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Engineer Diving Operations

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Engineer Diving Operations

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Preface

This FM provides the doctrinal basis and the responsibilities, relationships, procedures, capabilities, constraints, and planning considerations for the conduct of engineer underwater operations throughout an area of operations (AO). Its primary purpose is to integrate engineer underwater operations into the overall sustainment and mobility engineering structure. The doctrine presented is applicable for joint interagency and multinational environments in the full spectrum of operations.

Army Regulation (AR) 25-30 mandates that all Army programs and functions will use the metric system. To ensure compliance with this requirement, an English-to-metric measurement conversion chart is provided in Appendix A.

The proponent of this publication is HQ TRADOC. Send comments and recommendations on Department of the Army (DA) Form 2028 (Recommended Changes to Publications and Blank Forms) directly to Commandant, United States Army Engineer School (USAES), ATTN: ATSE-DOT-DD, 320 MANSCEN Loop, Suite 336, Fort Leonard Wood, Missouri 65473-8929.

Unless this publication states otherwise, masculine nouns and pronouns do not refer exclusively to men.

Chapter 1

Engineer Diving Missions

Engineer divers provide assured mobility by supporting the forward movement of troops and equipment. Divers also provide support to general engineering operations in and around water. Supporting assets range from a small scuba team to multiple larger teams with a diverse range of capabilities, including the use of surface-supplied diving (SSD) apparatus and heavy equipment. The following seven major essential missions are identified for engineer divers:

- Mobility/countermobility.
  - River crossing operations.
  - Bridge inspection and repair.
  - Hydrographic survey.
  - Obstacle emplacement/reduction.
- Port opening, construction, and rehabilitation.
  - Planning and inspection.
  - Clearance.
  - Repair.
  - Construction.
- Salvage.
- Search and recovery.
- Protection (physical security).
  - Security of bridges, ports, locks, and dams.
  - Physical security systems.
- Ship husbandry.
  - In-water hull inspections.
  - In-water maintenance.
  - Damage control and repair.
- Joint logistics over the shore (JLOTS).
  - Hydrographic survey (beachhead).
  - Mooring systems.
  - Offshore petroleum distribution.

MOBILITY/COUNTERMOBILITY

1-1. Engineer diving teams support the mobility of troops and equipment. Divers provide critical support to the engineer commander for wet-gap crossing sites. A light diving team can support bridge reconnaissance for all bridging operations. Regardless of the crossing means, each site needs engineer reconnaissance swimmers or an engineer light diving team to reduce obstacles and develop exit points on the far shore.

1-2. Divers can inspect and repair fixed or floating bridges. FM 3-34.343 is an excellent resource detailing inspections and repairs of bridges. Since the basics of bridge design are similar to pier design, the same inspections conducted on piers and pilings will be conducted on bridge components. Divers make temporary or permanent repairs to bridges, depending upon the time available and the degree and type of damage to be repaired.

1-3. Divers also provide support to countermobility. This includes such things as bridge demolition and obstacle emplacement.

RIVER CROSSING OPERATIONS

1-4. FM 90-13 establishes doctrine for conducting river crossings. Maneuver commanders require up-to-date intelligence of crossing sites in order to choose the most appropriate site or sites. The corps normally provides an engineer light diving team to support river crossing operations. Divers work closely with bridge units in order to provide accurate information for the crossing site commander. Divers conduct nearshore and far-shore reconnaissance and perform bottom composition surveys. FM 5-170 gives details on the type of information required. This information may include the following:

- Gap width.
- Stream velocity.
- Nearshore and far-shore bank composition and characteristics.
- Bottom composition.
- Obstacle type and location.
- Approach and bypass information.

1-5. The survey of a river crossing site is similar to other hydrographic surveys conducted by divers. The degree of accuracy delivered will depend upon the commander's requirements and the threat level. In an unsecured location, engineer divers require support from security personnel.

1-6. To facilitate emplacement of bridging, divers may also neutralize underwater obstacles, construct underwater bridge structures, perform in-water repair to bridging and watercraft, recover sunken equipment, and search for and recover casualties. Once the bridging is emplaced, divers assist in installing impact booms, antimine booms, and antiswimmer nets to prevent damage caused by waterborne munitions and collision by floating debris. Antiswimmer nets are placed both upstream and downstream to protect bridges from enemy swimmers or underwater demolition teams.

