

For this reason these categories are here defined as:

Rescue and Assistance

Rescue and assistance comprises those measures administered to a ship which is still afloat and is either in distress or in danger of a distress situation. Rescue and assistance can best be administered by salvage ships but may also be provided by any ship able to tow or to supply a fire and rescue party. Rescue and assistance is considered as salvage work when the effort is directed at saving the distressed ship and/or its cargo. Typical examples are rescue towing, off-ship fire fighting, and emergency repairs such as clearing a fouled propeller.

Afloat Salvage

Afloat salvage comprises those measures administered to assist a ship damaged or disabled at sea by collision, fire, storm, mechanical failure, or enemy action where the situation is so grave, or potentially so, as to require the services of trained salvage personnel and special salvage equipment.

Offshore Salvage

Offshore salvage involves refloating stranded or sunken ships in exposed locations along the coast, or on reefs or islands. Ships aground on beaches or reefs are subjected to extreme structural stresses. Their salvage is nearly always difficult, dangerous, and of an urgent nature because conditions of wind and sea combine to cause further damage which makes salvage progressively more difficult, unless immediate and correct action is taken. This type of salvage requires trained personnel and special salvage equipment.

Harbor Salvage

Harbor salvage is the salvage of ships and work of a salvage nature in harbors or protected waters. Time is generally not the important factor that it is in offshore salvage. However, a ship located in a navigable channel, alongside a pier, or in a mooring area will normally receive priority attention.

Combat Salvage

Combat salvage may include elements of any of the foregoing types of salvage, as follows:

Rescue Salvage. Ships incapacitated or damaged in a combat zone require expeditious rescue towing to a safe haven. Such towing may be performed by fleet tugs and/or salvage ships organic to the task force or, in an emergency, by combatant ships until the arrival of auxiliary towing type ships. Ships damaged and/or on fire in a combat zone may require off-ship fire fighting and damage control assistance to prevent further damage or total loss.

Amphibious Salvage. Amphibious salvage is normally conducted to clear landing beaches and boat lanes of landing craft and amphibious vehicles. In most cases, salvage efforts are effected immediately by the naval beach party and other salvage units. Distressed ships would require salvage

MARINE SALVAGE - A NAVAL PERSPECTIVE

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SUMMARY

This paper will define marine salvage from the naval viewpoint; will describe the organization, personnel and equipment requirements of a naval salvage force and will address key interfaces between private or commercial enterprise and military salvage endeavors.

MARINE SALVAGE

In the merchant or commercial world, the term marine salvage connotes those efforts to save maritime property at risk. The admiralty lawyer will take a more specific view in that marine salvage is considered to be a voluntary response to a maritime peril by other than the ships own crew and from which the ship or property could not have been saved without the effort of the salvors. The naval definition of salvage, on the other hand, is much broader encompassing not only the saving of ships and property at risk at sea, but also rescue towing, harbor clearance, and the recovery of aircraft and/or other objects.

Within the U. S. Navy, there are eight categories of salvage; each requiring unique assets for successful prosecution. These categories include Rescue and Assistance, Afloat Salvage, Offshore Salvage, Harbor Salvage, Combat Salvage, Submarine Salvage, Cargo Salvage, and Recovery.

Understanding what each of these categories entail is essential if an effective organization is to be developed to cope with each emergency.

efforts beyond the capability of the naval beach party. For that reason, auxiliary and salvage ships are frequently assigned to amphibious task forces.

Harbor and River Clearance. Harbor and river clearance is basically harbor salvage and comprises the work of clearing blocking ships, sabotaged ships, damaged bridges, locks, and demolished port facilities left by an enemy in order to preclude or restrict the use of the harbor or access channel. This work may occur in captured harbors or as an ongoing effort to keep a harbor or channel from being blocked due to enemy interdiction.

Submarine Salvage. Submarine salvage is a very specialized class of salvage and may be classed under either harbor salvage or offshore salvage, depending on the circumstances.

Cargo Salvage. Cargo salvage comprises the saving or retrieval of cargo from a distressed or sunken ship or aircraft. This may include specific items of cargo, such as gold or the ship's safe, classified documents, special recording devices, such as the flight recorder on an aircraft, or it may involve bulk and general cargo. Cargo salvage is also considered to include ammunition or weapons, either in or lost from a ship or aircraft, as well as lost weapons, such as missiles or torpedoes, whether fired operationally or lost on a test range.

