AD-A127 309 FEASIBILITY OF USING RECON III-B AS A COAST GUARD HAZARDOUS CHEMICAL SPIL..(U) PERRY OCEANOGRAPHICS INC RIVIERA BEACH FL G S MANERS ET AL. SEP 82 USCG-D-6-83 1/1

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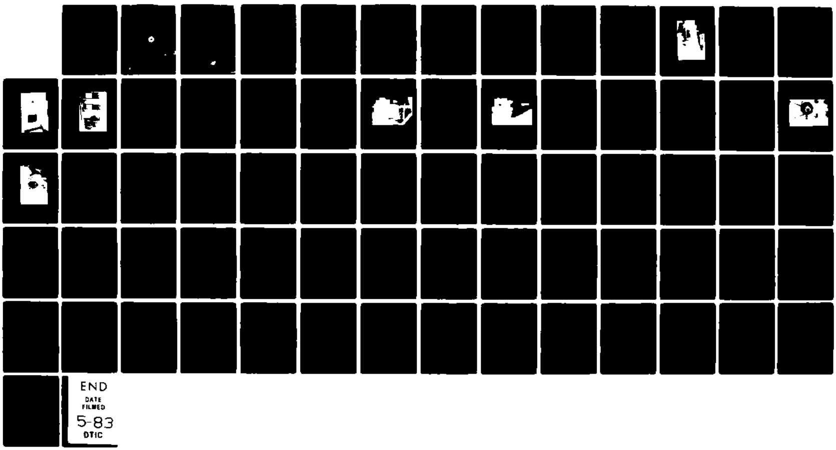

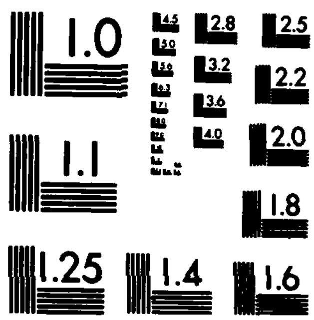

MICROCOPY RESOLUTION TEST CHART
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and

Richard T. [illegible]

U.S. Coast Guard Research and Development Center
Avery Point Groton, Connecticut 06340

September 1982

FINAL REPORT

PREPARED FOR
U. S. DEPARTMENT OF TRANSPORTATION
UNITED STATES COAST GUARD

OFFICE OF RESEARCH AND DEVELOPMENT
WASHINGTON D.C. 20593

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16. Abstract

A field test was performed in order to assess the RECON III-B vehicle performance characteristics in a standard configuration, and with Coast Guard payload for hazardous chemical spill response tasks. The specific mission tasks are to (a) provide remote inspection, damage assessment and documentation of an endangered tankship or barge that is carrying hazardous chemicals *in bulk*; (b) provide the capability for remotely plugging a ruptured vessel hull using the Coast Guard foam plugging device; and (c) deploy sampling devices to obtain water samples in and around the spill site and return them to the support vessel. The second part of the report consists of a compatibility study of the materials used in construction of the RECON III-B and a representative list of hazardous chemicals.

The field tests showed that RECON III-B is capable of performing the required tasks under most conditions. The vehicle successfully performed inspection, sampling and plugging tasks during the test. Surface wave-induced surge hampers the plugging procedure due to the reduction in the vehicle's station keeping ability in near surface rough water conditions. The tests also showed that the configuration of the Coast Guard's foam plugging device should be modified to be acceptable for remote vehicle deployment. The hazardous chemical/vehicle compatibility study concludes that the RECON vehicle is acceptable for operation in hazardous chemical environments as defined in the study parameters.

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METRIC CONVERSION FACTORS

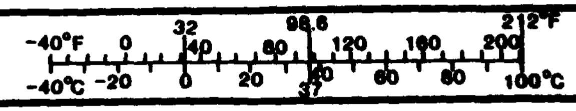
Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (WEIGHT)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (EXACT)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures. Price $2.25. SD Catalog No C13.10.286.

Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (WEIGHT)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	0.125	cups	c
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (EXACT)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



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SECTION 1

SUMMARY OF RESULTS

The test procedure and study documented by this report were performed to evaluate the ability of a remote vehicle system to perform pollutant sampling and vessel hull rupture plugging during hazardous chemical spills.

Part I testing in which a RECON® III-B vehicle was used to take water samples and plug test target holes using preselected equipment supplied by the U.S. Coast Guard has shown that a remote vehicle is capable of performing the necessary tasks, under certain conditions. The tests have also shown that the configuration of the plugging wands used in, but not designed for, the tests is not acceptable for use in a remote vehicle application.

The hazardous chemical vehicle effects study concludes that the RECON® III-B vehicle is acceptable for operation in hazardous chemical conditions as defined by the United States Coast Guard. Only one substitution requires attention, this being vehicle paint, but it is not mandatory for successful operation. Otherwise the RECON® system, as is, will perform in the defined hazardous chemical environments with the high reliability shown in the commercial operations. This work was performed for the Department of Transportation, United States Coast Guard, per contract DTCG39-81-C-80311.

RE: Proprietary Information, Attachments 2 and 3
Attachments 2 and 3 do not contain Proprietary Information per Mr. Richard T. Walker, U. S. Coast Guard R & D Center, Groton, CT

SECTION 2
INTRODUCTION

The marine transportation of hazardous chemicals has shown dramatic increases in recent years. As a result of the rising trade in these materials, there is a corresponding increase in the potential threat to the marine environment and welfare of the general public due to the possibility of an accidental spill of such material. The responsibility of responding to hazardous chemical spills within the waters of the U.S. has been delegated to the Coast Guard. This mission is carried out through the Captain of the Port office and the Coast Guard Strike Team responsible for the given area. Presently, however, the Coast Guard cannot respond satisfactorily to the complete range of hazardous chemical spills due to the inadequacy or non-existence of appropriate methods and hardware. In order to improve the Coast Guard's capabilities in the event of a hazardous chemical spill, a program entitled "Hazardous Chemical Discharge Amelioration" was developed. The objectives of this program were to develop methods and equipment for responding to hazardous chemical spills in U.S. waters, and to expand and improve the Chemical Hazard Response Information System (CHRIS) hazard assessment models. Under this program, the Coast Guard Research and Development Center is responsible for the Project Area of "Hazardous Chemical Discharge Prevention and Reduction." This project is directed at the investigation and development of techniques and hardware designed to prevent the discharge of hazardous chemicals from an endangered marine vessel, and to stop or reduce the spillage from a marine transport container which is already leaking.

Previous work under the overall program has resulted in the development of several pieces of hardware which extend the Coast Guard's chemical pollution response capabilities. Among these are: a) Protective suits with integral breathing apparatus and environmental monitoring devices for personnel working in hazardous areas; b) The Vapor Reduction Device which reduces toxic vapor concentrations around a deck opening during pumping operations conducted while a vessel is undergoing emergency lightering of hazardous chemicals; c) The polystyrene foam plug, evacuated foam plug, and the air/water inflatable bag plugging system for the reduction of hazardous chemical discharges due to vessel hull damage; and d) An over-the-side deployment system using an underwater video camera for vessel hull damage assessment.

In addition to d) above, a study of more advanced techniques for damage assessment and related tasks resulted in a report entitled "State-of-the-Art Survey of Hardware Delivery and Damage Inspection Methods for Coast Guard Hazardous Chemical Spill Response." This report investigated potential techniques and hardware for accomplishing the following mission objectives:

a) Provide inspection, damage assessment and documentation capabilities of an endangered tankship or barge that is carrying hazardous chemicals in bulk.

b) Provide a platform capable of delivering the polystyrene foam lance plugging system.

c) Provide the capability to deliver a chemical sensor or sampling hardware to a spill site to obtain information relevant to the detection, identification, and quantification of the spilled material.

Based upon criteria established in the report, the most viable approach to accomplishing the stated mission objectives is by using a Remotely Operated Vehicle (ROV). ROVs represent a capable and rapidly improving group of small, tethered, unmanned submersible vehicles. Within this group, the RECON III-B vehicle, manufactured by Perry Oceanographics, was ranked highly based on its relatively light weight, small size, payload capacity and cost.

The RECON III-B system consists of 3 major components; the deployment module, including the operating vehicle and tether management system, Figure 2-1, the handling system which includes the winch and boom, Figures 2-2 and 2-3, the control module consisting of the main vehicle console, Figure 2-4, and the auxiliary console, Figure 2-5.