1-7. Diving teams also conduct inspections and surveys of deep-water fording sites. When the divers cannot easily span the distance between banks, an inflatable boat or a bridge erection boat can be used. Helicopters may be used to drop teams in the water or place teams on the far shore if the situation permits. Engineer diving teams routinely conduct river reconnaissances at night.

BRIDGE INSPECTION AND REPAIR

1-8. Engineer divers also provide critical support to fixed-bridge crossing sites. Divers conduct both underwater and surface reconnaissance of bridges to determine structural integrity and capacity. Divers may be used to repair or reinforce bridge structures and neutralize underwater obstacles in and around the bridge. Divers may also assist in installing impact booms, antimine booms, and antiswimmer nets to prevent damage to fixed bridging.

1-9. Engineer divers support countermobility by denying enemy access to bridging assets. Divers can be used to survey, emplace, prime, and detonate explosives on bridge supports to degrade or destroy bridges.

HYDROGRAPHIC SURVEYS

1-10. Hydrographic surveys provide a depiction of underwater bottom profiles of an operational shoreline or port area. Products from a survey may indicate bottom depth gradients, ship channels, and the location and type of obstructions that may impede vessel traffic.

1-11. Hydrographic surveys can be done with two levels of accuracy. A hasty survey is quicker to perform and gives the commander a general idea of the bottom profile, but the degree of detail is correspondingly less. A deliberate survey can take more time but produces more accurate results and provides a complete picture of the underwater profile, including obstacles.

OBSTACLE EMPLACEMENT/REDUCTION

1-12. Underwater obstacles can be man-made or natural and may include mines and other explosive devices. FMs 5-102 and 5-34 show many examples of obstacles that can be adapted and emplaced underwater. Divers can locate, identify, and reduce underwater obstacles.

1-13. Divers can be used to emplace or reduce underwater obstacles. Divers use demolitions underwater in the destruction of obstacles. Many of the same principles and techniques for using demolitions above water are used when employing demolitions underwater. Divers use sympathetic detonation to clear in-water munitions. This is accomplished by emplacing demolitions on or near underwater obstacles. Demolitions are always detonated from the surface.

1-14. A diving team is fully capable of utilizing available materials to deny access to any site that has aquatic or vehicular traffic. Steel can be welded into hedgehog or tetrahedron configurations and concrete can be poured into block, cylinder, or tetrahedron molds. In the event of retrograde operations, the diving team is fully capable of rigging a bridge substructure with explosives for command detonation.

1-15. Divers can be used to emplace or breach underwater minefields. FM 20-32 gives clear guidance on the emplacement of surface minefields.

Many of the same techniques can be adapted to underwater operations. Divers can emplace mines in water, but additional factors to consider are as follows:

- Many rivers or beaches have currents and waves that prohibit using mines with tilt rods.
- Floating debris may prematurely detonate mines.
- Soft river bottoms may prevent pressure-activated mines from detonating.

1-16. Divers can emplace mines in the water, but the mines must have additional anchors to hold them in place. One method is to use crossed pickets under the mine. This not only helps to anchor the mine but also helps to create a larger surface area in soft bottoms so that the mine can be pressure-activated.

1-17. Divers can breach underwater minefields. They use mine detectors or side-scan sonar to locate underwater mines. The mines are then marked and, if necessary, neutralized to create a safe lane for passage. Sympathetic detonation of underwater mines is accomplished by emplacing explosives on or near the mine, dependant on the type of fuzing mechanism. Divers can also identify mines for removal by qualified explosive ordnance disposal (EOD) teams. The Army does not have EOD-trained diving teams. Clearing an underwater minefield is a slow and deliberate process and should only be used when other alternatives for crossing have been exhausted.

PORT OPENING, CONSTRUCTION, AND REHABILITATION

1-18. Port facilities are key to the movement of personnel and material for any military operation. Port facilities can either be improved for friendly forces or destroyed to deny use by the enemy. Engineer divers can be used in either capacity and can assist in the planning of any port operation to help determine priorities of work or prepare work estimates. Port facilities that have been damaged by either natural or man-made causes can have damage to piers and quay walls prohibiting the on-loading or off-loading of supply vessels. Vessels may be either partially or completely sunken to deny passage of supply vessels. Port equipment such as cranes, vehicles, and materials-handling equipment may be sunken near piers to deny access to vessel berths.