Recovery. Recovery is the retrieval of aircraft or aircraft components, and other valuable objects or material from the ocean and harbor bottom. Recovery operations are conducted at depths down to 20,000 feet using manned and unmanned submersibles, and air, mixed gas, and saturation diving support platforms. Recovery operations may involve simple tasks such as surface towed grappling, diver operations, or more complicated tasks requiring deep submergence manned or unmanned submersibles. In most cases, a recovery operation will require preliminary search and location phases using sonar, underwater television and visual techniques assisted by precise navigation equipment. Most recovery operations are not extremely time sensitive but because of water depths and the often unique characteristics of the objects or aircraft to be recovered, the operations do require a high degree of technical expertise and specially designed equipments and systems.

#### ORGANIZATION FOR SALVAGE

In order for an organization to be effective in managing a salvage force and in prosecuting time critical salvage operations, it must be free of bureaucratic constraints, have firmly established and direct lines of communication and have well defined levels of responsibilities. In general, such an organization will have a central group, or staff, responsible for overall operational and logistic management and will have one or more field units directly responsible for the prosecution of actual salvage operations. Since each type of salvage operation is invariably unique, the most important requirement of a salvage organization is that it be totally flexible to cope with the emergency at hand.

#### Central Staff

The central staff will have overall responsibility for the management of the salvage force including operational assignments. Typical areas of responsibility include: assignment of available assets or field units to

a particular operation; legal and financial matters; contract administration; maintenance and repair of equipments; provision of naval architecture and other engineering services; and provision of logistic support.

#### Field Units

In the context of this paper, field units are considered as individual salvage ships or tugs; as shore based mobile salvage teams; or as any combination of these units. The primary difference in the organization of these units and the central staff is that these units are organized to prosecute the on scene salvage effort. In many cases however, the on scene units will reflect the functional organization of the central staff albeit on a smaller scale. Of necessity there will be groups within the unit responsible for overall direction of the salvage effort, legal, financial and contract management, and engineering and logistic support.

#### Division of Responsibility

As previously mentioned, it is imperative that the responsibilities of each echelon of the salvage organization be well defined. The central staff is clearly responsible to provide overall management, direction and support for its field units. At the same time, it is equally important that the on scene organization be fully responsible for the prosecution of the salvage effort. The problems associated with a particular salvage or recovery effort are unique to that operation and are totally influenced by local conditions. The central staff can provide technical advice and support but should refrain from giving direction. The on scene salvage officer must call the shots and receive any and all logistic support required.

#### Salvage Personnel

If a salvage organization is to be effective, it must be staffed with knowledgeable and competent personnel. Salvage skills are not learned in a classroom but are gained through extensive participation in all types of salvage operations. For this reason the training of personnel to staff the salvage organization is long term in nature. The skills required in salvage are many and varied. For purposes of continuity, these required skills will be discussed in relation to the requirements for the central staff and the field units.

#### Central Staff

As previously stated, the central staff is primarily a management organization. Its makeup includes accountants, attorneys, contracting officers, financial planners, and logistic specialists skilled in transportation, inventory management and warehousing matters. In order to provide engineering services, the staff should have engineering talent that is thoroughly familiar with the unique naval architectural and mechanical engineering aspects associated with salvage, diving and recovery. The personnel who decide on the assignment of particular units to actual salvage operations must be able to comprehend and understand fully the particular military requirements associated with an individual operation and at the same time possess a thorough knowledge of the commercial salvage industry including the functions of cargo and hull underwriters, P and I clubs, owners, charterers, etc.

Field Units

The skill and trade mix of the personnel that comprise the field units will make the difference between a particular salvage operation being a success or failure. The heart of the field unit must be considered to be the diver. This individual must be a fully capable underwater mechanic and have the skills of an electrician, a welder/cutter and a rigger. Topside personnel requirements include riggers, pump mechanics and operators, diver tenders, welders/cutters, electricians, petty officers and chief petty officers, and of course the salvage officer.

The salvage officer will be in overall charge of a particular operation and will also possess the greatest knowledge of the techniques of salvage. Not only must he have a thorough technical and "nuts and bolts" knowledge of salvage operations, but he must be familiar with the principles of naval architecture including buoyancy, stability, hull strength and ship construction.