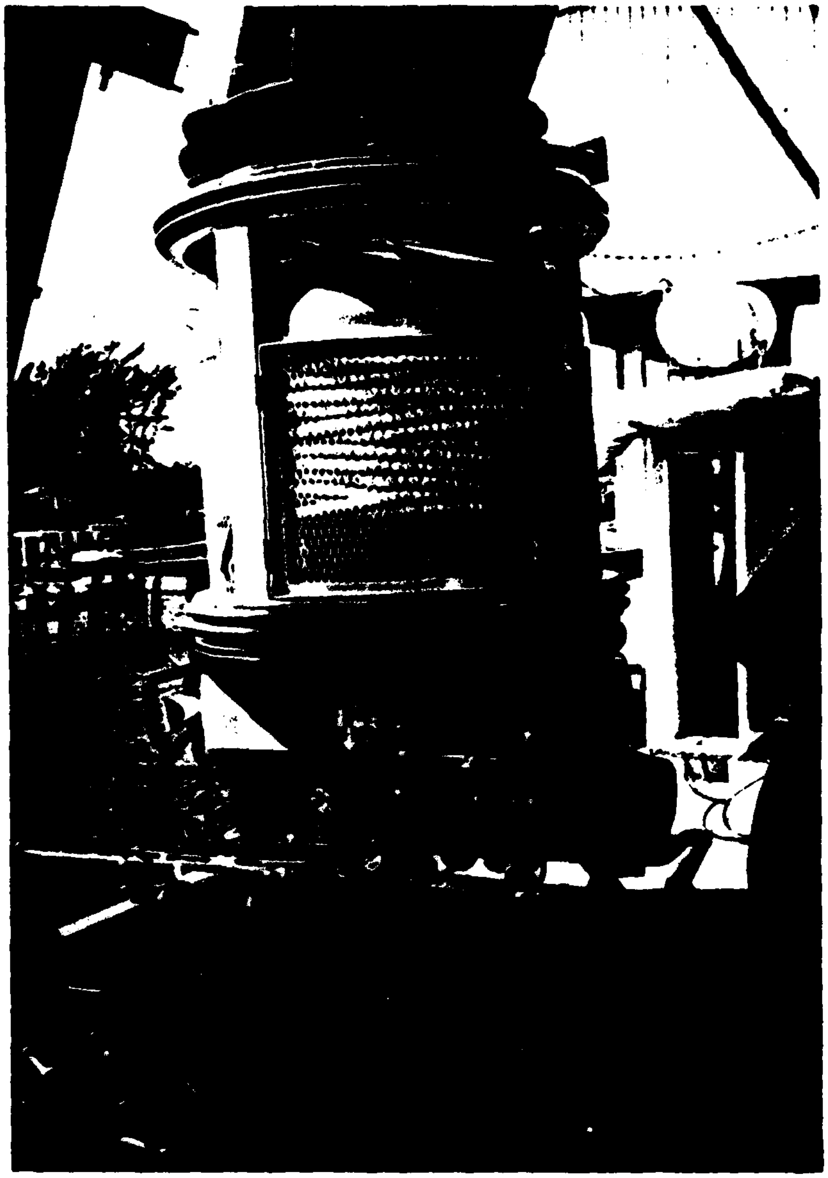

FIGURE 2-1. RECON III-B Deployment Module

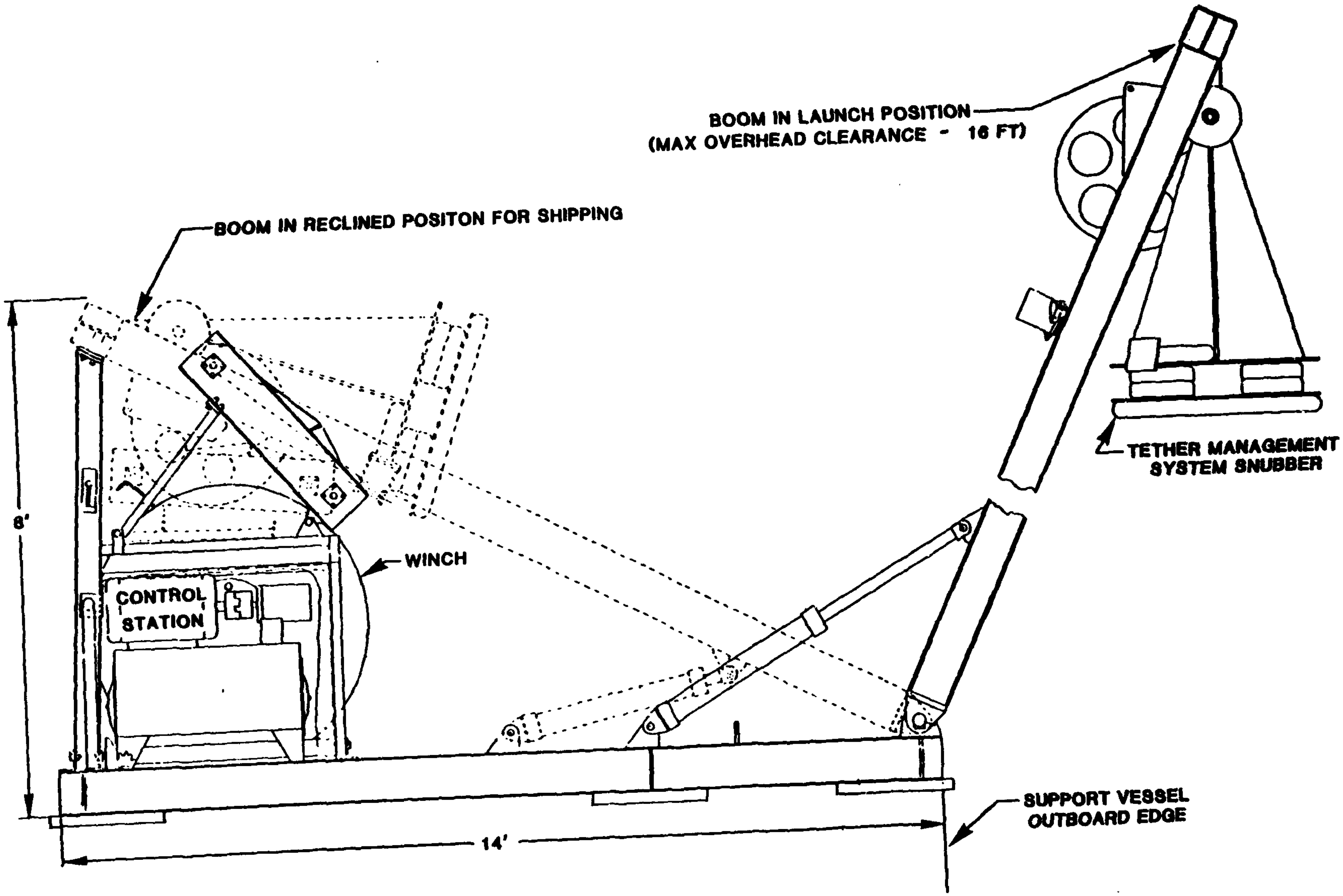

Figure 2-2 RECON III-B HANDLING SYSTEM (SIDE VIEW)

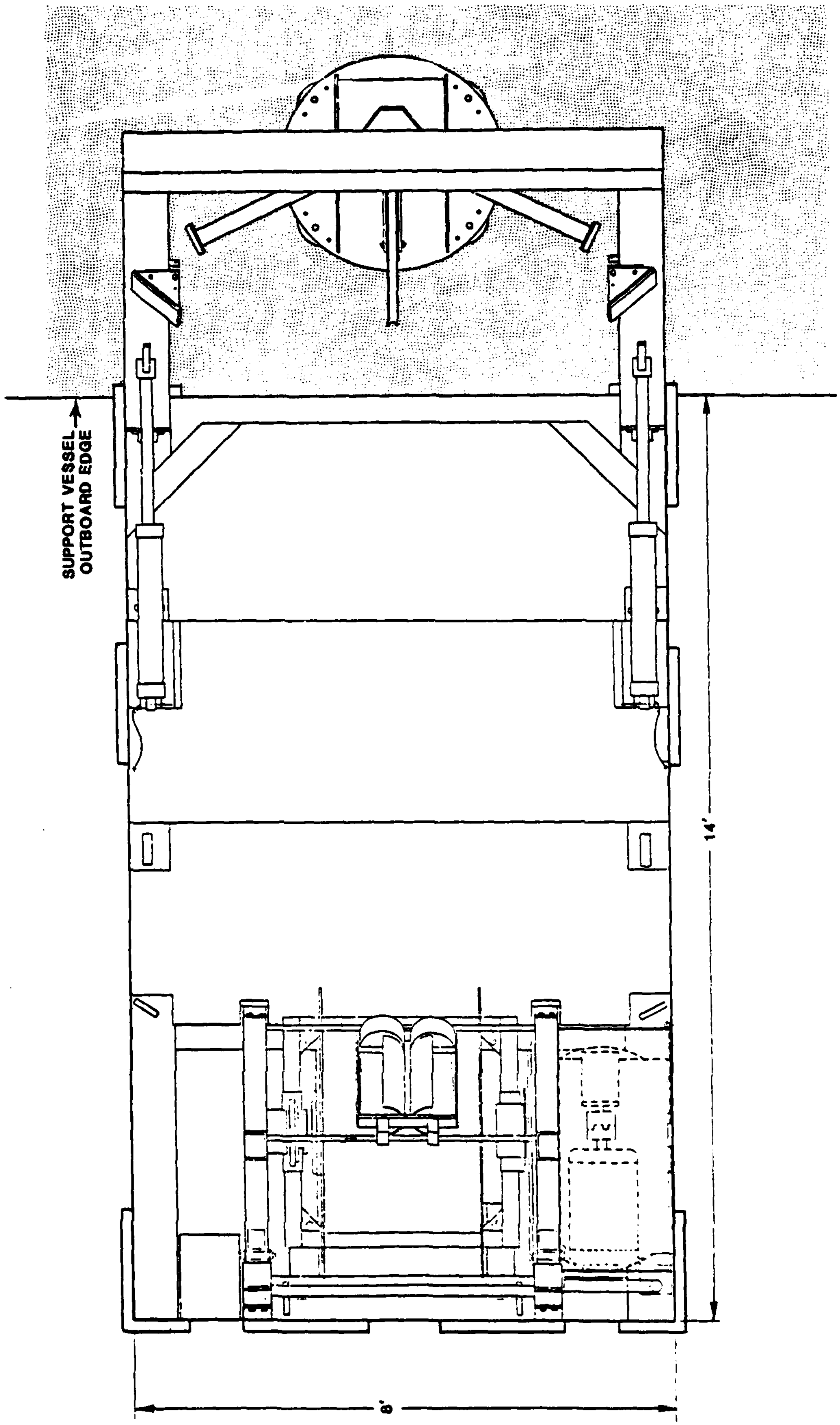

Figure 2-3 RECON III-B HANDLING SYSTEM (PLAN VIEW)

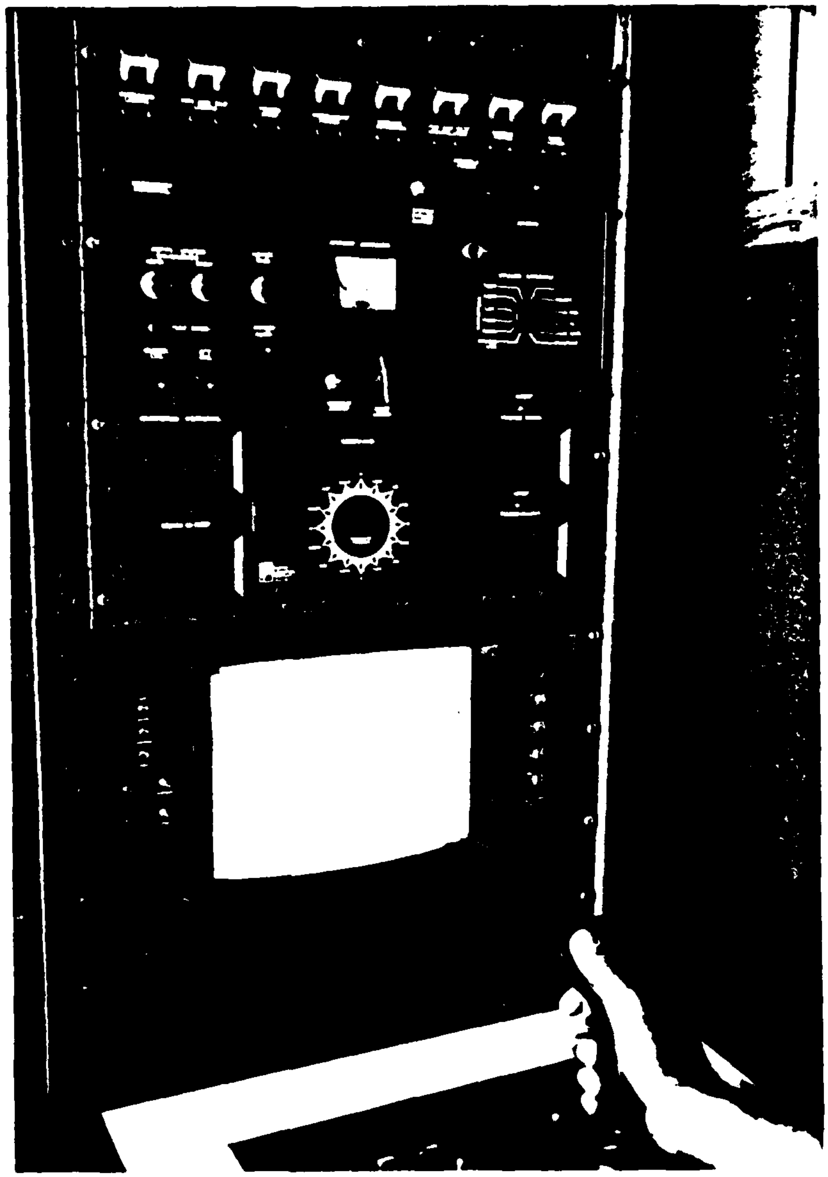

FIGURE 2-4. Main Vehicle Console

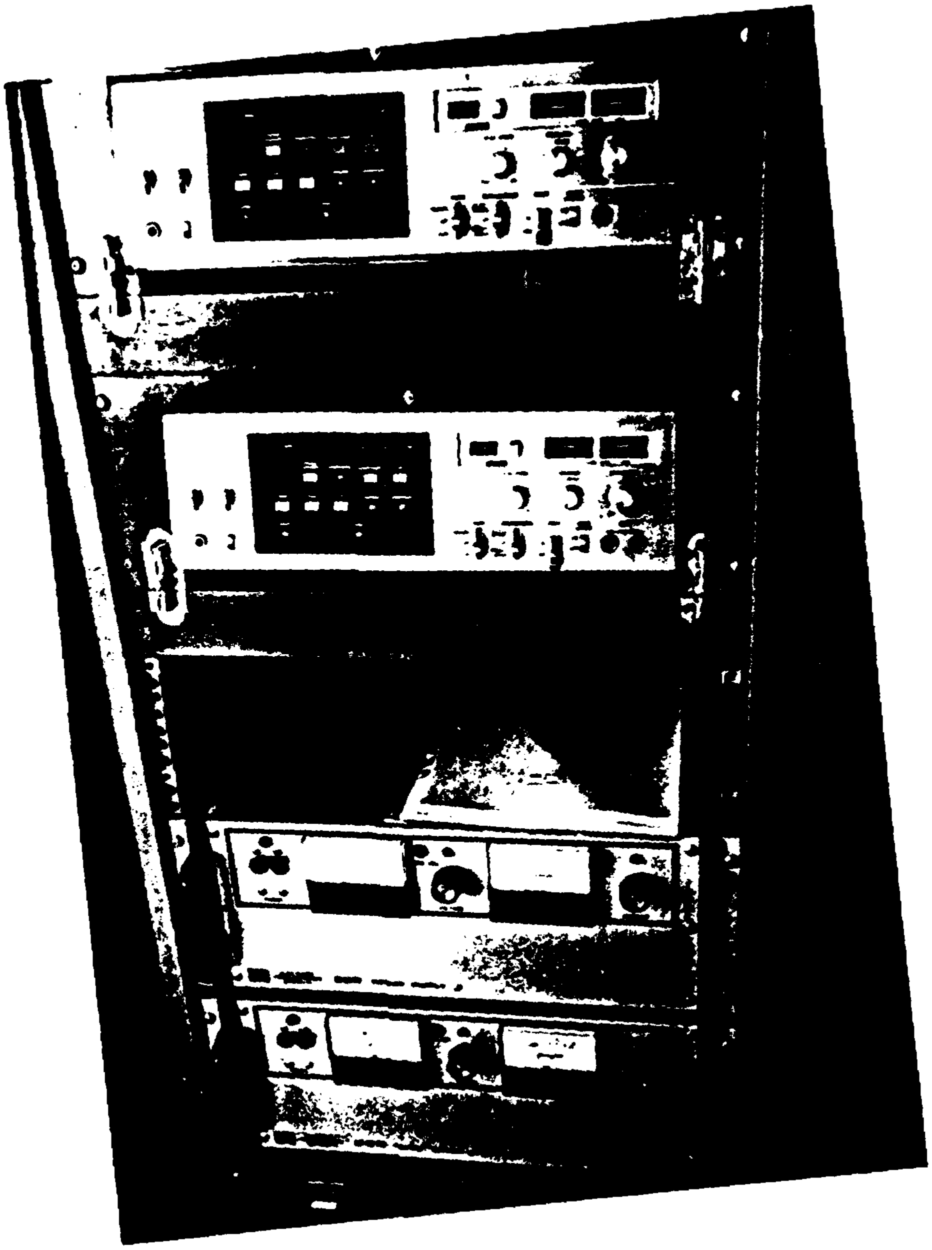

FIGURE 2-5. Auxiliary Console

The RECON III-B operating vehicle has an open construction aluminum framework. The top-mounted flotation module gives the vehicle a slight positive buoyancy. The physical characteristics of the vehicle are as follows: length - 65", width - 30", height - 30", weight - 500 lbs, payload - 90 lbs. The vehicle is propelled by a 4-motor variable speed thruster system. Standard payload consists of a video camera with lights on a pan and tilt, depth sensor, and compass.

