required towing and control capability.

<u>SPILL RESPONSE IN ICE INFESTED WATERS.</u> Response efforts in ice infested waters are strongly influenced by the ice characteristics during a spill situation. Important characteristics which must be considered include the concentration and dynamics of the ice field, the age, porosity and thickness of the ice floes, whether the ice is growing or decaying and the amount of snow cover. The behavior of oil spilled in broken ice fields depends upon the oil and ice types (whether fresh water or salt water), the ice field concentrations, wind, waves and currents. Generally, light refined oils penetrate into the ice and flow

between the ice pieces. Crude oils and residuals spilled in broken ice conditions typically adhere to the ice surface and remain in relatively thick pools. The areal extent is strongly dependent on the concentration of the ice field and on the amount of rafting, pressure ridges and hummocks present. As expected, the more concentrated an ice field the more localized the spill will be. Wind and currents can cause localized pooling of light refined oils in pressure ridges and on rafted ice. However, they do not directly affect spill movement. Instead, these forces determine the dynamics of the ice which then interacts with the oil. Crude and residual oils which adhere to the ice cause melt pockets and holes during warming periods due to surface albedo differences.

The spreading rate and areal extent on an oil spill on or under shorefast ice is determined by the ice's roughness characteristics and porosity which result from its initial growth from pancakes and subsequent deformation by winds and currents. The areal distribution of a spill and spreading rate are much less than in open water because of absorption of oil into porous surface layers and the holding capacity of the surface cavities and depressions.

The presence of snow further inhibits the spreading of oil but also makes response operations such as surveillance and recovery more difficult. The most important factors which influence oil and snow interaction are the oil viscosity, snow crystal structure and temperature differences between the oil and the snow. When the temperature of the oil is greater than that of the snow, melt holes form which allow the oil to penetrate to a greater depth into the snow. The snow behaves like a sorbent and a stable mulch is formed which is approximatley 75%

water by volume. Oil saturated snow can ultimately form into an oil layer between two ice layers. Once a spill in ice has spread to its terminal radius it will remain relatively stable (unless the ice is very lightly concentrated and highly dynamic) until a warming period or spring thaw occurs. Therefore, although spills in ice infested waters are more complex than open water spills and response efforts must almost be tailored to each spill situation, there is generally more time available for these operations. Due to the wide range of ice conditions, three types of response systems are required. These are: (1) a system for use on shorefast ice; (2) a system for use in sub-arctic, or lightly concentrated dynamic broken ice field conditions; and, (3) a system for arctic or heavily concentrated dynamic ice field conditions. The sub-arctic dynamic ice response and a shorefast ice response system designed for ice up to 3 feet thick, are necessary now in the Great Lakes and Sub-arctic Alaska. The arctic dynamics ice response and a shorefast ice response system with increased capability, will be required once Arctic offshore development commences and icebreaking tankers become operational.

SHOREFAST ICE RESPONSE. A shorefast ice response operation is required whenever there is a release of oil beneath or on top of thick stable level ice. The thick ice and/or shallow water conditions prevent ready access by most marine vehicles including icebreakers. All response efforts must be conducted by work parties on the ice logistically supported by helicopters, air cushion vehicles, or conventional land based vehicles. Since the spill will remain relatively stable until the ice starts to deteriorate, tracking and monitoring of the spill movement are not necessary. The rough undulating under ice surface provides a substantial degree of spill containment for under ice spills while the presence of snow cover and surface roughness limit the areal extent of a spill on top of ice. Once it is initially located and the areal extent determined, response efforts are primarily concerned with gaining access to the oil trapped beneath the ice through the use of large drills, chain saws or shaped charge explosives, and with disposing of the oil as it is pumped to the surface. The process of drilling access holes into the thickened pools of oil trapped beneath the ice is labor intensive and will pace the entire response operation. Oil which is thinly spread must be pumped to the access holes by divers or special devices. When the spill is accessible by road, conventional disposal via trucks can be considered. Otherwise, the logistic difficulties associated with a spill of this type require that the recovered oil be burned through flaring or in-situ combustion if possible. Crude oil that is spilled on top of the ice can often be burned in-situ if it does not form an oil mulch. If a mulch is present, the contaminated snow must be transported to a disposal site where it is melted and the oil-water mixture separated.

