UTILIZATION OF DIVING AND SALVAGE EXPERTISE IN THE PREVENTION OF OIL POLLUTION

Lt. Barry E. Chambers, USCG
and
Lt. Comdr. Hugh D. Williams, USCG
USCG Atlantic Strike Team
Elizabeth City, North Carolina

INTRODUCTION

The Federal Water Pollution Control Act Amendments of 1972, among other things, called for a National Contingency Plan for removal of oil and hazardous substances. Additionally, a strike force was to be established "consiting of personnel who shall be trained, prepared and available to provide necessary services to carry out the [National Contingency] Plan." The National Contingency Plan provides further detail regarding the strike force by specifying that the National Strike Force (NSF) shall be formed around the strike teams established by the U.S. Coast Guard on the East, West, and Gulf Coasts. "The NSF shall provide assistnace to the OSC (On Scene Coordinator) during Phase III, IV and V operations as circumstances of the situation dictate."

The phases referred to are operational response phases: phase III is Containment and Countermeasures, phase IV is Cleanup, Mitigation, and Disposal, and phase V is Documentation and Cost Recovery. Phase III activities are considered the most significant for the NSF because containment and countermeasures are preventive and describe measures taken to avoid further discharge. A successful phase III response may preclude cleanup, mitigation, and disposal which are the most uncertain and damaging aspects of a pollution incident. Containment and countermeasures appear to have been subsequently translated into the responsibilities specified in the National Contingency Plan for the strike teams comprising the NSF. "These teams include expertise in ship salvage, diving, and removal techniques and methodology." Thus, the National Contingency Plan indirectly relates ship salvage and diving to containment and countermeasures. The purpose of this paper is to describe ship salvage and diving as it relates to pollution containment and countermeasures in greater detail, including training of personnel, equipment utilized, procedures developed, and future plans to increase effectiveness.

Diver qualification

The Atlantic Strike Team at Elizabeth City, North Carolina, has a complement of 15 enlisted and 4 officers. Within this total complement of 19, 8 positions, or billets, are assigned as diving billets, including one ship salvage diving officer (SSDO), two second class divers, and five scuba (self-contained underwater breathing) divers. SSDO, Second Class, and Scuba are diving classifications obtained by completion of respective USN Diving Schools. The Naval Ship Salvage Diving Officer School is located in Washington, D.C., and consists of 16 weeks of intensive training in hard hat or deep sea equipment, scuba, use of underwater tools, underwater cutting and welding, demolition, damage control and ship stability as related to marine salvage. The USN Second Class Diving Schools are 10 weeks in duration and include hard hat, scuba, underwater tools, and cutting and welding training. The scuba school consists of four weeks of training utilizing basic self-contained underwater breathing apparatus. All Navy Diving Schools also devote time to the study of underwater physics and physiology. The Coast Guard requires that any man drawing diving pay must be a qualified USN Diving School graduate. Requalifications are required biannually. Graduation from a USN Diving School does not automatically produce an experienced diver. Diving expertise is developed by exposure to various tasks and conditions. Therefore, to fill the Atlantic Strike Team diving billets initially, qualified divers were assigned from Alaska, San Diego, New York, and New Orleans to form an experienced nucleus. The remaining diving billets were filled eventually by other personnel assigned who competed and thus prepared themselves physically for the rigorous Navy Scuba training. Exposure to varying conditions remains an important consideration. Key West, Florida, and Boston Harbor in December represent a wide variation in environmental stress. Research studies indicate that the interactions between such environmental conditions and performance are significant and quite complex. Memory, in the form of recognition and recall, is adversely affected by environmental stress. Adverse conditions also impose limitations on equipment. To circumvent or mitigate such environmental stress, training and specialized equipment are necessary. Therefore, on-the-job success is usually the result of specific (equipment) adaptation to the environment and the application of practiced techniques.

Diving Equipment

The inventory of diving equipment available has been expanding rapidly in the past few years due to the need for specialized equipment in deep sea exploration and off-shore drilling operations in cold water areas such as the North Sea. For this reason the selection of equipment for the Atlantic Strike Team has not been difficult. The following are the basic diving sets used by the Atlantic Strile Team.

a. Standard 1/4-inch wet suit, single hose regulator, aluminum 72 CUFT tank, fins, mask, hood, underwater tool (diving knife), depth gauge, tank pressure gauge, life jacket (2 CO_2 cylinders, 25 gms), weight belts, and Sub Com wireless underwater communications (diver to diver and diver to surface). This system is used for diving in water temperatures down to 40°F (for short durations).
b. Unisuit, single hose or double hose regulator, aluminum 72 CUFT single or double tanks, fins, mask, underwater tool, depth gauge, tank pressure gauge, weight belt, and Sub Com wireless underwater communications. This system is used for diving in any water temperature for long durations.
c. Unisuit or wet suit, Kirby Morgan Band Mask, helmet, escape bottle, fins, depth gauge, weight belt, and wired

communications-to-deck transceiver. This system is similar to the hard hat diving rig but has the additional advantages of greater versatility and mobility for the diver. Other diving and related equipment considered as auxiliary can be categorized as follows:

1. cutting and welding equipment
2. explosive stud gun
3. portable compressors
4. hogging lines
5. sealants and epoxies
6. line, wire, and other rigging
7. transportation equipment for rapid response (boats, vehicles, and aircraft)

Procedures

Pollution cases are never identical. The same premise applies to diving and salvage-related pollution cases. However, certain procedures are basic and contribute to a successful operation. The first might be called damage location and evaluation. In the case of a small vessel, barge, or ship, the location and marking of hull damage due to grounding or some other casualty can be marked and measured rapidly by use of scuba and a line from the surface to attach to the rupture. Measurements, using the reference line, could be easily made and because of the small underwater hull area, would be relatively accurate. Now consider underwater damage sustained by a VLCC (very large crude carrier) or even an ordinary tank ship. The underwater body of such a vessel may resemble three football fields, end to end. Couple this with current, poor visibility, and cold water and a hull survey becomes a much more complex task. The procedure used in this situation is hogging lines. Two lines are run under the hull at a predetermined distance apart, and hopefully, at or beyond the ends of the damage. A running line is then attached between the hogging lines. The diver or divers then swim along the running line, moving the running line to the limits of visibility when they reach each hogging line. By keeping a record of the location of the hogging line and the length and location of the running line at the damaged area extremeties, an accurate description of the damage can be determined. This procedure is enhanced by the use of the Kirby Morgan Band Mask with hard wire communications which permits the diver to relate his observations directly to the tenders on deck. The reasons for rapid damage location and evaluation are: (a) ship stability and salvage decisions require accurate and timely assessment; (b) the extent of further discharge will depend upon the relationship of vessel trim and the location and size of damage; and (c) if patches or other repair procedures are to be undertaken, rapid assessment is important in expediting repairs.

Another fundamental procedure is the repair or patching of holes or other openings through which product might escape. While efforts are underway topside to remove product from a damaged tank, divers can be placing a patch over the rupture. One method is the use of the hogging lines by bringing them together to bind the patch of steel or plywood to the hull. Once the patch is in place, studs could be shot in to complete the job. Smaller ruptures can be sealed with plugs, quick drying cement, or epoxy compounds developed for this purpose. Similar sealing procedures have been successfully employed to seal cargo tank vents and other openings in sunken vessels.

Salvage implies the location and removal of a vessel, or parts thereof, from the bottom, the shore, or the surface. Major salvage operations are usually complex undertakings requiring support platforms with cranes, air compressors, welding or cutting apparatus, pumps and so forth. Strike force divers will not normally be called upon to perform major salvage operations due to private industry providing expertise and equipment in all major port areas. However, rapid response in sealing leaks and supervision or monitoring of such salvage operations are important strike force responsibilities.

Case studies

The basic procedures described have been categorized as (1) damage location and evaluation, (2) repair or patching, and (3) salvage. The following cases illustrate the application of the procedures outlined.

Tanker *Lalibella* (damage location and evaluation). On or about December 22, 1973, an Ethiopian tanker, the *Lalibella*, grounded while transiting the Cape Code Canal. Aerial surveys confirmed that the cargo of crude oil was leaking. The vessel master was ordered to remain offshore until provisions could be made to receive the vessel and cope with the loss of cargo. A contractor and the Atlantic Strike Team were called and arrived in Boston on December 23. In the meantime the vessel was permitted to enter Boston Harbor where it was immediately boomed. The strike team brought pumps as well as diving equipment, and when the tugs cleared the area, divers were sent down. Hogging lines were rigged from the forward most tank bulkhead to 100 ft. The divers located a hole approximately 32 ft long, ranging in width from 6 in to 2-1/2 ft. Comparison with the vessel's general arrangement drawing indicated that the damage was confined to the number 1 port wing tank. Evaluation of vessel trim and tank soundings led to the conclusion that if the vessel maintained a draft forward of 20 ft, no further discharge of product could occur.

Sunken small vessels (plugging leaks). On two separate occasions, Atlantic Strike Team divers have been called to seal or plug leaks from sunken vessel tank vent lines. In the latter case, the divers and patching equipment were delivered to the scene by a Coast Guard helicopter. In both cases, the vents were sealed successfully with plugs and plastic caps. The owners were proceeding independently to arrange salvage via private companies. By rapidly securing the discharges, the pollution threat was removed and significant savings of both the environment and the owners' funds resulted.