The tether cage houses and controls the flying tether, and serves as a depressor weight to decouple the vehicle from surface ship motion and long cable drag. The cage also mates with the vehicle during launch and recovery operations. This configuration is shown in Figure 2-1. The cage is 55" in diameter, 52" high, weighs 1367 lbs in air, and 990 lbs in water.

The surface control station consists of a main and an auxiliary control console. The main console contains the primary vehicle controls and video screen as well as the pilot's joystick control. The joystick control is mounted on a portable consolette which may be detached from the main console for visual piloting. The auxiliary console contains two video recorders, power supplies, video annotation controls and has space for additional items. Both consoles are 22" wide, 69" high and weigh approximately 980 lbs. An optional van to house the entire control station requires a deck space of 8x10 feet.

The handling system is skid mounted and consists of a U-boom, cage snubber, cable winch, and hydraulic power unit. The hydraulically powered cable winch is mounted on the rear of the skid, and can handle up to 1200 feet of 0.9-inch diameter cable. The cage snubber is pivoted on the U-boom which in turn pivots on the outboard edge of the skid. The snubber latches to the U-boom in order to restrain cage/vehicle motion during launch and recovery. The handling system, without payload is 8' wide by 14' long. The overhead clearance required varies from a minimum of 8' to a maximum of 16', depending on the position of the boom. The handling system weight is 6000 lbs.

To deploy the vehicle, the tether management system cage, with the vehicle mated below, is launched and lowered to the desired depth using the primary cable controlled by the winch. At that depth the pilot detaches the vehicle from the cage and maneuvers away on the end of the flying tether. The flying tether is a 400' neutrally buoyant cable paid out from the cage using the surface controlled feed mechanism. Vehicle and tether retrieval is accomplished by reversing the powered feed and pulling the tether back inside the cage.

2.1 PART I--VEHICLE TESTING

In order to further investigate the feasibility of using RECON III-B for hazardous chemical spill response tasks a field test program was developed to: a) Determine the vehicle performance characteristics with and without Coast Guard sampling and plugging equipment, b) Collect water samples from a known area, and c) Plug several holes in a fixture simulating a ruptured ship's hull. Part I testing was performed by Perry and U.S. Coast Guard personnel (including members of the U.S. Coast Guard Research and Development Center and the National Strike Force diving team) at West Palm Beach, Florida, in February, 1982. Water sampler units and plugging devices were attached to the vehicle frame and tested for proper operation; these were as supplied by the U.S. Coast Guard.

2.2 PART II--VEHICLE EFFECTS STUDY

In addition to the field tests a study was made of the compatibility of the in-water components of the RECON system with a variety of hazardous chemicals commonly transported by ship. This consists of an engineering evaluation of the reaction of the materials used to fabricate the RECON vehicle assembly when in the presence of various chemicals. Based on this evaluation, it was determined if any vehicle design or material changes are required to permit it to survive repeated immersion in the hazardous chemical environment over a normal operational lifetime.

SECTION 3

PART I--VEHICLE IN-WATER TESTING

3.1 TEST PROCEDURE

The purpose of the testing was to determine the following:

a) RECON vehicle performance with and without Coast Guard equipment attached.

b) The vehicle's ability to gather water samples from a specific area without contaminating the sample by its presence.

c) The vehicle's ability to plug test target holes of various sizes using a Coast Guard polystyrene foam plugging device.

The test procedures (Attachment 1) define in detail the procedure followed to accomplish these objectives. The raw data obtained during the tests are also included in Attachment 1.

3.1.1 Vehicle Performance

RECON III-B vehicle motion is controllable in three axes; fore-aft, lateral, and vertical. Attachment 1, paragraph 3.1, defines procedures for the testing of the vehicle in each of these axes in addition to the verification of the physical parameters of the system and the video image quality. Attachment 1, paragraph 3.2, identifies the same testing but with the vehicle modified to include as payload as many as six water samplers and two plugging lances. Perry drawing SK-C-25902, provided herein as Attachment 2, describes the method used for sampler and lance attachment to the vehicle. Figure 3-1 also shows the configuration of the Coast Guard hardware as it was mounted on the vehicle for testing. Two sample bottles are mounted on a plate attached to the vehicle. The lances are strapped directly to the vehicle frame. In this case the starboard lance is inclined for plugging a slanted target.

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3.1.1 Vehicle Performance

The RECON III-B remote vehicle is designed for the purpose of performing underwater work tasks. The major features of the design are as follows:

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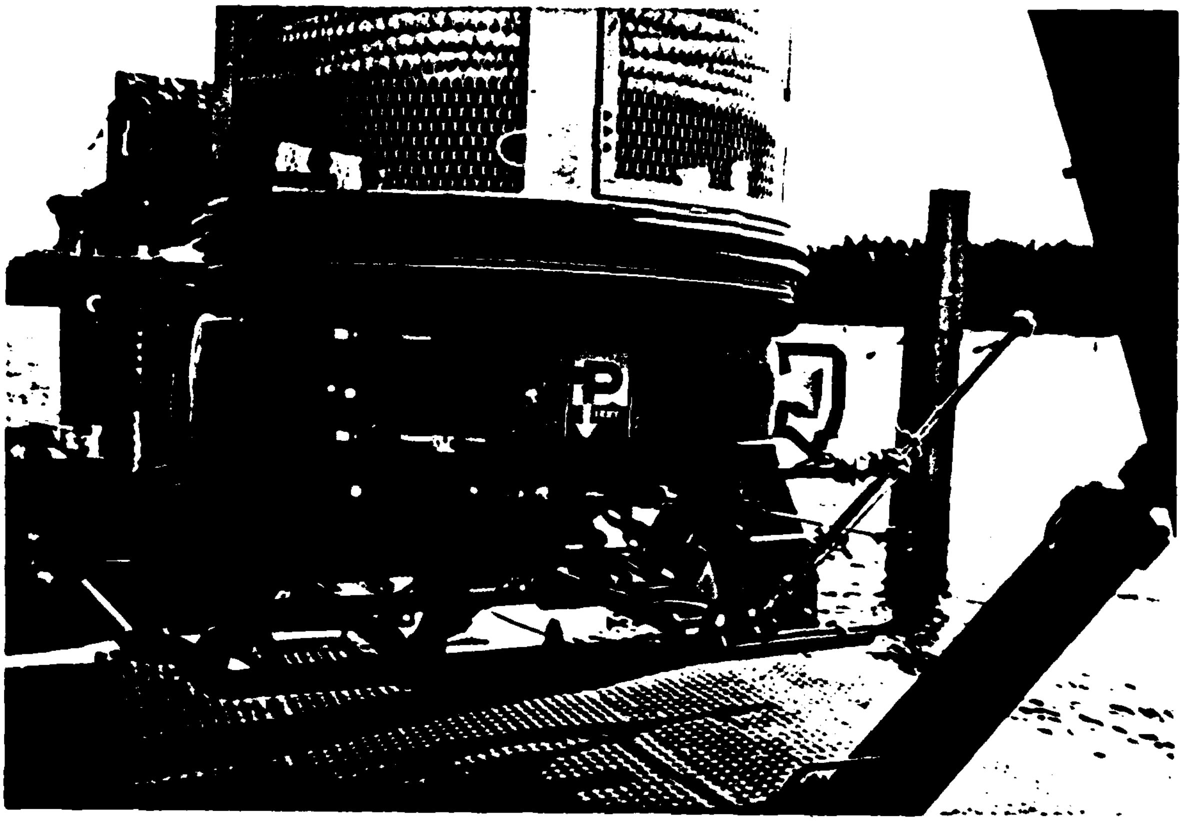

FIGURE 3-1. RECON Vehicle with Coast Guard Hardware

Performance testing of the vehicle consisted of running the vehicle through a measured course and timing the run. The vertical speed was calculated from the ascent time of the vehicle as it was maneuvered from the bottom straight to the surface.

3.1.2 Chemical/Water Sampler Testing

Testing of the chemical/water sampler operation included the following steps:

a) In a predetermined location, divers took an initial reference water sample.

b) The vehicle was flown in both directions in all three axes around a central point. Then, two vehicle-mounted samplers were triggered by divers. (The vehicle was not modified to allow remote actuation through the control system although such tasks are well within the capabilities of the standard RECON system.)

c) After the vehicle samples were taken, the divers took a second reference water sample.

3.1.3 Hole Plugging Lance Tests

Testing of the vehicle's ability to plug holes was accomplished by using two sheet steel fixtures with holes of various sizes as test targets. One fixture had a flexible end which could be positioned to provide a slanted surface to simulate a listing ship. The back of each unit was covered to provide a darkened hole. The fixture design is shown in Attachment 3. Each hole was to be plugged by a vehicle mounted lance and recorded by both vehicle and diver-held video cameras. The slanted targets would be at 30 and 45 degrees, sloping away from top to bottom. A test target with 3 test plugs in it is shown in Figure 3-2.

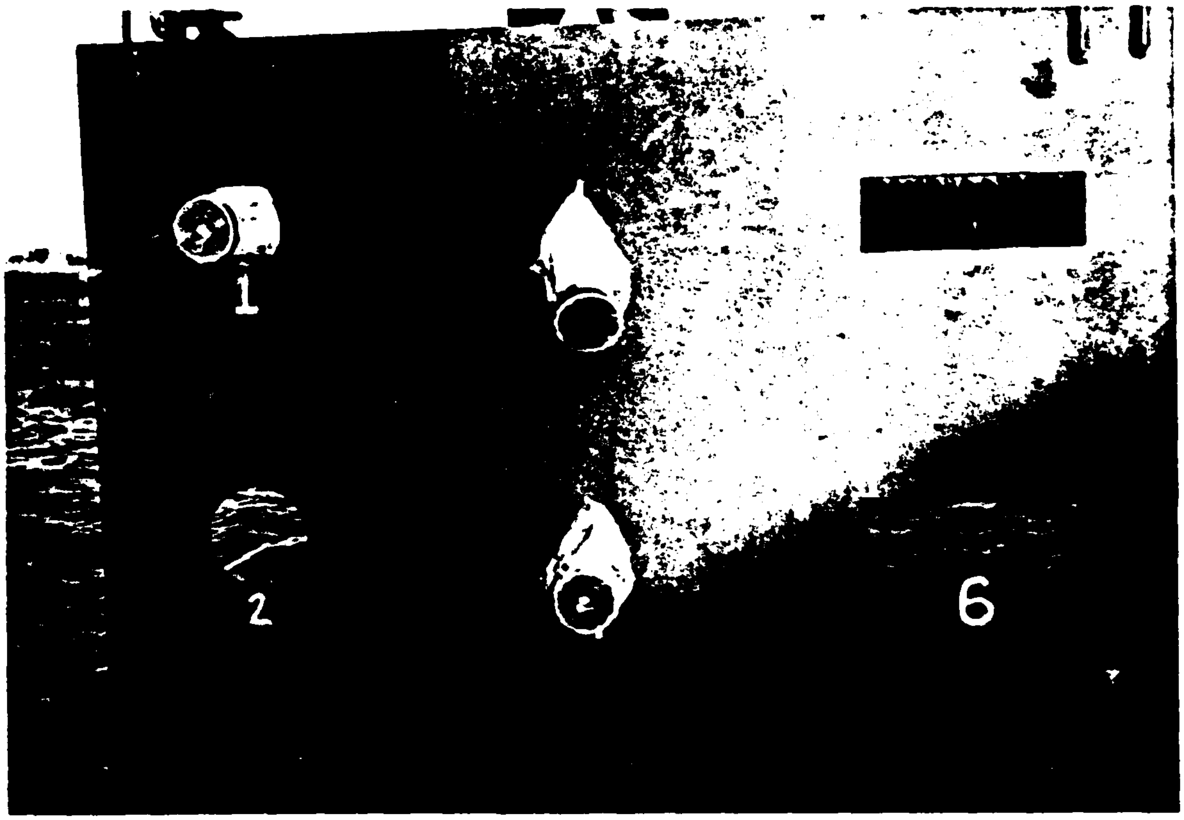

FIGURE 3-2. Test Target with Foam Plugs

3.2 TEST RESULTS

3.2.1 Vehicle Performance (Procedure Sections 3.1 and 3.2)

a) Fore-Aft Testing--From a running start the vehicle was flown along a 100 ft measured course and the elapsed time was recorded. In the standard configuration (without payload) the velocity was 3.2 ft/sec (1.9 kn). With water samplers added (open and closed) and the lances, the vehicle performance was unaffected.

b) Lateral Testing--The results of testing in the lateral direction deviated from what would have been expected. With only one lateral thruster, the amount of thrust to the port side is greater than that to starboard. This is due to unimpeded exhaust to port and the exhaust passing over the motor to starboard. Testing showed a reduction in lateral port velocity with the addition of more equipment. However, an operator systematic error seems to appear in the starboard velocity data. The velocity to starboard (due to greater thrust to the port side) would be expected to be greater than that to port. The starboard velocity of the vehicle with only the sampler plates attached would also be expected to be higher than when the samplers and lances are attached. The expected did not occur in either of these cases. Also, there was only one trial run in the starboard direction. These three reasons seem to indicate that the lateral velocity to starboard with only the sampler plates attached (1.3 ft/sec) is in error. It should be higher, most likely in the 1.6 ft/sec to 1.8 ft/sec range.