Major differences between a fast ice spill response operation under Arctic conditions and one in the Great Lakes or northern rivers include the differences in ice thicknesses, the oil type and expected spill volume, and logistic and personnel support requirements. Arctic ice thickness can exceed six feet. Crude and refined oil spills associated with petroleum development will predominate in the arctic while residual and light refined oil spills from pipelines and shore transfer operations will occur in the lower 48 states. Since spill incidents in Alaska will most probably be associated with OCS development, it is likely that land based vehicles and support will be available. However, all dedicated response equipment and personnel will have to be brought to the area by heavy lift aircraft such as C-130s configured for landing on ice or snow packed runways. Aircraft with this capability are not in the Coast Guard inventory and must be acquired from DOD facilities. If specialized all terrain vehicles are not available at the site, it is likely that these vehicles will also have to be acquired from DOD facilities in Alaska. In no case is it expected that response efforts will be able to recover more than 25 to 30% of the amount spilled. The remaining oil will either be lost due to weathering or be trapped in the porous surface layers of the ice.

Much of the equipment needed for a shorefast ice response operation is within the state of the art; however, many of the response operations have yet to be attempted. Thus, in addition to research and development efforts to close system gaps in the state of the art, demonstration programs must be conducted before the Coast Guard can be considered to possess this type of response capability. Research and development efforts required include the development of electronic methods to detect oil under ice, the testing and development of diving systems for under ice operations, a demonstration of drilling techniques for accessing trapped oil, and the development of flaring disposal equipment and suitable incendiary devices.

<u>SUB-ARCTIC DYNAMIC ICE RESPONSE.</u> A sub-arctic dynamic ice response operation is required whenever there is a release of oil beneath or among a lightly concentrated dynamic broken ice field. Ice coverage during this type of operation ranges from 20-60%. Ice thickness that must be addressed during a sub-arctic response operation range from 0.25 to 3 feet. These relatively low concentrations

of unstable thin ice require that the response be totally marine based since work parties cannot otherwise be safely deployed on the ice. Helicopter support is necessary only for surveillance, cleanup monitoring and emergency evacuation. Spill movement models and remote tracking devices are required to aid in surveillance and cleanup. All equipment required including logistic support and personnel protection must be specially designed to operate in a low temperature oil/ice/water environment. Special materials, lubricating fluid and operating procedures are required. A conventional sweeping mode recovery system utilizing narrow diverting barriers must be adapted to operate in ice concentrations up to 20-40%. Features which must be incorporated into the recovery device include an ability to handle heavy viscous oils and to process oil coated chunks of ice. Two specially modified disk drum oil recovery devices have been placed in the Coast Guard response equipment inventory as a result of field and tank tests of off the shelf equipment in 1974. These skimmers provide some interim capability to process coated pieces of ice up to 1 foot thick and 6 feet in diameter but are limited in their capability to handle viscous oils. Barriers used in conjunction with the recovery devices or in containment and diverting modes must also be specially designed such that they are not destroyed by ice forces but instead release the contaminated ice whenever barrier loads are excessive.

Barriers which possess these required design features have been identified and are currently being procured. In ice concentrations greater than 40%, additional ice diverting booms are necessary. Feasible designs exist for this type of boom. Transfer pumps must have the capability of passing oil/ice/water mixtures. Recovered fluid heating equipment will frequently be required to transfer weathered crude and residuals. Some residual spills may require that contaminated ice be melted either by adding heat or natural thawing before the oil can be separated, recovered and disposed. Disposal is a more serious problem than in open water response operations and a flaring disposal capability is desirable.