PLANNING AND INSPECTION

1-19. Preliminary and detailed construction planning is an overall guide for construction activities and is accomplished before beginning construction work. Planning should include formulating a strategy for returning the port to operation as efficiently as possible. The headquarters should include a qualified planner (such as a team leader, executive officer, or senior/master diving supervisor) to identify diving requirements and to ensure proper allocation of diving assets. The planner assists in the development of an inspection plan and provides guidance to the inspection team for initial on-site surveys. After completing initial inspections, the team leader will designate the appropriate diving team that is most capable of performing the mission. In the event that the operation requires extensive diving assets, such as major salvage, construction, or harbor clearance, multiple diving teams may be task-organized to support the mission.

1-20. A completed inspection can provide the water terminal commander with a report of existing conditions of underwater port facility structures. A hydrographic survey depicting water depths and obstruction locations can be included in the report. The information provided assists the area engineer and port construction units in determining the scope of construction required for port repair. It can also assist in the development of a port repair plan and time estimate.

1-21. A detailed report may include—

- Details of the port or facility.
- Assessment of underwater damage to existing pier facilities.
- Recommendations for restoration.
- The location and condition of sunken vessels or other obstructions.
- Water depths of ship channels within the port.
- Recommendations for vessel or obstacle removal.
- The location of underwater mines and munitions.

NOTE: Engineer divers can clear mined areas by using sympathetic detonation with demolitions. Divers can also locate and mark suspected mined areas for removal by qualified Navy EOD teams.

NOTE: If the inspection is being done in an unsecure port, diving teams require the support of security personnel.

CLEARANCE

1-22. Clearance operations are undertaken to neutralize or reduce obstacles that are blocking the shipping channels in ports, loading facilities, mooring sites, marine railways, dry-dock facilities, lock and dam structures, and other navigable waterways. Clearance consists of locating, marking, surveying, and removing or reducing underwater obstructions. The operations include the removal of natural (underwater rock formations) or man-made obstacles, battle debris, or enemy-emplaced objects intended to prevent the use of navigable waterways or port facilities.

1-23. Demolitions provide an efficient method for reducing underwater obstacles in the port area. Most explosives are capable of being used underwater. Explosives are used to clear ship passages or to cut wreckage. In complimentary use with manual underwater-cutting techniques, explosive cutting has extensive application in cut-and-lift harbor clearance operations and in certain patch-and-pump situations when portions of an obstruction are refloated individually. Special precautions are required when employing demolitions underwater. Charges detonated near any vessel or personnel in the water can cause substantial damage or injury.

REPAIR

1-24. The repair of port facilities is more desirable than initial construction because it is far less time and resource intensive. The repair may involve both underwater and surface operations and will depend on the close integration of both engineer divers and general engineer assets. Divers can perform repairs to underwater structures, such as bearing piles, fender and dolphin systems, and support walls. The inspection and repair of these structures may require specialized equipment. Repairs can be as simple as filling minor cracks with special epoxy; installing a concrete protective support jacket; or replacing wooden, steel, and concrete supporting structures and hardware. Repairs can be as extensive as major rehabilitation and replacement of the underwater structure supports.

1-25. The repair methods used depend upon the original construction techniques and the material used in the construction and are basically the same as surface construction techniques. However, the underwater conditions such as near to zero visibility and cold water increase the time required to perform the same task as on the surface. The best analogy for planners to keep in mind is that just as efficiency decreases when soldiers go to mission-oriented protective posture (MOPP) level 4, so does efficiency decrease when tasks have to be performed underwater.

CONSTRUCTION

1-26. The construction of new ports and facilities is a major undertaking that usually requires extensive use of divers. Divers can provide valuable information during the initial site selection and survey. Hydrographic surveys of the proposed area are conducted to determine water depths, sea-bottom contours, and the location of ship channels and underwater obstacles. The techniques for underwater construction are similar to the methods used on the surface. Detailed port construction techniques are outlined in FM 5-480 and Naval Facilities (NAVFAC) P-990.