Testing also showed that with the additional payload the operator had less ability to control the vehicle and keep it on a straight course. This was caused by the large flat area of the sampler mounting plate which resulted in the aft part of the vehicle having an increased drag area. When moved laterally, the forward part of the vehicle moved ahead of the rear and the vehicle tended to rotate. The operator was, however, able to compensate.

c) Vertical Testing--Test results show a gradual reduction in vertical vehicle speed as the payload was increased. This would be expected since the additional equipment adds both weight and drag to the vehicle.

d) Yaw (Rate of Spin)--The yaw rate of the vehicle was found to be greater in one direction than the other. The reason for this is that to achieve the maximum yaw the lateral thruster is used. The difference in lateral thrust reported above therefore translates directly into the yaw performance.

e) Stability--The stability of the vehicle without payload was evaluated by having the vehicle run several straight courses (forward, lateral, and vertical) and observing the effort required by the operator to maintain heading. The results indicated that the vehicle was stable with little operator interference required. Drift did occur but was easily correctable.

f) Performance in Current--Time constraints and available conditions did not permit the completion of current tests as outlined in the test procedure. However, current conditions during some of the other tests did allow some useful observations. The presence of surge during some of the plugging tests had a negative effect on the vehicle's station-keeping ability as it tended to rise and fall with the orbital water motion. Insertion of the lance tip was more difficult under these conditions. A cross current of approximately .75 Kn was observed also to have a negative effect on station-keeping. During plugging tests with the lance mounted on one side and this current condition, the vehicle tended to skew off to one side once the lance tip was inserted.

3.2.2 Water Sampler Testing (Procedure Section 3.3, Step 3A)

The vehicle's ability to collect chemical/water samples without contaminating the sample by its own presence was tested. The testing was performed in accordance with the procedure and the samples taken by USCG for analysis. The results of this analysis are included in Attachment 5.

The vehicle was unable to overcome the additional buoyancy of the six samplers in the empty and closed condition with the original ballast load. Eleven pounds of ballast was added to overcome this, and the vehicle was then able to descend normally.

3.2.3 Lance Testing (Procedure Section 3.3, Step 3B)

The testing consisted of repeated insertion of the foam plugging wand into a variety of hole sizes and shapes. The tests were mostly successful in terms of the ability of the vehicle to insert the lance tip into the holes. Surge, cross current, and image white-out were the main problems that affected vehicle positioning and target acquisition. In terms of actual hole plugging, the tests were only marginally successful due to repeated damage to the lance and partial filling of the foam bags. Subsequent examination of the partially filled plugs showed that water intrusion into the applicator tip before firing caused artificially high resistance pressures in the bag and resulted in poor plug formation.

During several lance tests the vehicle took a slight stern up attitude. This may have been due to insufficient ballasting or insufficient operator compensation for the additional weight of the lance cantilevered in front of the vehicle.

3.3 CONCLUSIONS

3.3.1 Vehicle Conclusions

a) The weight of the vehicle and the inertia when moving is such that the alignment fixture and connecting rod assembly in the applicator tip of the foam lance were repeatedly bent and broken. Figure 3-3 shows a plug with one alignment rod bent and one rod missing. In order to perform the testing, the fixture was modified to a heavier construction. This arrangement worked much better than the original but the fixture still fell off the lance (it was held by only a press fit into holes) on impact. Welding the alignment fixture to the metal pipe thread reducer on the bag finally solved this problem. Figure 3-4 shows the improved alignment fixture.

b) The lance should be mounted on the vehicle centerline. For these tests the lance was mounted on the side of the vehicle on the lower frame rail. With the lance inserted into the hole, it was necessary to hold the vehicle position until the lance was fired. Because of the off center mounting and one point of lance contact, the use of the thrusters to hold the vehicle caused the vehicle to constantly rotate and sometimes lose contact with the target.

This problem was solved during the test by adding to the opposite side of the vehicle a fixture rod (PVC pipe) which allowed the vehicle thrust to be equalized. For slanted surface shots, a second pipe was added to control pitching.

3.3.2 Lance Conclusions

a) A lance designed for use with a remote vehicle would be required to support regular operations. The lance used for the testing was of a U.S. Coast Guard design developed for use by divers. Several times the lance was inserted by the vehicle into the target and when actuated either failed to fire completely or only partially filled

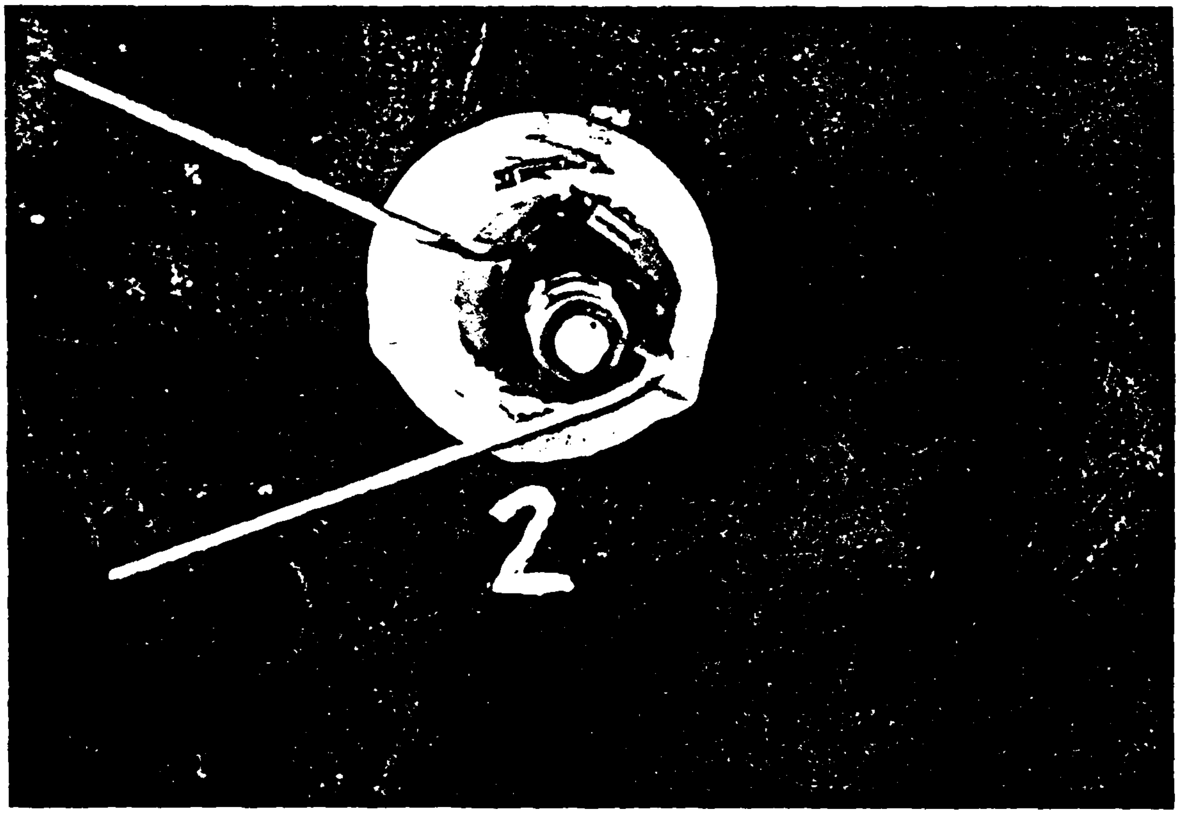

FIGURE 3-3. Foam Plug with Damaged Alignment Fixture

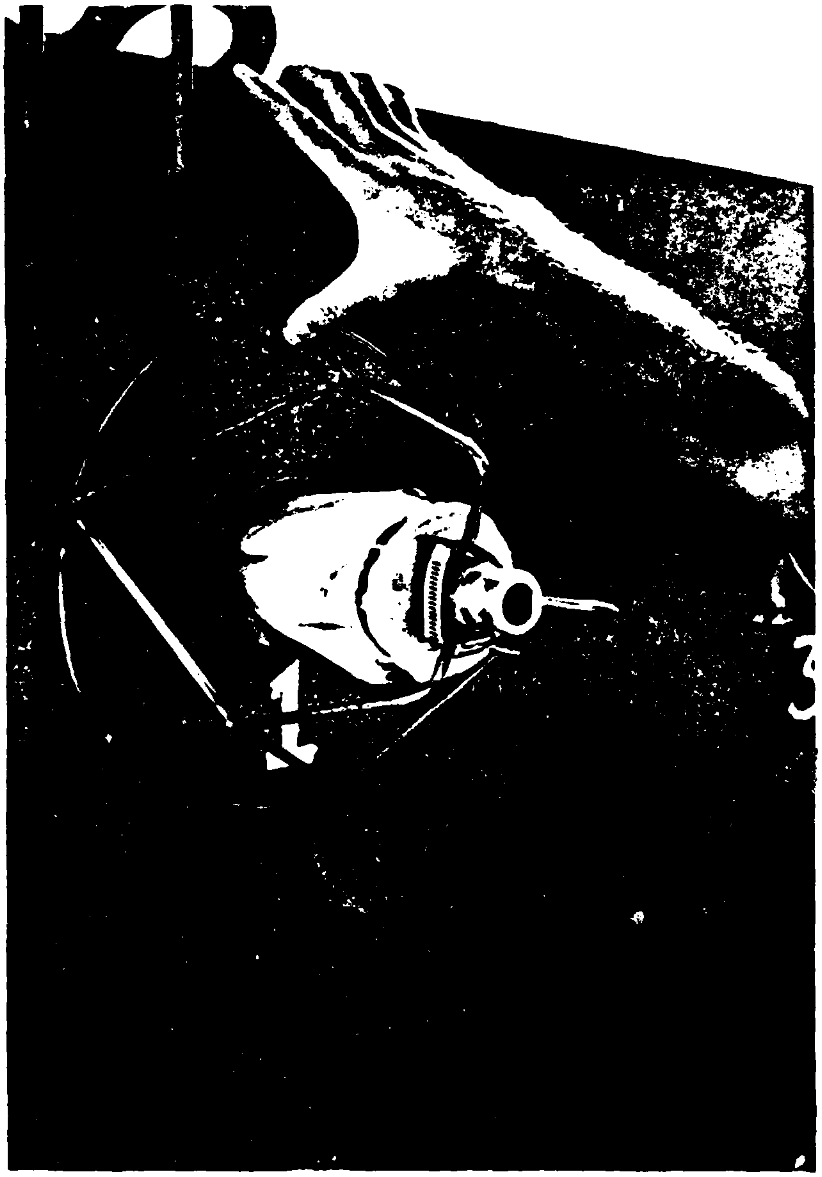

FIGURE 3-4. Applicator Tip with Improved Alignment Fixture

the plug bag. Of the 12 lances used only four were completely successful, both firing and filling the plug bag. The conclusion is that the design of the lance is not structurally adequate for service in a remote vehicle application.

3.3.3 Target Conclusions

a) Conditions for the testing varied as follows:
   i. From brilliant sunshine to overcast
   ii. From a depth of about 8 feet to 40 feet
   iii. From calm clear water to high current with turbulent conditions
   iv. From clear to nearly zero visibility

Performance was best in conditions of clear water at the maximum depth of 40 feet. This permitted clear working conditions and moderated the light levels such that when looking up at the slanted target the video monitor did not white out. In actual operation, all the above conditions could be made acceptable by the use of auxiliary equipment such as light filters and low light level cameras.

3.4 DESIGN RECOMMENDATIONS

3.4.1 Water Samplers

Mounting of the water samplers should be distributed around the vehicle rather than concentrated at the rear. This would permit a better trim of the vehicle as well as placing the samplers in locations where the thruster performance would not be impaired.

3.4.2 Plugging Lances

The plugging lance should be redesigned for use with a remote vehicle. The redesign should include the following:

- Structural redesign of the applicator tip to provide a solid mechanical or welded attachment for the alignment fixture, and a more rugged connecting rod assembly.

- Design of an alignment fixture to permit adjustment of the angle of incidence of the fixture to the target by the vehicle pilot while keeping the fixture and target on the vehicle centerline.

- Design of the applicator tip to lance body interface to provide positive release of the foam plug by surface command of the vehicle pilot. This release should be instantaneous so that the plug will not be worked in the hole by vehicle motions.