A sub-arctic dynamic ice response system designed for Alaska will differ from one designed for use on the Great Lakes and in the northern rivers and harbors in that it need not include equipment designed for residual fuel spills. However, it must meet more difficult logistic deployment contraints and perform under more severe environmental conditions. All support vessels required for the response operation must have, in addition to capabilities outlined in other sections of this report, some icebreaking or ice transiting capability. All response equipment for Alaskan applications must be configured for delivery by C-130 aircraft. Heavy lift helicopters may frequently be required for equipment deployment. This capability will have to be supplied from DOD facilities.

The research and development initiatives needed to improve the existing sub-arctic response posture include: (1) development of recovery devices suitable for use in a broken ice field and capable of recovering highly viscous oil; (2) development of transfer systems capable of handling oil/ice mixtures as well as viscous oils; and, (3) development of a flaring burner for oil disposal.

<u>ARCTIC DYNAMIC ICE RESPONSE.</u> An Arctic dynamic ice response operation is required whenever there is a release of oil among a heavily concentrated thick broken ice field. Ice concentrations during this type of response operation will exceed 60% coverage. The ice field will frequently include extensive pressure ridges and

hummocks. These high ice concentrations require that any recovery operation be controlled and logistically supported from a Polar Icebreaker, although all response efforts must be conducted by work parties on the ice and remotely from aircraft or helicopters. Operations conducted by work parties using small portable skimmers and pumps capable of handling viscous oils and small particles will be necessary to recover oil which has become trapped in the pressure ridges and rubble fields that form in a vessel's track. Because of the logistically remote areas where the Arctic dynamic ice spill response operation will be required, disposal by any method other than in-situ burning or on site flaring does not appear feasible.

An Arctic dynamic ice spill response system is not expected to be required until the 1990s when OCS development in the Chukchi sea has progressed to a point that icebreaking tankers are being considered for crude oil transport. Furthermore, at that time the inventory of equipment need not be overly extensive. Redundant sites will also be unnecessary since all logistic support must be provided by Polar Icebreakers. Therefore, the development of an Arctic dynamic ice response system need not commence until 1983, and many of the necessary research initiatives will have already been concluded in the development of the other ice related systems. The major new initiatives involve the development of helicopter deployable incendiary devices and oil wicks which can be dropped onto exposed pools of crude oil obviating the necessity for deploying work parties.

<u>REDISTRIBUTION TECHNIQUES.</u> An alternative to oil spill recovery is redistribution of the oil into the water by the use of chemical dispersants or sinking agents or

into the air by burning. The potential effectiveness of these alternatives has been examined since there are definitely some circumstances in which it will not be possible to accomplish mechanical recovery. The environmental impacts of the approaches have also been examined.

While sinking of an oil slick by the addition of sand, chalk, or other material may result in initial success in removing oil from the ocean surface, there is the immediate concern with the impact on the bottom where the oil is sunk. This concern coupled with several other limitations regarding the long term effectiveness of the technique has led the Federal government to establish a policy that prohibits the use of sinking agents.

Burning an oil slick on the ocean surface in an open water wave environment does not appear feasible at this time. However, there is general interest in the potential for this technique, and its capabilities and limitations are not currently well understood. Burning oil in the "quiet water" environment of an oil spill in various ice conditions is considered the most promising approach to spill mitigation for reasons discussed previously. Continuation of current research and development efforts to fully evaluate and define the capability of in-situ burning is therefore recommended.

The use of chemical dispersants to remove the oil from the water surface and suspend it as tiny droplets in the water column, is a technique that warrants continued research and development as well as the establishment of an operational capability by the Coast Guard. The technique for surface vessel application has been developed and refined over a period of ten years by the British, who have structured a national spill response posture around the use of dispersants. Aerial application techniques using both helicopter and fixed wing aircraft have been under active development recently as a result of the formulation of "self mixing" dispersants which do not require significant mixing energy upon application to be effective. During the past year, the Environmental Protection Agency (EPA) has accepted the product data on eight dispersants, the first such data to be submitted as is required by the National Contingency Plan.