1-27. Divers work with army port construction companies as well as other joint, interagency, and multinational organizations during construction operations. These units have cranes, pile drivers, earth-moving equipment, and any other heavy equipment necessary for port construction.

SALVAGE

1-28. Major salvage operations include the clearance and removal of sunken vessels, equipment, supplies, or other materials from port channels, berthing and docking facilities, mooring sites, lakes, lock and dam facilities, and other navigable waterways. A diver's ability to salvage vessels or other equipment depends on the type, size, and location of the object and the time available for the salvage effort. Salvage methods range from simple operations to recovering sunken objects to large-scale operations requiring complex integration of surface-support assets, including multiple vessels and lift assets.

1-29. The condition and disposition of a sunken object may dictate how it is to be salvaged. Raising a sunken object is a complex and timely operation. The immediate tactical need to use a harbor or port may require the expedient removal of the obstruction. Unsalvageable vessels and other equipment can be marked and left in place; sectioned and removed; or flattened, dispersed, or settled with explosives. Reference Navy salvage manuals for specific techniques.

SEARCH AND RECOVERY

1-30. Divers assist in the search and recovery of equipment and casualties lost in or near water. The most important aspect of recovery operations is to have a clear idea of where the object or person was lost. General directions and indecision will waste valuable work hours and increase the likelihood that the object will not be recovered. Whenever possible, a person or vessel should stay in the exact area that the object or person was lost.

1-31. Engineer divers can perform underwater recovery operations, but often not within the time limits needed for emergency rescue. In the event that personnel are lost in or near water, divers may be used to conduct in-water searches for casualties. Recovery operations of this type are normally conducted using one or more scuba teams to conduct a search of the area.

1-32. If a recovery operation is conducted, there are several techniques to search underwater. The method chosen will depend upon many factors, including the size and sensitivity of the item. Environmental conditions such as the size of the search area, weather, surf, bottom topography, and underwater visibility will also affect the technique chosen. Because using divers for an unaided visual search over a large area is time consuming and labor intensive, this type of search operation should incorporate the use of side-scan sonar and other search equipment whenever possible. A reconnaissance dive may be conducted before other scheduled dives to gather information that can save in-water time and identify any special hazards of the dive mission.

1-33. Diving skills are not recognized as a substitute for lifesaving skills. Tactical situations may require the use of engineer divers to prevent drowning. Such situations might include river crossing operations where the far shore has been secured or amphibious operations. Engineer divers are not trained, qualified, or equipped to perform as certified lifeguards and should not be used as such. Special training and equipment are required to safely perform lifeguard responsibilities. Agencies such as the American Red Cross provide the necessary training and qualifications required for lifeguards.

PROTECTION (PHYSICAL SECURITY)

1-34. Divers can be used to enhance protection in contingency operations or in response to national security concerns. Divers can be quickly deployed in order to secure areas. Planners and senior staff should be aware of the divers capabilities and integrate them into any response plan.

BRIDGE, PORT, LOCK, AND DAM SECURITY

1-35. Physical security of bridges, ports, locks, and dams may include both active and passive systems to protect or provide early warning of impending danger. Divers can assist in placing and maintaining physical security systems in port areas and waterways and on fixed bridges, locks, or dams. Divers provide security by swimming the area to be secured and providing an active early-detection system. Divers can perform physical security swims on the underwater portion of a vessel before it enters a facility or while it is moored outside a secured perimeter.

1-36. Divers must use specialized equipment when searching for mines or explosives. Although divers are capable of performing these inspections, they cannot remove any foreign explosive devices found during the inspection. The removal of these devices is the responsibility of underwater EOD teams.

PHYSICAL SECURITY SYSTEMS

1-37. Physical security systems are usually placed at harbor entrances, along the open areas of port facilities, and around bridge abutments. The systems may be passive or active and are designed to stop or detect vessels, underwater swimmers, or floating mines. These systems usually require diving support for installation and maintenance. Barriers across a harbor entrance restrict approaches to the harbor. Electronic security systems are designed to detect and, in some cases, deter attacks by underwater swimmers. Divers place and secure the systems underwater after qualified personnel assemble the systems on the shore. Periodic security swims are necessary on installed physical security systems to detect maintenance requirements and sabotage.