3.4.3 Vehicle

Changes to the vehicle are minimal, being confined mostly to the rearrangement and addition of equipment as follows:

- With the foam lance mounted on the vehicle centerline, it will be necessary to move the video camera to one side of center to provide perspective. Due to the open frame construction of the vehicle, this is a minor change.

- Large objects sonar unit should be added to permit the acquisition of the target in murky conditions. This is common with remote vehicles where even when moored within 100 feet of an oil platform, the vehicle pilot cannot find it in conditions of low visibility. The spare conductors which are standard with the RECON® system are easily able to accommodate this addition.

- An adjustable frame should be designed for addition to the front of the vehicle to provide a multi-point base on which the vehicle can thrust to provide a stable platform for firing the plugging lance. As with the camera change described above, the vehicle structural frame can accommodate this unit easily.

SECTION 4
PART II--VEHICLE EFFECTS STUDY

4.1 VEHICLE EFFECTS ANALYSIS

4.1.1 Study Objectives

The purpose of the study is to evaluate the ability of the RECON® III-B remote vehicle system to operate when used in an environment likely to be encountered during a hazardous chemical spill from a barge or tanker. The chemicals which might possibly be spilled are as identified by the U.S. Coast Guard and provided herein as Table 1 (Section 4.1.3). The method of study is to evaluate each of the materials used in the system components which are in the water against the various chemicals in concentration ranging from zero to one hundred percent and determine the extent of material damage which might result. Also, if there is damage beyond that which would permit the vehicle to continue operation over a reasonable span of time, evaluation and recommendations are provided for design, material and maintenance procedure changes.

4.1.2 Acceptability Requirements

A profile of the performance of RECON® III-B vehicle materials (Table 2, Section 4.1.4) in the presence of specific chemicals (Table 1, Section 4.1.3) has been developed. This information was drawn from industrial and government sources verifying the chemical resistance of standard materials (Attachment 4).

RECON® III-B acceptance has been determined by an engineering evaluation of the vehicle materials in the presence of the USCG identified chemicals. Where interaction between the chemical environment and the vehicle materials is considered possible, the vehicle modifications necessary to ensure vehicle performance have been reviewed. These modifications take three forms: Material Treatment, Material Replacement, and Additional Maintenance Guidelines. The data to support identified changes is summarized in Section 4.2. of this report.

4.1.3 List of Hazardous Chemicals

The Table 1 List of Chemicals was defined by the United States Coast Guard as representative of those chemicals most likely to be encountered by a RECON® III-B during hazardous chemical spills operations.

TABLE 1

Acetic Acid	Isopropyl Alcohol
Acetic Anhydride	Methyl Acrylate
Acetone	Methyl Alcohol
Acrylonitrile	Methyl Ethyl Ketone
Ammonia (28% Aqueous)	Nitric Acid (concentrated)
Benzene	Oleum
Caustic Soda	Phenol
Cresols	Phosphoric Acid
Cyclohexane	Styrene
Ethyl Acetate	Sulfuric Acid (dilute)
Ethyl Acrylate	Toluene
Ethyl Alcohol	Turpentine
Ethylene Diamine	Vinyl Acetate
Ethylene Dichloride	Xylene
Hexane	Xylenol
Hydrochloric Acid	

4.1.4 List of Vehicle Materials

Table 2 is a listing of the RECON® III-B vehicle materials cross referenced to their general area of application on the vehicle.

TABLE 2

FUNCTIONAL AREA / MATERIAL	FRAME AND ASSOCIATED HARDWARE	FLOTATION	TETHER	PROPULSION	INSTRUMENTATION PAYLOAD
18-8 SS	XXXX				
17-4 PH SS	XXXX				
304 SS	XXXX				
316 SS	XXXX			XXXX	
6061-T6 Aluminum				XXXX	XXXX
Ameron 450 Painted Surfaces	XXXX			XXXX	
Ameron 2133 Painted Surfaces	(Not used at present time, but can be applied as a replacement for Ameron 450 in highly corrosive environments)				
Neoprene	XXXX				
Epoxied Syn. Foam		XXXX			
Buna-N					XXXX
FRP				XXXX	
Polypropylene			XXXX		
Maintenance Items					
Nylon	Connectors				
Magnesium	Anode Teardrops				
Tungsten Carbide	Thruster Grommet				
Tungum	Tubing				
Lead	Ballast				
PVC	Heat Shrink Tubing				
Polyurethane	Tygon Tubing				
Delrin	Bearing Pads				
Methacrylate	Camera Lens				

4.2 STUDY RESULTS

RECON® III-B vehicle materials are acceptable without qualification for exposure to the Table 1 chemicals for missions of a maximum duration of four hours. Structural materials show excellent chemical resistance for almost all of the chemicals. Potential problem areas lie in exposure to four of the acids.

Acceptability, in the case of this study, is defined as the vehicle satisfactorily performing all normal and required functions in a hazardous chemical environment. This means that all vehicle materials exposed to chemical spillage will not fail because of this exposure, within the guidelines of protection and maintenance as described herein.

Soft goods on the vehicle (gaskets, hose, wiring, etc.) are acceptable without qualifications for use in the chemical environments listed. They are susceptible to swelling and softening in some of the chemicals, but failure may be precluded by inspection and replacement as part of the normal vehicle maintenance procedures. Swelling, when it does happen, will normally occur only after extended chemical exposure. Effects can be expected to be the same as with a normal RECON® III-B mission time of three to four days of continuous operation in water.

With such minimal effects, normal maintenance and minor repairs are all that is required to maintain vehicle operation. The RECON® vehicle is particularly suited to this condition, since all components are readily accessible.

Table 3 was composed from data acquired from industrial and government sources. Corroboration by experimentation of the chemical/material compatibilities was not part of this contract. The degree of compatibility will of course be affected by environmental conditions such as temperature and chemical concentration, but the limits of these variables and their effects fall within the range of acceptable performance for the vehicle.

TABLE 3

MATERIALS \ CHEMICALS	Acetic Acid	Acetic Anhydride	Acetone	Acrylonitrile	Ammonia 28% Aqueous	Benzene	Caustic Soda	Cresols	Cyclohexane	Ethyl Acetate	Ethyl Acrylate	Ethyl Alcohol	Ethylene Diamine	Ethylene Dichloride	Hexane	Hydrochloric Acid	Isopropyl Alcohol	Methyl Acrylate	Methyl Alcohol	Methyl Ethyl Ketone	Nitric Acid (conc.)	Oleum	Phenol	Phosphoric Acid	Styrene	Sulfuric Acid(dilute)	Toluene	Turpentine	Vinyl Acetate	Xylene	Xylenol
304 SS	X	X	X	X	X	X		X	X	X	X	X		X	X	N	X	X	X	X	X	X	X	X	X	N	X	X	X	X	
316 SS	X	X	X	X	X	X		X	X	X	X	X		X	X	N	X	X	X	X	X	X	X	X	X	N	X	X	X	X	
18-8 SS	@	@	@	@	@	@		@	@	@	@	@		@	@	N	@	@	@	@	@	@	@	@	@	N	@	@	@	@	
17-4 PH SS	@	@	@	@	@	@		@	@	@	@	@		@	@	N	@	@	@	@	@	@	@	@	@	N	@	@	@	@	
6061-T6 Aluminum	X	X	X	X	X	X		X	X	X	X	X		X	X	N	X	X	X	X	N		X	N	X	N	X	X	X	X	
Ameron 450 Painted Surfaces	X	X	X	X	X	X		X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Ameron 2133 Painted Surfaces	X	X	X	X	X	X		X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Epoxied Syn. Foam	X	X	X	X	X	X		X	X	X	X	X		X	X	X	X		X		X	X	X	X	X	X	X	X		X	
Neoprene	X	X	X	X	X	X		X	X	X	X	X		X	X	X	X	X		X	X		X	X	X	X	X	X	X	X	
Buna-N	X	X	X	X	X	X		X	X	X	X	X		X	X	X	X		X	X	X		X	X	X	X	X	X	X	X	
Polypropylene	X		X		X	X		X	X	X		X		X	X	X	X		X	X	X	X	X	X		X	X			X	
FRP																															

Maintenance Items	See Note 1
Nylon	Connectors
Magnesium	Anode Teardrops
Tungsten Carbide	Thruster Grommet
Tungum	Tubing
Lead	Ballast
PVC	Heat Shrink Tubing
Polyurethane	Tygon Tubing
Delrin	Bearing Pads
Methacrylate	Camera Lens

Key
- X Performance Acceptable (Section 4.2.2)
- @ Performance Judged Acceptable
- N Performance Not Acceptable (Note 2)
- Blank Space - No Data Available

NOTES TO TABLE 3

NOTE

1. These maintenance items are all acceptable for use in hazardous chemical conditions. They must be inspected more frequently and closely than the rest of the vehicle materials for signs of deterioration and chemical attack.

2. All of the metallic surfaces are primed and painted. Some are passivated or anodized in addition to this. If a metal is marked N, not acceptable under a specific chemical condition, this only means the bare metal. The only way for contact between the bare metal and chemical to occur is if the painted surface is scratched or damaged. Some localized corrosion might then occur, but not at a high rate. Post mission maintenance would prevent further deterioration.

3. Performance was judged acceptable based upon similarity to other stainless steels. Explicit data on corrosion resistance on these specific metals was not available.

4.3 CONCLUSIONS

4.3.1 Vehicle Materials

Performance of a RECON® III-B vehicle would be highly satisfactory during hazardous chemical operations. Vehicle material/hazardous chemical compatibility is excellent in 95% of all cases considered. Less than 5% represent situations where slight material/chemical interaction might occur. These cases can be prevented or accounted for by minor design modification before the system begins hazardous chemical operations and normal maintenance during operation. None of the cases represent any danger to the vehicle nor would result in the failure of vehicle equipment.

4.3.2 Chemicals

Of the thirty-one hazardous chemicals listed in this report, seventeen are shipped in quantities large enough to be considered "bulk quantities". This data was obtained from a U.S.C.G. report, "U.S. Import and Export of Substances Listed in Annex II of the MPC", dated 3 April 1978. Of these seventeen, three are acids which are incompatible in varying degrees with materials on the RECON® III-B vehicle. These are hydrochloric, phosphoric, and sulfuric acids. They are corrosive to bare aluminum and stainless steels. However, the metals that might be affected will all be protectively painted to prevent corrosion (Section 4.4.1.1). Reasonable precautions could be implemented to avoid overexposure of the vehicle to these three chemicals. Tabulated material compatibility for three of the chemicals could not be found, although a general chemical interaction review indicates that none would be considered a threat to the vehicle. One of the three, Xylenol, was listed in the USCG "Chemical Data Guide for Bulk Shipment by Water", CIM 16616.6, 1982 as Cresylic Acid.

4.4 DESIGN OPTIONS AND MAINTENANCE RECOMMENDATIONS

4.4.1 Material Treatment

4.4.1.1. Painting

Currently, all of the frame and flotation materials are primed with Ameron 71 epoxy primer and painted with a topcoat of Ameron 450 GL. This topcoat is rated very good in acid, alkaline environments, and good in solvent environments. This paint will hold up extremely well under most of the chemical conditions pertinent to this study, but it might be softened when subjected to some of the harsher chemicals.

It is recommended therefore, that a topcoat of Ameron 2133 R be applied instead of the 450 GL. 2133 R is highly resistant to chemical attack and is compatible with any of the materials on the vehicle. It is presently successfully used in painting the interior of Perry manned diving systems.

4.4.1.2. Anodization and Passivation

Anodization and passivation of the aluminum and stainless steel components increase the corrosion resistance. Some vehicle parts already go through these processes and all presently interacted components may be treated with no impact on vehicle functions.

Standard procedure is to paint these surfaces after they have been treated, thereby affording double protection.

4.4.2 Material Replacement

4.4.2.1 Possible Substitutes

Since all of the present RECON® III-B materials are acceptable, material replacement is not recommended. Some materials are available that, if used in lieu of an existing type, would increase the probable life expectancy for a part subjected to hazardous chemical conditions.

A higher grade of stainless steel could be used for bolts, nuts, and other associated hardware instead of 18-8 stainless. This would increase the corrosion resistance to some chemicals and also increase the strength properties of the part. This change would also bring an increase in cost which has to be weighed against the advantages of the replacement.

Viton could be used to replace the softgoods that might be susceptible to attack by certain chemical elements. Viton shows excellent resistance to chemical degradation and weathering. Cost impact would be minimal since there are so few areas of the vehicle that this modification would affect. It is very tough and sturdy, but is slightly harder to work with because of its toughness.

There are a few more materials that could be replaced with more chemically resistant materials, but the gain in chemical resistance as compared to cost and design factors is questionable, and such replacements are not recommended.

4.4.3 Inspection and Maintenance Procedures

In addition to the normal maintenance procedures, the following sections identify recommended additions.

4.4.3.1 Post Hazardous Chemical Mission

Same as standard procedure (fresh water rinse and visual inspection) with the following additions:

1. Inspect all exposed soft goods for signs of deterioration; i.e., splitting, peeling, or blistering. Replace if deterioration is determined to be extensive enough.