This, together with greatly improved formulations with regard to toxicity, and the fact that the use of dispersants constitutes the only known response action that can presently be used in all sea states in which an oil slick might exist, indicate that the Coast Guard should have the capability to use dispersants. As suggested above, aerial application appears operationally feasible in all weather conditions in which an oil slick could exist. Dispersants, however, are quite expensive ($7 or $8 a gallon for the "self mix" type which would be required for aircraft application) with little near term cost reduction anticipated. An application ratio of 1 gallon dispersant to 10 gallons of oil treated may be taken as a "rule of thumb" to assess the potential cost. Ratios as low as 1 to 50 are claimed by some manufacturers, but these do not account for inefficient application which is a very real problem in the field. Others argue that the effective ratio is really 1 to 1. These same figures when applied to a practical spill response scenario using either vessel or aerial application indicate that a major logistics problem is involved in mounting a large dispersant treatment response. Notwithstanding the above discussion, much controversy remains regarding dispersant effectiveness, their effect on the environment, and the proper testing techniques for determining these effects. Continued research on all these matters by the EPA and other interested agencies is considered essential, and is included in their current and future plans.

Dispersants are most effective on very thin slicks, whereas, mechanical recovery systems function best on thicker slicks. It is quite plausible then, that in dealing with a large spill situation, that a response which includes mechanical control and recovery near the spill source and dispersants at some distance, after the spill has spread and thinned, may be the best overall strategy, in a particular situation.

A national inventory of a sufficient quantity of dispersant to handle 10% of a 100,000 ton spill is considered appropriate. Based on assessments of commercial stockpiles it is considered necessary that the Federal government purchase approximately $1.2M of dispersants to meet this goal.

VI. RESEARCH AND DEVELOPMENT PLAN

GENERAL. A Research, Development, Test, and Evaluation program totaling $21.M over the next five years is recommended to support an improved pollution response capability. Three major elements are included:

- o Prevention and Amelioration $6.9M
- o Open Ocean and Fast Current Oil Control and Recovery $9.2M
- o Ice Infested Waters Pollution Response $4.9M

These figures include all oil pollution response projects which have been discussed in the main report as well as those which are a part of the current research and development plans extending over the next five years. The discussion in the main report is not repeated herein. Those R&D projects which have not been elaborated on elesewhere in the supplemental or the main report are identified and briefly commented on in this section to indicate their relationship to the total program. A project listing of all proposed research is included in Table VI-1.

PREVENTION AND AMELIORATION. The Task Force has concluded, as have past studies, that the greatest potential benefit will be derived from pollution prevention efforts. From a pollution response viewpoint this amounts to tanker (or other vessels) salvage. The applicable currently planned research and development project, G-DOE project area 4117, should therefore be accelerated and significantly expanded. The extreme weather response systems evaluation study completed as background for this report has identified tanker and lightering vessel mooring systems, ships and cargo assessment tools and techniques, high capacity water pumps, booster cargo offloading pumps and floating hoses as candidates for development efforts. A general improvement in the Federal response posture may be achieved by a straightforward engineering design, test, and evaluation effort with regard to certain of these items. Others are seen as being amenable to significant improvements in the technology through a research and development effort. Each development will be complicated by the desire to provide high capacity systems at minimum weight and minimum packaging dimensions. Due to the intended application in situations involving varying combinations of highly unfavorable working conditions it is essential that all systems or subsystems be thoroughly tested during development. The proposed budget provides for a mix of relatively short term development and testing effort and longer term innovative research efforts.

A longer term effort recommended as an approach to providing an alternative to the temporary storage, transportation, and disposal of offloaded product is the development of a pump fed cargo flaring system. Although the prospect for eventual development of a high capacity system which can safely be used for this purpose does not appear promising, continued study and testing of this and alternate approaches to the controlled burning of the cargo on site is recommended.