SHIP HUSBANDRY

1-38. Ship husbandry is the in-water inspection, maintenance, and repair of vessels. Vessels require periodic maintenance just like any other piece of equipment. Engineer divers are tasked to provide maintenance assistance for these vessels.

IN-WATER HULL INSPECTIONS

1-39. In-water inspections of military vessels are performed to assess the condition of the underwater hull and appendages. The inspections cover all parts of the vessel below the waterline and are part of the scheduled maintenance or damage assessment. The inspection provides the vessel master with information necessary to determine the condition of the vessel. These inspections provide the following information:

- **Hull.** Damage assessment and identification of buildup from marine organisms growing on the hull, plus the condition of antifouling paint surfaces.
- **Propulsion and steering systems.** Condition of shafts, screw propellers, and rudders and the serviceability of protective coatings, seals, and bearings.
- **Vessel appendages.** Determination of the general condition and operational ability.

IN-WATER MAINTENANCE

1-40. In-water maintenance of military vessels is performed for scheduled maintenance or deficiency correction. In-water maintenance enables the Army water terminal commander to have immediate use of his watercraft. He can also keep the marine railway, dry dock, and other vessel maintenance facilities open for vessels requiring maintenance and repairs that divers cannot perform in-water. Divers provide in-water maintenance of propulsion and steering systems, sea chests, and heat exchangers; the clearing of lines, ropes, or other debris from the propeller; and the cleaning of any appendage located below the waterline.

DAMAGE CONTROL AND REPAIR

1-41. Damage control and repair provides immediate assistance to a vessel in distress. Repairs are temporary in their application and are meant to keep the vessel afloat until permanent repairs are made. Divers can provide assistance ranging from installing small damage control plugs to welding on large patches. The vessel commander will direct the repair in coordination with the on-site diving supervisor.

JOINT LOGISTICS OVER THE SHORE

1-42. JLOTS operations are the water-to-land transfer of supplies to support military operations. They are conducted over unimproved shorelines and through partially destroyed fixed ports, shallow draft ports not accessible to deep-draft shipping, and fixed ports that are inadequate without using JLOTS capabilities. Divers are an important asset during JLOTS operations because of the large number of watercraft involved in the transfer of supplies. The scope of JLOTS operations depends on geographical, tactical, and time considerations. JLOTS operations can replace terminals destroyed by enemy action, relieve congested lines of communication (LOC), reduce land transport distances in supporting combat forces, establish terminal operations where none existed, supplement the capacities of existing fixed terminals (ports), or disperse supply and support operations.

1-43. As an initial step in planning a JLOTS operation, the terminal brigade or group commander selects beach sites. He may select beach sites based on intelligence information already on file in the theater or he may find it necessary to open new JLOTS beaches. Working with naval authorities, he selects proposed sites, based on a study of maps, hydrographic charts, special reports prepared by intelligence agencies, and aerial reconnaissance reports. Final site determination is made after a beach reconnaissance party conducts a detailed ground and water reconnaissance of the selected areas.

1-44. Representatives of the terminal group commander organize and supervise the beach reconnaissance party. The commander of the battalion that is to operate the beach, the Operations and Training Officer (US Army) (S3), and other appropriate members of his staff make up a portion of the reconnaissance party. Other necessary members include, but are not limited to, engineer, signal, and quartermaster officers; representatives from amphibian and landing craft units; the Navy; military police; and units with special equipment.

1-45. Unloading and transporting supplies at sea may result in the loss of supplies into the water. Divers can recover these supplies quickly and assure continued support to fielded units. They can also assist vessel crews by unfouling anchor lines or clearing debris caught in the propellers.

1-46. The salvage of equipment during JLOTS operations is the same as that during normal salvage operations. Items salvaged can range from individual weapons and equipment to major equipment such as tanks or helicopters. Lift support is required from outside sources if the item to be salvaged is a large piece of equipment such as a tank.