2. Check flotation, propulsion, frame, and any other equipment for undue signs of chemical attack, especially around welded joints and assemblies. Repair any dents or cuts in the flotation block to prevent water and/or chemical intrusion into the foam. Touch up scratches on painted surfaces with Ameron or equivalent.

3. Very thoroughly rinse entire vehicle with fresh water, especially on and around connectors, junction boxes, pan and tilt, lights, and any other sealed equipment. Check camera and vehicle lights for frosting of the lens. Replace if necessary.

4.4.3.2 Every 100 Operational Hours

Same as identified in Section 4.4.3.1 with special checklist to verify detailed inspection.

TST-A-25854-001

ATTACHMENT 1

TEST PROCEDURE

FOR

U.S. COAST GUARD REMOTE VEHICLE STUDY

Prepared by

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TEST PROCEDURE
FOR
U.S. COAST GUARD REMOTE VEHICLE STUDY

TABLE OF CONTENTS

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TEST PROCEDURE
FOR
U.S. COAST GUARD REMOTE VEHICLE STUDY

1. PURPOSE

The purpose of this procedure is to define those actions required to fulfill the requirements of U.S. Coast Guard Contract DTCG39-81-R-80311. Performance of this procedure will be by Perry Oceanographics and USCG personnel with jointly provided equipment.

2. REQUIRED EQUIPMENT

The following equipment is required to perform this test procedure.

2.1 PERRY OCEANOGRAPHICS

A. A RECON III-B remote vehicle system as detailed in Attachment 1.

B. A launching platform for the vehicle system capable of supporting the herein identified actions.

C. All hardware necessary to attach to the RECON system two (2) foam plug lances and six (6) water sampling devices so designed to permit access for a diver to actuate the units.

D. A target assembly which complies to the requirements of Contract DTCG39-81-R-80311 as modified during the Perry/USCG meeting of 26 September 1981. The target design is herein provided as Attachment II.

2.2 U.S. COAST GUARD

A. All hardware required to support USCG divers, including video equipment.

B. Current measuring equipment.

C. Polystyrene foam lances--quantity of 8.

D. Water samplers--quantity of 13.

E. Blank video tapes for use with USCG and Perry video systems. Tapes for use with Perry equipment to be VHS format.

3. TEST PROCEDURE

The following procedure will be formated identically to the Preliminary test plan proposed by USCG in the ROV Test Plan Outline provided to Perry on 23 September 1981.

3.1 STANDARD VEHICLE OPERATION

Step 1A--Launch/Retrieval Operations

A. Required Deck Space for Handling System (see Figures 2-2, 2-3)

- Length from ship side	14 ft
- Width	8 ft
- Overhead operating clearance	16 ft
- Overhead shipping clearance	8 ft

B. Power Requirements

- Consoles (operator and auxiliary)	20 kVA, 230V, 60 Hz, 3-phase
- Handling system	30 kVA, 230V, 60 Hz, 3-phase

C. Lifting Requirements

- Lifting capacity	6,000 lbs (point of winch slip)
- Lifting reach	5 ft (approximately)

D. Personnel Required (Offshore Operating Team)

- Operator (vehicle)	1
- Electrical technician	1
- Mechanical technician	1

E. Time to Launch/Retrieve (to 1000 ft)	15 min. (one way) 30 min. (total)
F. Launch Limitations	12 ft seas/rolling swells (This is approximate. RECON vehicles have, on occasion, operated in worse sea states.

Step 1B--Video Image Quality

Perry and USCG personnel are to observe and record the following video information.

A. Resolution Excellent; 525 lines/frame

B. Dynamic Range Excellent; 10,000 to 1

C. Field of View Excellent; 42^{o} vertical x 54^{o} horizontal x 60^{o} diagonal with 8mm f1.7 lens

D. Target Image Excellent; subject to water conditions; sloped target difficult to see when looking up with bright surface backlighting.

E. Lighting Quality Excellent; (4) 250 watt, incandescent

Step 1C--Baseline Vehicle Performance

The vehicle is to be launched and maneuvered to permit the measurement of the following parameters.

Step 1C(1)--Vehicle Speed

The vehicle shall run a straight and level course of known length in conditions of zero current at the surface. The speed of the vehicle is to be taken with two stopwatches and the time averaged to produce the vehicle speed. The course is to be run three times and the recorded values averaged for the final vehicle speed.

A. Forward Direction

Run 1	3.2	ft/sec	100 ft in 31.8 sec
Run 2	3.3	ft/sec	30.1 sec
Run 3	3.1	ft/sec	31.9 sec
Average	3.2	ft/sec	

USCG Perry

B. Repeat step (A) in the lateral direction.

Run 1 (To Port)	1.5	ft/sec	50 ft in 32.6 sec
Run 2 (To Port)	1.6	ft/sec	30.8 sec
Port Average	1.6	ft/sec	
Run 3 (To Stbd)	1.3	ft/sec	38.9 sec

USCG Perry

C. Repeat step (A) in the vertical direction. The course shall be the time from the surface for the video camera to pass a known point (wall or piling, etc.).

Run 1 (Up)	1.6	ft/sec	7.3 ft in 4.5 sec
Run 2 (Up)	1.4	ft/sec	7.3 ft in 5.3 sec
Up Average	1.5	ft/sec	
Run 3(Down)	.75	ft/sec	7.9 ft in 10.5 sec

USCG Perry

Step 1C(2)--Vehicle Speed in Current Conditions

A. Repeat step 1C(1) with the vehicle on a straight and level course at the surface with a measured current running at 90° to the vehicle course. (Measured current ________).

Unable to find current conditions above .1 kn. This step not performed.

Run 1 __________ ft/sec
Run 2 __________ ft/sec
Run 3 __________ ft/sec
Average __________ ft/sec

__________ __________
USCG Perry

B. Repeat step (A) with the vehicle running into a measured current parallel to its course (measured current __________).

Run 1 __________ ft/sec
Run 2 __________ ft/sec
Run 3 __________ ft/sec
Average __________ ft/sec

__________ __________
USCG Perry

Step 1C(3)--Station Keeping Ability Current conditions unavailable. This Step not performed. RTW

A. The operator of the vehicle shall select a point reference in a measured current. The vehicle shall be positioned such that the vehicle is headed into the current. The operator shall attempt to keep the vehicle in a fixed position. The operator's ability to do this shall be judged as excellent, acceptable, or unacceptable (measured current __________).

Excellent __________
Acceptable __________
Unacceptable __________

__________ __________
USCG Perry

B. Repeat the above activity with the vehicle positioned such that the current is coming from directly aft of the vehicle (measured current __________).

Excellent ________
Acceptable________
Unacceptable________

________	________
USCG	Perry

C. Repeat the above activity with the vehicle positioned such that the current is perpendicular to the vehicle heading (measured current ________).

Excellent ________
Acceptable________
Unacceptable________

________	________
USCG	Perry

Step 1C(4)--Yaw Rate Measurement

The vehicle operator shall locate the vehicle on a straight and level course and turn the vehicle as fast as possible to exactly reverse its course 180°. The operation shall be measured in seconds. Three runs shall be performed and the average taken as the data point.

Run 1	4.4	sec(Port)	4.9 sec(Stbd)
Run 2	4.6	sec	4.7 sec
Run 3	4.6	sec	4.7 sec
Average	4.5	sec	4.8 sec

RTW	[signature]
USCG	Perry

Step 1C(5)--Lateral Speed in Current

The operator shall apply maximum lateral thrust into a measured current on the surface over a course of a known length. The data shall be in ft/sec. Three runs shall be performed and the average taken as the data point. This step not completed.

Run 1 __________ ft/sec
Run 2 __________ ft/sec
Run 3 __________ ft/sec
Average __________ ft/sec

__________ USCG __________ Perry

Step 1C(6)--During the performance of Steps 1 through 5, the participants shall observe the behavior of the vehicle for any appearance of natural frequency in pitch and roll. The USCG responsible agent shall note any such behavior below:

No lack of stability. No apparent tendency to pitch or roll at a natural frequency either at the surface or submerged. RTW

Step 1C(7)--The maximum payload of the vehicle shall be demonstrated to be 45 lbs. This demonstration shall be by determining the amount of ballast weight on the vehicle and demonstrating in the above steps that the vehicle is neutral in the water.

Vehicle ballast weight 67 lbs
Vehicle neutral in water Yes

RTW USCG   Perry

Step 1C(8)--Vehicle Stability

A. The operator shall bring the vehicle to rest on the surface. The operator shall give the vehicle lateral thrust starboard and port. The witnesses shall observe the vehicle, looking for the ability of the vehicle to move directly on the lateral axis without drift.

RTW USCG   Perry

Comments Vehicle stability and control is less with the additional USCG components. However, the operator is able to control the vehicle and keep it on course.

B. The operator shall bring the vehicle to rest on the surface. The operator shall give the vehicle full down thrust until the vehicle can no longer be seen. The operator shall then apply full up thrust until the vehicle returns to the surface. The witnesses shall observe the vehicle for the ability of the vehicle to move directly on the vertical axis. This maneuver shall be repeated as required to satisfy the USCG witness.

RTW — USCG   Perry

Comments Performed on a piling. The vehicle was able to rise and descend almost vertically. Hover varied between + or - .5 ft (vertical station keeping).

3.2 VEHICLE OPERATION WITH PAYLOAD

Step 2A(1)--With six water samplers mounted closed and empty on the vehicle, perform the following tests:

A. The vehicle shall run a straight and level course of known length on the surface in conditions of zero current. The speed of the vehicle is to be taken in terms of ft/sec. The course is to be run three times and the data point taken as the average speed.

Run 1	3.0	ft/sec	100 ft in 33 sec
Run 2	2.9	ft/sec	34 sec
Run 3	3.1	ft/sec	32 sec
Average	3.0	ft/sec	

RTW — USCG   Perry

B. Repeat step (a) in the lateral direction.

(Port) Run 1 1.1 ft/sec 50 ft in 45 sec

(Port) Run 2 1.1 ft/sec 47 sec Avg. 1.1 ft/sec

(Stbd) Run 3 1.1 ft/sec 50 ft in 47 sec

(Stbd) Run 4 1.5 ft/sec 33 sec Avg. 1.3 ft/sec

RTW USCG   Perry

C. Repeat step (a) above in the vertical direction. The course shall be the time from the bottom for the video camera to pass a known point (wall or piling, etc.).

Run 1	1.3	ft/sec
Run 2	1.2	ft/sec
Run 3	1.2	ft/sec
Average	1.2	ft/sec

RTW USCG   Perry

Step 2A(2)--Repeat step 2A(1) with the water samplers full and closed.

A. Straight and level

Run 1	3.17	ft/sec	100 ft in 31.5 sec
Run 2	2.99	ft/sec	33.5 sec
Run 3	2.94	ft/sec	34.0 sec
Average	3.03	ft/sec	

RTW USCG   Perry

B. Lateral

(Port) Run 1 1.1 ft/sec 50 ft in 47 sec

(Port) Run 2 1.0 ft/sec 48 sec Avg. 1.1 ft/sec

(Stbd) Run 3 1.49 ft/sec 50 ft in 33.5 sec

(Stbd) Run 4 1.56 ft/sec 32 sec Avg. 1.5 ft/sec

RTW USCG   Perry

C. Vertical

Run 1	1.2	ft/sec	7.3 ft in 6.0 sec
Run 2	1.0	ft/sec	7.0 sec
Run 3	1.1	ft/sec	6.7 sec
Average	1.1	ft/sec	

RTW
USCG

[signature]
Perry

Step 2A(3)--Close the water filled samplers on one side of the vehicle and leave the samplers on the other side of the vehicle closed and empty. Perform the following tests with the vehicle in this configuration.

A. Leave the vehicle on the surface with all thrusters stopped. Observe the vehicle for any abnormal attitude (in particular listing).

Port side filled
Stbd side empty

RTW
USCG

[signature]
Perry

Comments Vehicle lists 5° or less.

B. The operator shall run the vehicle in a straight and level course. Observe the vehicle for any tendency to yaw or assume an uncontrollable abnormal course.

RTW
USCG

[signature]
Perry

Comments Vehicle yaws very slightly to port. Operator corrections required are minimal.

Step 2B(1)--With two lances mounted on the vehicle (in addition to the water samplers added as part of Step 2A), perform the following tests:

A. The vehicle shall run a straight and level course of known length on the surface in conditions of zero current. The speed of the vehicle is to be taken in terms of ft/sec. The course is to be run three times and the data point taken as the average speed.

Run 1	3.0	ft/sec	100 ft in 33 sec
Run 2	3.0	ft/sec	33 sec
Run 3	2.9	ft/sec	34 sec
Average	3.0	ft/sec	

RTW
USCG

Perry

B. Repeat step (a) above in the lateral direction.

Run 1(Port)	.97	ft/sec	50 ft in 51.5 sec
Run 2(Port)	.89	ft/sec	56 sec
Port Avg.	. 9	ft/sec	
Run 3(Stbd)	1.4	ft/sec	37 sec

RTW
USCG

Perry

C. Repeat step (a) above in the vertical direction. The course will be taken from the bottom for the video camera to pass a known reference point (wall or piling, etc.).