Should the field unit be composed of both ships and mobile salvage teams, the salvage officer will generally have control over the employment of the salvage ships; however the responsibility for each ships safety will remain with its Captain.

In addition to the salvage officer, topside mechanics, riggers and divers the field units must have logistic specialists to obtain needed supplies and equipment. Also required are personnel with financial/accounting skills to keep track of the local costs on a daily basis.

SALVAGE EQUIPMENT

The equipment required in salvage operations can be divided into two basic categories: ships and floating equipment and portable equipment. The varied nature of salvage operations dictates that the equipment used in these operations be easily adaptable to the conditions encountered in the field. In the case of portable machinery and equipments, they must be rugged enough to withstand harsh environmental conditions yet lightweight for ease of transport and employment at the salvage site. The following paragraphs will outline the characteristics and capabilities required in both salvage platforms and portable equipments.

Salvage Ships

Ideally, a salvage force should be built around a nucleus of several fully capable and equipped salvage ships. In today's economic environment this may not always be possible, even for relatively large governments. In any case, in order to provide some protection for the maritime force it will be necessary to maintain some minimum number of fully capable Naval salvage ships.

The term fully capable must be defined in the context of the projected employment and operating range of the ship. The design characteristics to be examined and evaluated with respect to possible salvage situation requirements include draft, power, seaworthiness, deck space, towing capability, auxiliary equipment, portable equipment storage capacity, shop facilities and free running speed.

An efficient open ocean towing ship must have a relatively deep draft in order to have an effective transfer of power into the water. On the other hand, an effective salvage ship must have a relatively shallow draft in order for it to operate closer to the beach for grounded ship removals. Clearly a trade off is necessary if these two functions are to be incorporated in the same hull. It is desirable for both towing and salvage operations to have high power or bollard pull as well as sufficient seaworthiness to withstand the miserable weather and sea conditions that are likely to be encountered during these evolutions.

Towing capability or facilities can range anywhere from a cleat or H bit on the fantail to a fully automated double drum towing machine. Again, the desired capability must be tailored to the projected rescue and salvage scenarios.

The physical layout of the ship will depend on space allocated for portable machinery storage and handling, the amount and extent of shop capability desired such as plate bending, wood cutting, welding, machining, etc. and the amount of clear deck space required. The general rule for a salvage ship is that space for the above capability be maximized to the extent possible as this can be considered to be the ships main armament.

Finally free running speed, or the speed at which the ship can proceed when unencumbered by a tow, must be maximized in order for the ship to reach a distressed vessel in the minimum time frame. A compromise will be required here given that the ship must also incorporate some trade offs in draft and power characteristics.

Other Floating Equipment

This type of equipment will not be discussed in detail but rather general characteristics will be provided. Major types of equipment falling into this category include floating cranes, pulling barges, diving boats, and lift craft.

Floating cranes are generally of two types: shear leg or whirly or rotating cranes. In most cases these cranes are permanently mounted on a pontoon which contains power generating equipment, shop facilities, living quarters, and deck machinery and anchors for moving and securing the crane. Most floating cranes are non-self propelled however they can be powered through the use of portable outboard engines.

Pulling barges are useful in removing ships from a strand or assisting in parbuckling operations. They are generally made up as required and tailored for the job at hand. A typical pulling barge consists of a barge, approximately 100' x 300', outfitted with winches, heavy wire rope and blocks. Capacity of the winches and size of the wire will be determined by requirements and/or equipment available. Usually the latter is the case. Typical pulling winches are in the 50-100 ton range and employ wire rope from 1-1/2 to 2" in diameter.

Diving boats are useful primarily in support of harbor clearance or protected water salvage. The installed diving system is generally simple and supports air diving down to a depth of about 90 feet. Larger capacity systems can be installed but are generally not required in harbor salvage.

Lift craft are usually employed only in protected waters and are used for clearance operations. Conceptually there are two basic types of craft, tidal or ballast lift and mechanical lift. The ballast concept involves the passing of lift wires from the craft, under the object to be lifted and then to another craft; ballasting both craft down; tightening the lift wires; deballasting the lift craft and lifting the object; moving the object into shallower water until it grounds and then repeating the operation until such time as the object can be refloated or lifted from the water. A mechanical lift craft is employed in much the same manner except that the craft is not ballasted down. Lifting capacity is determined by the size of the lift winches.