The development plans for the foregoing topics must be worked out in close consultation with the office of the U. S. Navy Supervisor of Salvage, since that office is tasked with providing the Coast Guard with salvage assistance during pollution incidents.

The development of a low response platform from which to carry out a tanker salvage operation, and of floating breakwaters to provide a protected "lee" for the operation have been recommended by one of the background studies, but was rejected by the Task Force. Rejection of the low response platform was based on its anticipated high cost, low probability of appropriate circumstances for successful actual utilization, and limited range of operation for a single unit. This latter constraint would dictate a high national inventory. Rejection of the floating breakwaters, which are projected as being of the size of ships hulls is based on the same arguments coupled with the expectation that only moderate surface calming would result from their use.

OPEN OCEAN OIL CONTROL AND RECOVERY. It has been previously stated that preliminary information indicates that most oils will be naturally dispersed into the water column by wind driven seas of about 10 to 12 foot average wave height. The distribution of oil droplets to several meters below the surface has been observed under various circumstances. We are not, however, in a position to make legitimate useful predictions of the expected behavior of various oils spilled under varying weather and sea conditions. It is important to note that in many instances when natural dispersion has occurred, the oil has resurfaced and reformed as a slick with the moderating of the sea conditions. An improved understanding of the oil properties and the environmental conditions which determine the natural fate of an oil spill and the limits of existence of an oil slick is considered essential to achieving the following goals:

- Provide an improved "design limit" for the development of open ocean pollution response systems.

- Provide an operational capability for prediction of the subsurface movement of a dispersed oil spill and for its reappearance with moderating weather conditions. (This would facilitate decisions regarding deployment of appropriate equipment and personnel during a spill response situation.)

For these reasons continuation of a current project to provide the required understanding and predictive capability is recommended.

Initiatives to resolve the many problem areas in the utilization of Coast Guard owned as well as commercially available recovery systems and barriers in Sea State 3 and Sea State 4 conditions are recommended. These initiatives include extensive open ocean testing to validate performance projections, to identify required design modifications, and to facilitate the development of detailed operational plans for the use of the various systems. The development of these plans through such testing is considered vital to the successful execution of any open ocean spill response operation. The development of new subsystems to enhance the performance potential in these sea conditions is included as part of this project.

Development of the Vessel-of-Opportunity Skimmer (VOSS) concept as a potential approach to extending recovery capabilities to Sea State 5 is included. An initial prototype design, construction, test, and evaluation effort for a VOSS system for use in Sea State 3 is ongoing at this time. Based on several years of background research, the system uses sorbent polyurethane foam cubes for oil recovery. The sorbent is broadcast, harvested, and recycled for rebroadcasting to minimize the logistic requirements for the sorbent material. The development of several other concepts supported by the U.S. Navy and private industry is being closely monitored for potential application to Coast Guard requirements. The "ZRV" concept currently under development by the Coast Guard for protected water application is also considered a candidate for VOSS application in open water.

Accelerated development of air and surface delivery systems for dispersants is recommended in order that this capability can be made available to the On-Scene Coordinator in those circumstances where the use of dispersants is appropriate and acceptable. The background study recommended efforts to develop more effective dispersants and to identify areas where their use would be acceptable. These topics are under the purview of EPA and the National Response Team. The Task Force recommends that continued study of these topics by the appropriate agencies be encouraged, but that such studies should not be initiated by the Coast Guard at this time. (It should be noted that the EPA, Department of Energy, private industry, and various foreign interests have very active ongoing programs which include these topics). The Coast Guard should however develop systems for applying dispersants from Coast Guard cutters and aircraft.

The extreme weather response study also recommended the initiation of studies of sophisticated ocean going dedicated oil recovery vessels, with catamarans, or the more advanced Small Waterplane Area Twin Hull (SWATH) identified as the most promising concept. Such vessels could conceivably recover oil in any sea condition in which a slick could exist. Active development of this concept is not recommended at this time.