Run 1	1.0	ft/sec	7.3 ft in 7.0 sec
Run 2	1.0	ft/sec	7.0 sec
Run 3	.97	ft/sec	7.5 sec
Average	1.0	ft/sec	

RTW
USCG

Perry

Step 2B(2)--The operator shall run the vehicle in a straight and level course. Observe the vehicle for any abnormal behavior.

Comments None RTW

3.3 PAYLOAD OPERATION FROM VEHICLE

Step 3A

A. First, take two samples in the same area as those samples taken in (B). This sample is to be used as a reference sample to judge whether the samples taken in (B) were contaminated by the vehicle. Mark this sample as reference.

RTW ______ USCG ______ Perry

B. With six water samplers mounted on the vehicle, run the vehicle in the positive and negative directions in the horizontal, lateral, and vertical directions taking two samples at the center point. Return the vehicle to the surface and retrieve the samples. Mark the samples (i.e., P. or S.).

RTW ______ USCG ______ Perry

Step 3B(1)--With the vehicle loaded with six samplers and two lances do the following (reference attached drawings SK-C-25857 and SK-D-25858):

A. Address the target structure marked 1 (4 in. hole). Fly the lance into the hole and maintain position until the diver fires the lance. Pull the vehicle away from the target using first vertical down then reverse thrust.

RTW ______ USCG ______ Perry

Target entered and lance stabilized. When actuated, the rear portion on bag failed at the band clamp and the foam went into the water rather than into the bag.

B. Address the target structure marked 2 (6 in. hole). Fly the lance into the hole and maintain position until the diver fires the lance. Pull the vehicle away from the target using full down vertical and lateral thrust then full reverse thrust.

RTW — USCG | Perry

Lance in target. No problem.

1. 1st lance did not fire.
2. 2nd lance fired by itself before it could be placed into the hole.
3. 3rd lance fired, but the alignment fixture failed and the lance went through hole.

During the above steps observe the clarity with which the operation can be viewed and which of the decoupling procedures (A) or (B) worked best.

Bag filled, but behind the target.

RTW — USCG | Perry

Comments Both decoupling methods worked satisfactorily.

Step 3B(2)--This step requires the use of the target which has an adjustable slope face.

A. Address the target with the face of the target sloped 45° towards the vehicle from bottom to top. Address the target marked 7 (6 in. hole) and fly the lance into the hole maintaining position until the lance is fired by the diver. Pull the vehicle away from the target using the method developed in Step 3B(1).

Lance entered target and filled. Did not fill hard

RTW — USCG | Perry

B. Repeat (A) with target 8 (8 in. hole).

Lance entered target and filled. This was the best shot. The bag filled was hard.

RTW — USCG | Perry

C. Modify the slope of the target per the instruction of the USCG agent.

Slope 45 degrees USCG Agent RTW

Address the target marked 9 (6 in. hole). Fly the lance into the hole and maintain position until the diver fires the lance. Detach the vehicle from the lance.

RTW ____ USCG [signature] ____ Perry

D. Repeat step (C) with target 10 (8 in. hole).

____ USCG ____ Perry

Step 3B(3)--With the target in a measured current, perform the following tests:

A. With the target oriented such that the current is into the target face, address target 3 (6 in. triangle). Fly the lance into the target and maintain position until the diver fires the lance. Detach the vehicle from the lance (measured current ________). Put lance in target and fired. Appeared to perform acceptably, however, later inspection showed that the bag did not fill properly.

RTW ____ USCG [signature] ____ Perry

B. Repeat step (A) with the target oriented such that the current is out of the target. Use target 4 (6 in. triangle) (measured current ________).

RTW ____ USCG ____ Perry

Step 3B(4)--With the target in a measured current, perform the following tests:

A. With the target oriented such that the current is parallel to the face of the target coming from the vehicle port side (left), address target 5 (4 in. by 12 in. rectangle). Fly the lance into the target and maintain position until the diver fires the lance. Detach the vehicle from the lance (measured current _________).

_________ USCG _________ Perry

B. Relocate the target such that the current now comes from the vehicle starboard side (right). Address target 6 (4 in. by 6 in. rectangle). Fly the lance into the target and maintain position until the diver fires the lance. Detach the vehicle from the lance (measured current _________).

_________ USCG _________ Perry

4. CUSTOMER SIGNOFF

The following signatures constitute agreement by the U.S. Coast Guard that the procedure outlined herein satisfies the task requirements defined by contract DTCG39-81-R-80311 and that the procedure was supported and completed by Perry Oceanographics, Inc.

4.1 TEST PROCEDURE SIGNOFF

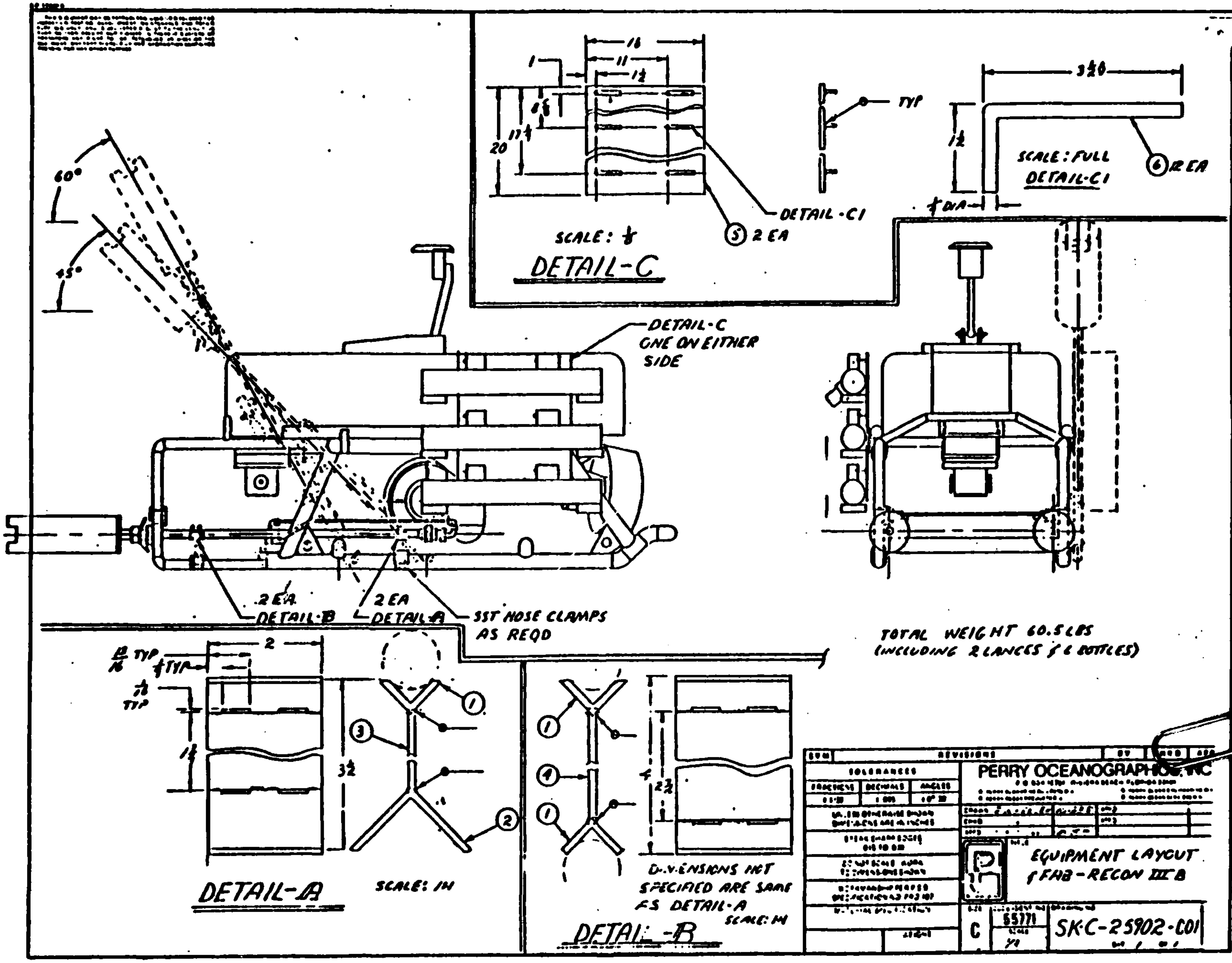
Signature by the below identified agents of the U.S. Coast Guard constitute agreement that the tasks identified by this procedure are in compliance with those tasks defined by contract DTCG39-81-R-80311 and satisfy the intent of the U.S. Coast Guard in this program regarding field evaluation.

1. Richard T. Walker
2. [illegible]
3. __________
4. __________
5. __________

4.2 TEST PERFORMANCE SIGNOFF

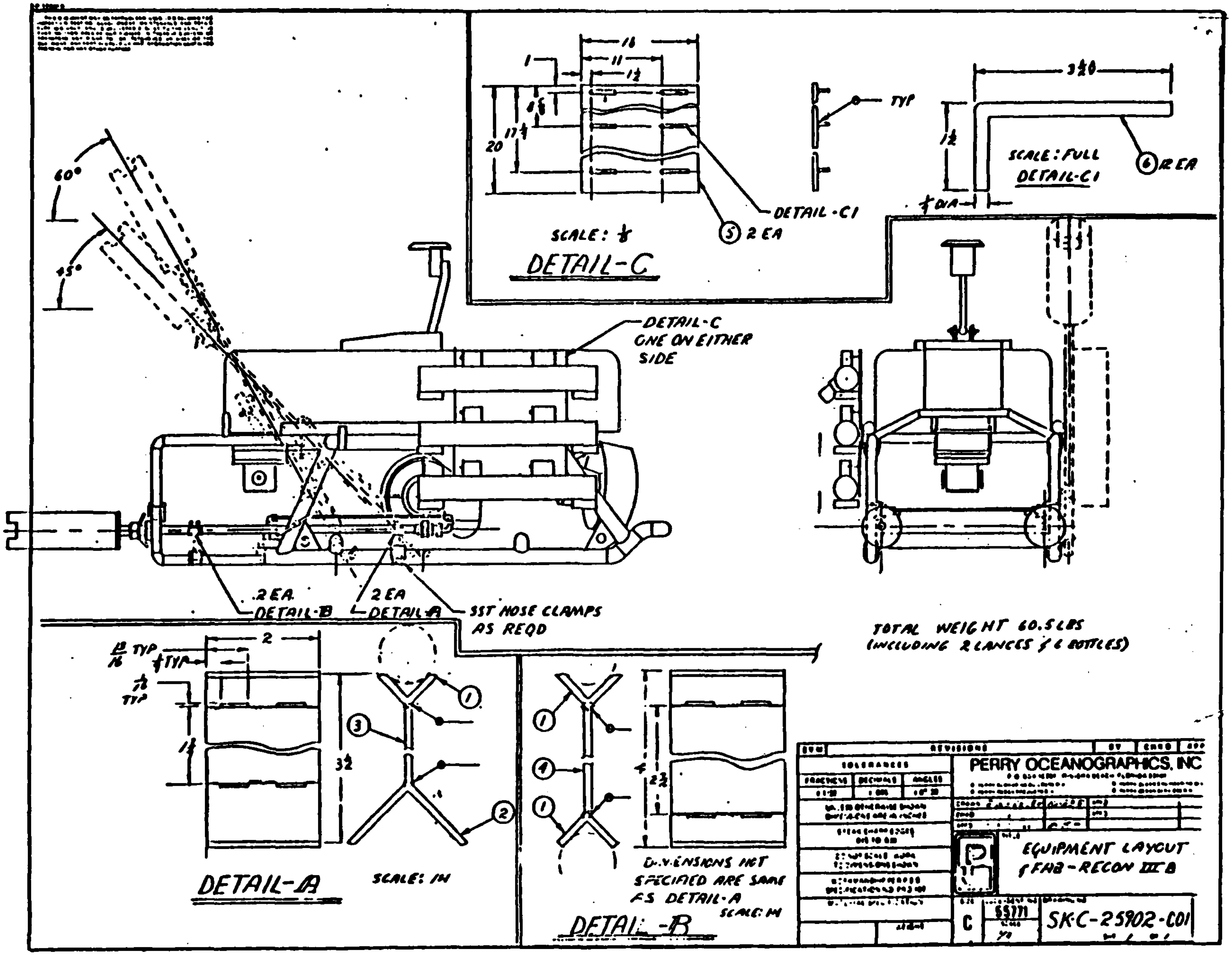
Signature of the below identified agents of the U.S. Coast Guard constitute agreement that Perry Oceanographics, Inc., has fulfilled the requirements of contract DTCG39-81-R-80311 with regard to providing personnel and equipment to support the performance of this test procedure and that no further activity or support by Perry Oceanographics, Inc. with regard to testing per this procedure is required.