#### Portable Equipment

The equipment in this category encompasses anything that is not installed in the salvage ship or floating platform. For purposes of this paper, discussion will be limited to the major pieces of equipment, i.e., air compressors, beach gear, generators, light towers, pumps, welding machines, winches and pullers, side scan sonar and tethered vehicles, and diving systems.

Air compressors are employed in salvage operations in many ways - the most common include dewatering, powering pneumatic tools, diving air and for inflation of lift bags and fenders. The compressor characteristics are determined based on the intended end use of the compressor, therefore the inventory of compressors is likely to include several different types. In dewatering for example, the pressure must be high enough to overcome the bottom pressure and the flow capacity must be enough to dewater a space in a reasonable amount of time.

Beach gear is a term applied to the equipment used in pulling a ship from a strand. It consists of two major components: the ground leg and the purchase or deck tackle leg. In the U. S. Navy, the ground leg consists of an anchor (6000-8000 lb), 1800 feet of 1-5/8 inch wire rope and one shot of 2-3/4 inch die lock chain. The deck tackle leg, which is used to pull on the ground leg, consists of two 5/8 inch quad blocks reeved with 5/8 inch wire rope, two wire holding stoppers, fairlead blocks and a portable deck winch. This system can be installed on a pulling ship or barge or on the stranded ship. The Navy system is sized to exert a pulling force of 50 long tons or 112,000 pounds.

Generators are indispensable on a salvage operation as they are used to power not only electrical pumps and equipment but to provide power for lighting and office type functions. The Navy maintains 30 KW and 5 KW capacity generators in its inventory.

Pumps are the other major workhorse in a salvage operation. They are classed as standard or submersible and are diesel, electric or hydraulically powered. They are used for a myriad of tasks including dewatering, ballasting, and tunneling or washing out mud and debris. The Navy inventory consists of 3, 6, and 10 inch diesel pumps, 1-1/2 and 4 inch electric submersible pumps, 4 inch electric submersible pumps, 4 inch hydraulic submersible pumps and 2-1/2 inch high pressure diesel jetting pumps.

In search and recovery operations, the portable equipment becomes somewhat more sophisticated. Search plans generally call for an accurate navigation system either shore or bottom located as well as a side scan sonar system for conducting the search. The recovery phase either employs divers or remote controlled unmanned tethered vehicles to recovery the lost object or attach lift lines to it.

In many salvage operations it may not be possible to position the salvage ship alongside the wreck or a particular diving platform may not be available; hence the need for a portable diving system. There are three categories of diving system: air, helium-oxygen (HeO<sub>2</sub>), and saturation. In the U. S. Navy the depth ranges of these systems are:

Air	0 - 190 feet
HeO <sub>2</sub>	0 - 300 feet
Saturation	0 - 850 feet

HeO<sub>2</sub> and Saturation systems are employed primarily at depths greater than 200 feet or when it is necessary to substantially reduce decompression time in shallower depths, 150-300 feet. The U. S. Navy has only portable HeO<sub>2</sub> and air diving systems.

#### MILITARY/COMMERCIAL INTERFACE

As may be gleaned from the foregoing paragraphs, the nature of salvage and recovery operations is one of great diversity requiring many different resources of both personnel and equipment. This fact, above all others, dictates that there be a strong, solid relationship between the government and the commercial salvage industry. The government maintains a minimum peacetime salvage capability for one reason: to be able to expand and conduct combat salvage operations. Since it maintains only a minimum peacetime capability, the government, must often call on the commercial sector to provide lacking salvage expertise and equipment. Additionally, if there are infrequent commercial salvage opportunities, it is incumbent on the government to solicit commercial participation in government salvage operations to ensure that the commercial salvors maintain some minimal amount of expertise.

Often, especially when the demand for salvage is low, the reasons for maintaining strong relationships between the government and the commercial sector become obscured. This then results in one side excluding the other from participation thereby weakening that sides' posture or capability. This must not be allowed to happen if a country desires a truly viable salvage capability.

#### CONCLUSION

In this paper, I have described, in a broad brush manner, the basic equipments required in the organization, personnel make up, and equipment inventory in a naval salvage force. I have also stressed the need for a strong relationship between the military or government organization and the commercial salvage industry.

This paper can perhaps be best summed up by stating that in order to successfully accomplish a salvage operation, competent, knowledgeable, personnel must be formed into a highly flexible organization and be provided with efficient, rugged equipment tailored for the particular operation at hand.