HYDROGRAPHIC SURVEY (BEACHHEAD)

1-47. Hydrographic surveys can provide the terminal brigade or group commander with a clear picture of underwater conditions at the selected sites. Hydrographic surveys can be done with two levels of accuracy. A hasty survey is quicker to perform and will give the commander a general idea of the bottom profile, but the degree of detail is correspondingly less. A deliberate survey can take more time, but produces more accurate results and provides a complete picture of the underwater profile, including obstacles.

MOORING SYSTEMS

1-48. Divers can install and maintain offshore mooring systems to provide safe anchorage to cargo vessels, causeways, and landing craft supporting JLOTS operations. Mooring systems can be emplaced, maintained, and removed by divers. These mooring systems are a series of anchors and mooring buoys that allow a vessel to be anchored at a specific location to assist in the off-loading and on-loading of supplies.

1-49. NAVFAC P-990 gives detailed instructions for the installation, inspection, and maintenance of mooring systems. Depending upon the type of vessel to be moored and the prevailing sea state or weather conditions, the anchors and buoys used may weigh many tons and be several meters long or several meters in diameter. A typical mooring system will consist of one or more anchors that lead to a mooring buoy. An example of a simple mooring system that allows a vessel to pivot around the buoy, depending upon the wind or current direction, is shown in *Figure 1-1*.

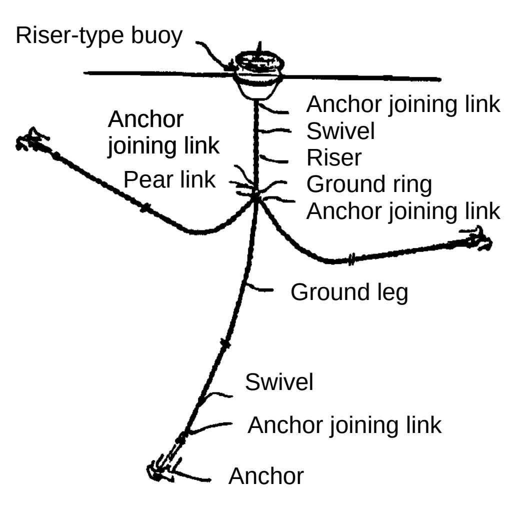

Figure 1-1. Single-Point Mooring System

1-50. A more complex system using multiple anchor sites that keep a vessel in a fixed orientation is shown in *Figure 1-2*. This type of mooring system is frequently used for petroleum distribution systems in order to avoid tangling flexible pipelines.

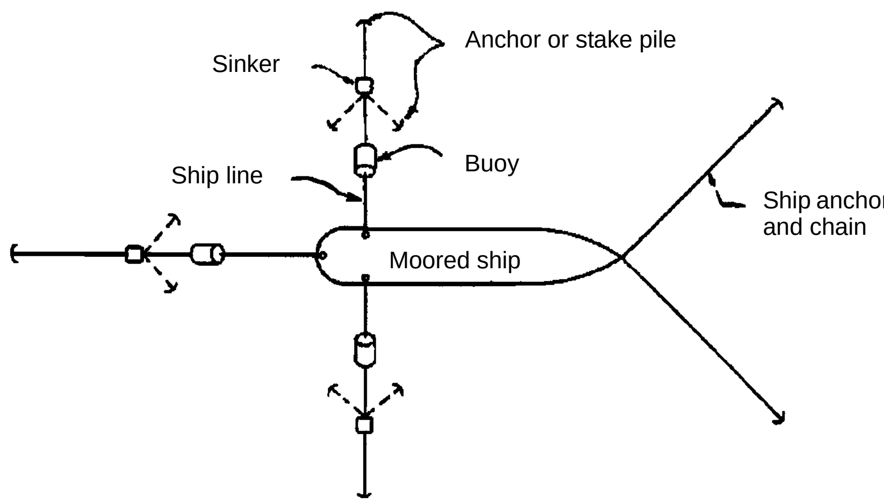

Figure 1-2. Multiple-Point Mooring System

OFFSHORE PETROLEUM DISTRIBUTION SYSTEMS

1-51. Offshore petroleum distribution systems (OPDSs) are designed to facilitate the high-volume movement of bulk liquid cargo from ship to shore and are used extensively during fuel transfer operations. Engineer port construction companies, engineer diving teams, and transportation watercraft groups play an important role in the preparation, installation, repair, and operation of the OPDS in the joint operational area (JOA). NAVFAC P-990 gives detailed instructions for the installation, inspection, and maintenance of the OPDS.