1. Richard T. Walker
2. [illegible] USCG
3. __________
4. __________
5. __________

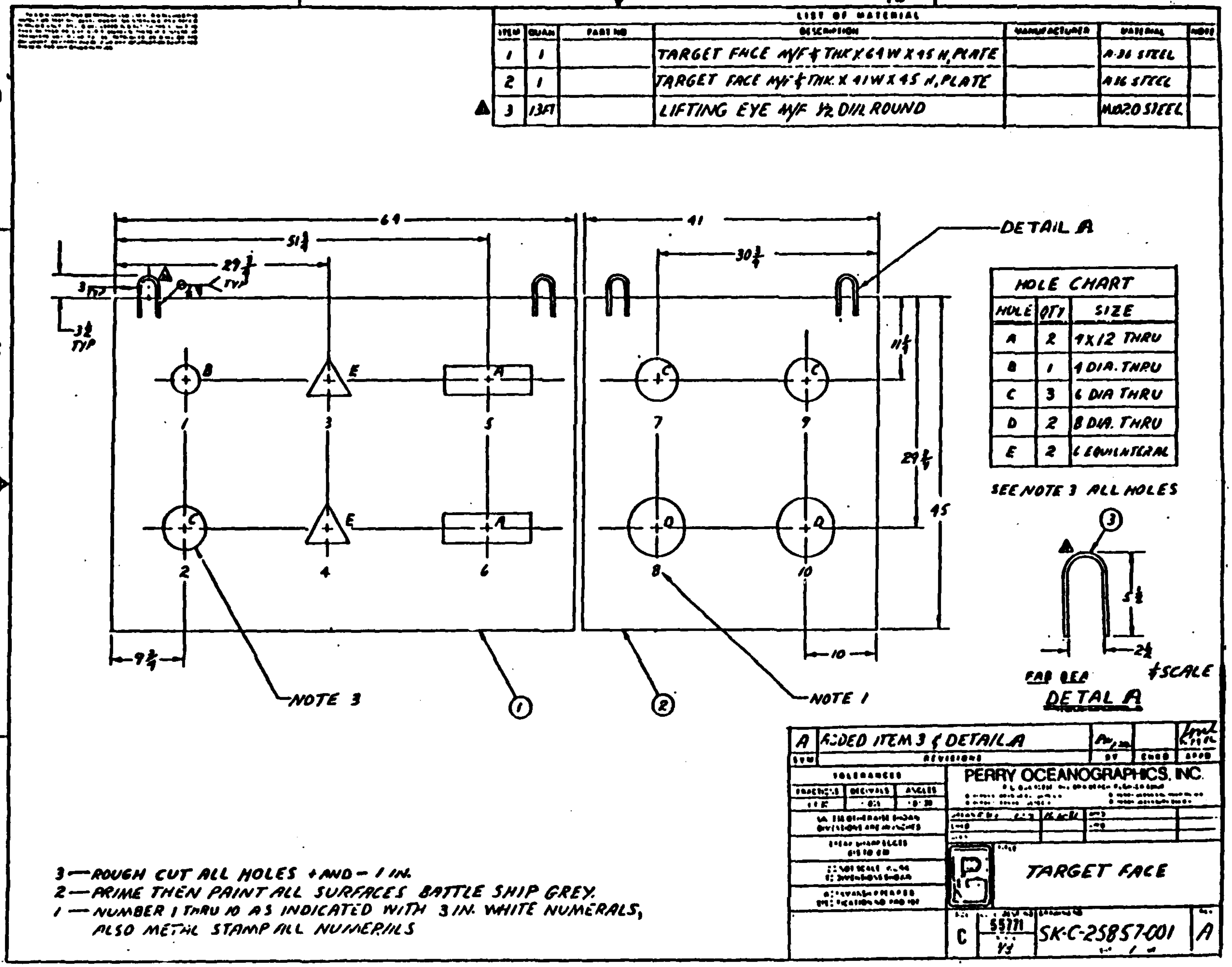


ATTACHMENT 2

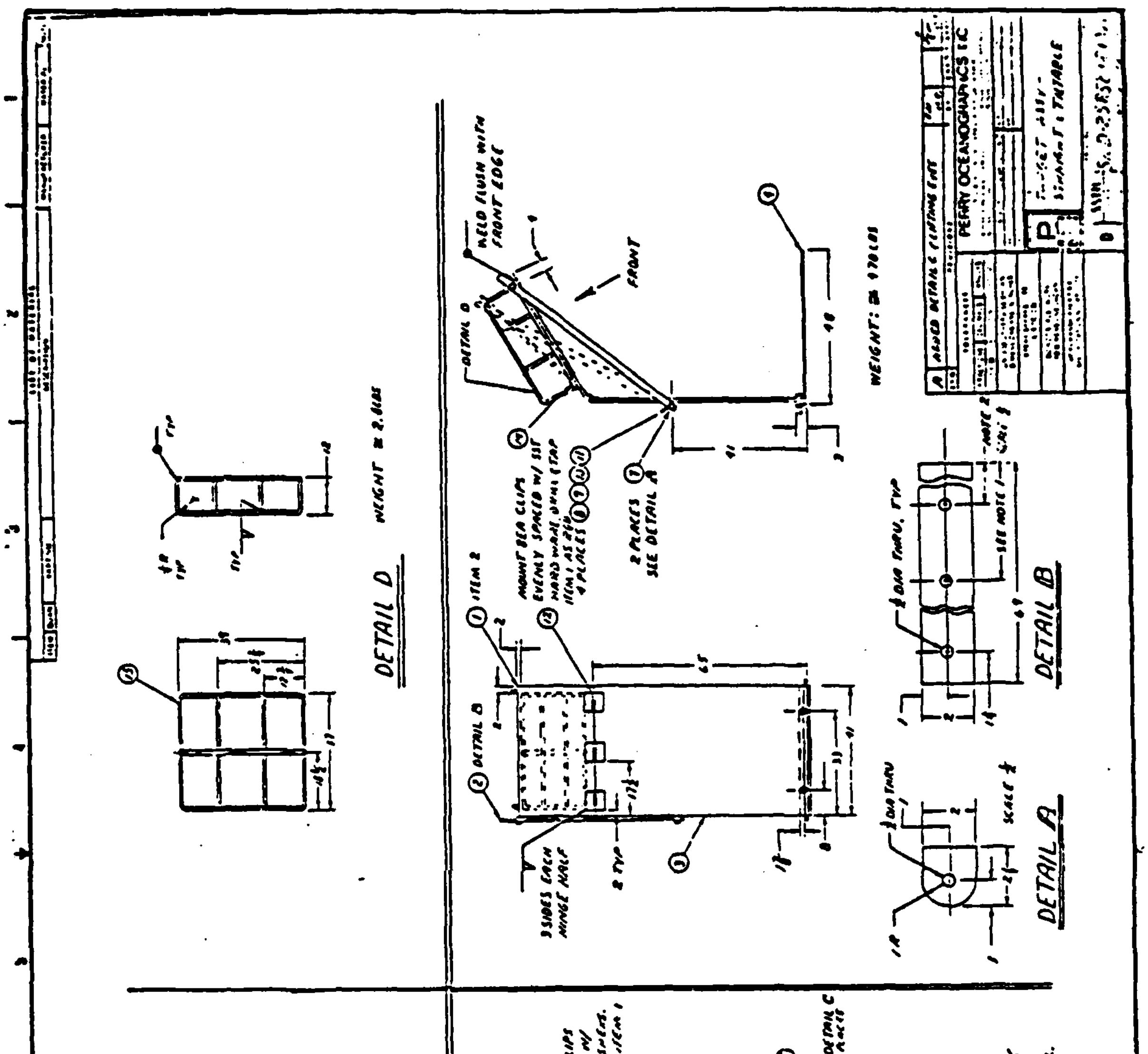
SKC-25902-001 Vehicle Arrangement



ATTACHMENT 2
Perry Drawing SKC-25902-001, Vehicle Arrangement



ATTACHMENT 3
Perry Drawings SKC-25857-001 and SKC-25858-001, Target Assembly


DETAIL C
DETAIL D
DETAIL A
DETAIL B
FRONT
PERRY OCEANOGRAPHICS INC

ATTACHMENT #4

SOURCES

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East Stroudsburg, PA, Copyright 1959

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"U.S. Import and Export of Substances Listed in Annex II of the MPC"
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TST-A-25854-001

ATTACHMENT 5

CHEMICAL ANALYSIS OF SAMPLES TAKEN BY RECON III-B

Prepared by

U. S. Coast Guard Research and Development Center

Avery Point

Groton, Connecticut 06340

CHEMICAL ANALYSIS OF SAMPLES TAKEN BY RECON III-B

1.0 The objective of this test was to determine if either the Perry RECON III-B vehicle or the operation of the lance-activated plugging devices would chemically contaminate water samples taken using the perry RECON III-B vehicle as a sampling platform. Two sets of samples were taken, one set to evaluate the Perry RECON III-B vehicle as a sampling platform and the second set after the vehicle was used to discharge a lance designed to plug holed vessels. These sample sets are identified in Table 1. The following sections of this attachment describe how the samples were taken, analyzed and the results of our analyses.

2.0 Water samples using the Perry RECON III-B vehicle as a sampling platform were collected using 1.7 liter Niskin water samplers. The Niskin bottles, one each, were attached to the upper port and starboard sides of the vehicle. The sampling devices were hand operated by divers. Clean water, i.e., blanks, were hand collected by divers using 1 gallon brown bottles which had previously been used to store spectro-quality organic solvents. The divers opened and closed these bottles beneath the water's surface to preclude the possibility of contamination by surface films. The samples collected using the Niskin bottles were transferred to 1 gallon brown bottles similar to those used in collecting the blank samples. Fifty milliliters of spectro-quality methylene chloride was added to each sample at the time of collection. The samples were subsequently returned to the R&D Center for analysis.

3.0 The collected samples were prepared for absorption and flourescence spectroscopic analysis as follows:

3.1 The upper water layer was decanted and discarded from each 1 gallon glass bottle.

3.2 The methylene chloride layer was removed and placed in a flash evaporator. The methylene chloride layer was reduced in volume to approximately 1 milliter tna transferred to capped conical centrifuge tubes.

3.3 The residual methylene chloride layer was evaporated to dryness under a stream of nitrogen. The resulting residue was reconstituted in 3.5 milliters of spectro-quality cyclohexane.

4.0 The objective of our analysis was to determine whether significant qualitative differences existed between the blank samples collected by the divers and those collected in the Niskin bottles attached to the Perry RECON III-B vehicle. The seven samples collected in this test were first analyzed by absorption spectroscopy from 200 to 800 nanometers using a Hewlett-Packard 8450 Diode Array Spectrometer.

The results are as follows:

4.1 Samples P-1 and S-2 taken with the Perry RECON III-B vehicle before and after firing the lance have similar absorption spectra to blanks 1 and 2 taken by the divers.

4.2 It is obvious that the tests were conducted in different areas based on the absorption spectra of blanks 1 and 2.

4.3 The absorption spectra of samples S-1 and P-2 contain significant differences as compared to their respective blanks. The absorption spectra of samples S-1 and P-2 are also different from each other.

4.4 No significant absorption was detected above 400 nanometers in any of these seven samples.

5.0 The samples were next analyzed by fluorescence spectroscopic techniques. The samples were analyzed using an excitation wavelength of 254 nanometers and recording the emission spectrum from 280 to 480 nanometers. All measurements were made using a fully corrected Farrand Spectrofluorometer. The results of these analyses are as follows:

5.1 The fluorescence spectra of samples P-1 and S-2 are identical to the fluorescence spectra of blanks 1 and 2.

5.2 The fluorescence spectra of samples S-1 and P-2 are distinctly different from each other and their respective blanks.

5.3 The fluorescence spectra of samples S-1 and P-2 cannot be related to each other based on possible differences in sample concentration which is obvious in the magnitude of the absorption response for these two samples.

5.4 The fluorescence spectrum of sample P-2 indicates that this sample contains components which are present in blank 2 and S-2, particularly on the long wavelength side. Additionally, the low wavelength side of the spectrum of P-2 contains components similar to those present in the fluorescence spectrum of sample S-1.

6.0 Based on our analysis two samples, P-1 and S-2, collected using the Perry RECON III-B vehicle as a sampling platform, are identical to blanks (background water) collected by divers. This indicates that neither the firing of the lance nor the operation of the vehicle in these two instances interfered with the use of the Perry RECON III-B as a sampling platform. However, discrepancies exist in the correlations of samples S-1 and P-2 with their respective blanks. Although the absorption and fluorescence spectra of both of these samples contain similar responses, these responses cannot be conclusively linked to a common source (i.e., the Perry RECON III-B vehicle). As such, the RECON III-B vehicle appears to be a satisfactory platform from which to collect samples in a hazardous chemical spill area without introducing any significant amounts of contamination due to its own presence.

TABLE 1

SAMPLE IDENTIFICATION

1. Sample Set 1

Samples collected before firing lance:

Blank 1 - hand collected by divers
Blank 1* - hand collected by divers
P-1 - 1.7 liter Niskin bottle, port side of vehicle
S-1 - 1.7 liter Niskin bottle, starboard side of vehicle

2. Sample Set 2

Samples collected after firing lance

Blank 2 - hand collected by divers
P-2 - 1.7 liter Niskin, port side of vehicle
S-2 - 1.7 liter Niskin, starboard side of vehicle

DATE
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