High life cycle costs combined with a very limited range of operation as well as minimal sweep width that the vessel would have are the overriding considerations. It should also be noted, however, that the development of advanced surface vessels by various interest groups will continue and that at any point it would be possible to initiate a design effort which would "marry" the most promising open ocean oil recovery concept(s) to a more appropriate surface platform if the VOSS concept proves inadequate for the desired level of capability. In fact several preliminary design studies for such oil response vessels are currently being reported, both in the U.S. and in foreign countries (notably those interested in the North Sea developments where weather conditions are quite severe and where it appears that the financial burden for "adequate" response equipment will be placed directly with the developers of the oil interest by the various governments).

Lastly, with regard to open ocean systems it should be noted that the background study concluded that in-situ burning of oil for Sea State 4 and above, even with the use of a confining fire-proof barrier does not look promising and recommended against development efforts. There is, however, general interest in this technique and its capabilities and limitations are not currently well understood. Burning of oil in the "quiet water" environment of an oil spill in various ice conditions has been demonstrated as feasible and is considered the most promising approach to spill mitigations for reasons discussed previously. The Coast Guard and the Department of Energy are currently co-sponsoring a feasibility study of in-situ burning. The recommended research program includes funds for continued research and development of this concept should the feasibility study indicate sufficient merit for development for any application. If the feasibility study indicates that the concept does not warrant further effort these proposed funds would be reprogrammed. The study results will be available in mid to late FY 1979.

ICE INFESTED WATERS POLLUTION RESPONSE. Section V described three different conditions of ice infested water and the influence these would have on a pollution response operation. Currently there is very limited operational capability to deal effectively with an oil spill under these conditions. It does appear that the most promising approaches involve the adaptation of equipment and procedures that have been previously developed for other purposes. Table VI-1 includes a summary of the recommended research and development effort, organized by the type of ice conditions to be dealt with. Extensive field testing to validate system concepts, to identify design details requiring modification, and to develop and document operational procedures is considered an essential part of these efforts. Because of the extremes of the conditions to be dealt with, the systems proposed for development are not viewed as providing an ability to physically remove the majority, or even a substantial portion of the spilled oil in some circumstances. In order to do so in a heavily ice infested environment the use of an ice processing vessel would be required. This vessel would physically process pieces of ice, remove the oil from on and from within the ice, and then return the ice/water to the sea. In addition to the complex system required for this purpose, the vessel would require an ice-worthy hull. Development of such a costly concept is not considered justified at this time. The background study addressing cold weather response has recommended against it and the Task Force concurs in this view.

REQUIRED RESOURCES. Execution of the plan outlined in Table VI-1 is estimated to involve an average of 28 new or follow-on contracts a year requiring 22 project officers in the Office of Research and Development and 4 individuals in the Office of Comptroller to serve as contract negotiators and administrators. FY 1979 resources include 12 project officers and 3 contract negotiators/administrators. Ten additional project officers and one negotiator/administrator postions are therefore needed to carryout this program. These figures include consideration of the current and anticipated future role of the Coast Guard Research and Development Center in pollution response projects. FY79 supervisory position levels are considered adequate. The FY79 level of oil pollution response research and development is expected to be $ 1.7M.

TABLE VI-1

OIL POLLUTION RESPONSE RESEARCH AND DEVELOPMENT PROGRAM

CATEGORY/PROJECT	ANTICIPATED COST ($000s)
I PREVENTION AND AMELIORATION	
(a) High Capacity/High Viscosity Pumping	1,500
1. High Capacity Pumps	
2. Cargo Heating	
(b) Cargo Burning	1,000
1. Flaring	
2. Advanced Concepts	
(c) Tanker Mooring Systems	1,000
Moorings and Winches	
(d) High Capacity Ballast Systems	500
(e) Barge Mooring Systems	400
(f) Large Diameter Lightweight Hoses	1,000
(g) Sunken Vessel Offloading (Preliminary Effort)	500
(h) Ship and Cargo Tank Assessment (Advanced Concepts)	500
(i) Outflow Prevention (Preliminary Efforts)	500
1. Cargo Jelling	
2. Membrane, etc.	
	6,900