USNS *Towle* (hull repair-salvage). The USNS *Towle* had been holed by a small iceburg (growler) off Hamilton Inlet, Labrador. The strike team response consisted of 24,000 lb of equipment, including ADAPTS pumping systems, diving gear, underwater cutting and welding equipment, and so forth. It was found that the vessel had been holed in a number of places in an area about five feet by seven feet, with the damage centered on the tank top between the no. 1 double bottom and the no. 1 lower hold. The oil (navy special) had entered the no. 1 lower hold through a rupture in the tank top and also through the external openings. Using thief samplers to sound the lower hold, it was estimated that 220 barrels of oil remained therein above 6 ft of water. Unfortunately, the hold was full of soap, cleanser, napkins, and towels which complicated the removal of the oil. Sealing the external holes, pumping down the double bottom, and pumping out the water bottom in the cargo hold was necessary. To do this an underwater patch was needed. The underwater patching was accomplished using marine epoxy, wooden plugs, two-by-fours, and other materials. The plugs were coated with 1 to 2 in of epoxy and forced into the various ruptures. Then additional epoxy was used to smooth the surfaces around the plugs. After waiting 8 hours for the epoxy to harden, suction was taken on the double bottom and revealed that the input rate was reduced to 50 GPM, which was acceptable. The water bottom under the oil in the no. 1 lower hold was pumped to slop tanks using the ADAPTS pumping systems. The tank top rupture beneath the hold plugged itself with cargo debris. Following the pumping operation a large traditional patch was constructed and fitted using hogging lines. The patch was removed and kept as a contingency in case the epoxy failed. The *Towle* then steamed at standard speed to Goose Bay without incident. This operation prevented any further discharge of oil from the vessels double bottom fuel tank into an extremely valuable Canadian salmon resource.

Future plans

Many new and innovative types of diving equipment and procedures have been developed recently. An effort is underway to review, purchase, and adapt new equipment to increase the efficiency of strike force diving operations. A description of the new equipment being considered is best made by relating it to the basic procedures previously described.

Evaluation of underwater damage can be greatly facilitated by using underwater television equipment. The strike teams currently

have television cameras and recorders. Currently, watertight containers and lighting systems are being evaluated in order that the equipment on hand can be used for this purpose.

An explosive stud gun is a valuable tool for use in hull repairs and patching. Stud guns are not designed to be used underwater, but with minor modifications, such use is possible. Explosive studs were used successfully during the application of underwater patches on the USNS *Towle*. By the same mechanism, fittings can also be driven to permit the connection of air hoses for salvage work.

To salvage cargo from submerged tanks, a procedure known as hot tap can be used. The term *hot tap* stems from the use of this method by oil company personnel to drill holes in high temperature oil pipes while maintaining a steady rate of flow. The Murphy Pacific Salvage Company successfully demonstrated the use of hot tap on the SS *Arrow* and the MV *Oriental Warrior*. This method involves the use of an enclosed rotary cutter to penetrate a container. The technique as applied to salvage is modified so that the cutting operation is conducted through a gate valve attached to the deck above the cargo tank to be penetrated. This arrangement provides positive control over the deck opening to prevent upward discharge of the oil. The base of the gate valve sits on a spool piece that has been studded to the tank top. A suction hose is connected to the gate valve with a 90° elbow fitting after the drilling rig is withdrawn. The hot tap machine can be operated either hydraulically or pneumatically and requires an umbilical to its source on the surface. In operation, the hot tap machine is first flange mounted to the gate valve. The gate valve is then opened and a manually operated gear mechanism on the machine is used to lower the cutting head through the gate valve and spool piece. After the cutter head has penetrated the tank, the head is withdrawn and the gate valve is closed. A 6-in suction hose is affixed to the elbow connection for pumping operations. It is feasible to incorporate the ADAPTS single vane submersible pump in the suction line near the elbow connection. This will permit the integration of the hot tap equipment as a part of the ADAPTS system. This method is relatively simple and can be a very cost effective approach to the removal of product from submerged containers.

Alternatives to using a hot tap to reach the cargo through the tank wall do exist. A fully or partially submerged tank with accessible tank openings such as a butterworth cleaning opening, a tank hatch, a vent outlet, a sounding tube, or an ullage port can be evacuated by direct entry. A cofferdam would create flow from the tank, assisted by gravity in the case of petroleum products with low specific gravities. To increase flow into the cofferdam, the tank could be pressurized through other openings. The pressurization is accomplished by injection of water. This would also permit direct connection of a discharge line to a small opening, a vent for example, with water pressure applied to another opening. If only one small opening is available, water hose of a small diameter could be led through a discharge hose enabling pressurization and discharge via one connection.

CONCLUSION

Containment and countermeasures are response activities which preclude environmental damage and arduous cleanup and removal tasks. The best container for cargo containment is the cargo's original tank, rapidly repaired to avoid further loss. The best countermeasure is rapid removal from the damaged tank to secure storage. Diving and salvage make these goals possible and, consequently, diving and salvage expertise has been incorporated into the National Strike Force.