II EXTREME WEATHER RESPONSE (non-ice)

(a)	Dispersants	1,200
(b)	Modular Skimmer Systems (VOSS units)	2,000
	1. SORBS	
	2. ZRV, others (open ocean)	
(c)	Open Ocean Barrier/Skimmer Systems	1,500
	1. Barrier Extensions	
	2. Recovery Systems - Open Ocean Testing	
(d)	Rigid Rapid Response Container/Separator	200
(e)	Separator Subsystem	600
(f)	Oil Slick Limits/Behavior Studies	400
(g)	Disposal Systems	1,500
(h)	Fast Current System - Harbor and Rivers	600
(i)	Inter-Agency OHMSETT Testing	800
(j)	Slick Burning	400
		9,200

III ICE INFESTED WATER RESPONSE

A.	Shore Fast Ice		1,800
	1. Sensor/Detection/Under Ice Marker	540	
	2. Access Device Development & Tests	350	
	3. Igniters for in-situ Burning	790	
	4. Arctic Oil Response Clothing	120	

B. Sub-Arctic Dynamic Ice Response		2,100
1. Tracking/Modeling Systems	800	
2. Recovery Device Tests	600	
3. Viscous Oil/Ice Transfer	300	
4. Flaring/Pit Disposal	400	
C. Arctic Dynamic Ice Response		1,000
1. Personnel Logistics Support	100	
2. In-Situ Combustion Incendiary Devices	500	
3. Tracking/Modeling Systems	200	
4. Lightweight Skimmer Heads	200	
		4,900
IV TOTAL PROGRAM		$21,000

SUMMARY OF COSTS TO IMPLEMENT PRESIDENTIAL INITIATIVES REGARDING POLLUTION RESPONSE

TASK	COST ($,000s) Non-recurring	Recurring
Equipment Emergency Port Task Forces (EPTFs) (includes 11 AC&I positions for 3 yrs)	33,600	1,900
Provide Personnel for EPTFs (333)	536	4,100
Site Construction and Land Acquisition to house EPTFs, Equipment, and relocate Strike Teams to high spill potential areas. (includes 14 AC&I positions for 3 yrs)	13,600	2,300
General Support		
1. Provide for training (includes 6 personnel)	400	440
2. Provide diving capability and salvage expertise to make rapid vessel damage assessment possible (25 personnel)	50	360
3. Administration (27 personnel)	66	600
Improve the Implementation of Existing Technology and Procedures		
1. Seek international agreement to make technical information for performing damage assessments on tankers readily available.		
2. Assure availability of support vessels for offloading and recovery operations.		300
3. Improve operational techniques for oil recovery.	600	
4. Insure adequate availability of dispersants and support craft.	1,200	
5. Develop characteristics for future and modify existing Coast Guard cutters to support marine environmental protection program.	8,500	

TASK	COST
Research and development effort to support necessary advances to state of the art. Principal programs in the effort follow. (includes 10 R&D positions)	$4.4M per year
1. Improve vessel assessments/salvage capabilities/offloading equipment.	($6.9M over 5 years)
2. Advance sea state in which oil recovery units will function.	($8.9M over 5 years)
3. Develop Arctic/ice response capability.	($4.9M over 5 years)

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1. "Deployment Requirements for U. S. Coast Guard Pollution Response Equipment", Report No. CG-D-63-78, Transportation Systems Center.

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3. "Investigation of Extreme Weather Oil Pollution Response Capabilities" Seaward International, Inc.

4. "Spill Cleanup Equipment Inventory", U. S. Coast Guard, (G-WEP-4), COMDTINST 16465.9, July 1978.

5. "Salvors Handbook", U. S. Navy, NAVSEA Pub. 0994-LP-017-8010.

6. "Emergency Ship Salvage Material Catalog" U. S. Navy, NAVSEA Pub. 0994-LP-017-3010.