1-52. *Figure 1-3,* page 1-12, shows a single-anchor, leg-mooring system (SALMS) emplaced as a mooring station and discharge manifold. The SALMS provides a semipermanent installation for the bulk transfer of fuel directly from an offshore tanker to port storage. This system is employed during OPDS operations, and divers may be required to support it by—

- Performing hydrographic surveys to determine beach gradient and underwater contour.
- Improving beach approaches.
- Clearing enemy-emplaced or natural obstacles from beach approaches.
- Supporting the installation of an OPDS.
- Connecting underwater-pipeline components.
- Inspecting pipelines and their components.

- Performing maintenance on underwater pipeline components.
- Performing emergency repairs to damaged pipe sections.

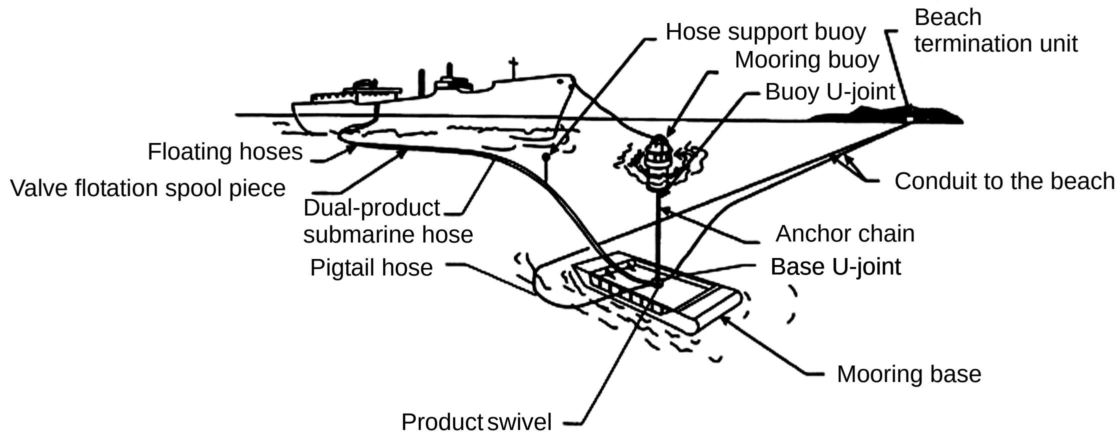

Figure 1-3. OPDS SALMS Sunk to the Bottom and Acting as a Mooring and Discharge Station

1-53. The construction of a permanently installed submarine pipeline is not expected during mobilization. However, systems already in place may require extensive repair and maintenance.

1-54. The underwater components and mooring assemblies for all types of distribution systems require periodic maintenance support. Specific areas of repair and maintenance performed by divers are as follows:

- **Tanker hose discharge assemblies.** These connecting hoses are of various types and require periodic replacement of gaskets and damaged sections. Control valves located at pipeline connections require periodic lubrication and seal replacement.
- **Mooring systems.** Mooring systems prevent ship movement during petroleum transfer operations. Maintenance includes periodic inspection and replacement of chain hardware connections and worn chain sections. Surface marking buoys require periodic cleaning and replacement.
- **Pipelines.** Permanently installed pipelines need periodic inspection and maintenance to ensure watertight integrity.

1-55. Divers repair or replace pipe flange connections, damaged pipe sections, and concrete encasements. They also conduct security swims along the length of the pipeline to verify pipeline integrity.

Chapter 2

Engineer Diving Organizations

Engineer divers support nearly all specialized underwater missions on the battlefield. Engineer diving teams are relatively small, specialized organizations. Each team has specific duties and responsibilities but is flexible enough to support the commander in most situations. They normally provide general support to the Army Service Component Command (ASCC) commander. They also provide direct support to commanders below ASCC level when approved by the ASCC commander. Diving units are divided into two tables of organization and equipment (TOEs). The engineer diving team (TOE 05530LA00) and the engineer light diving team (TOE 05530LC00) may be assigned or attached to supported units anywhere within the AO.

ENGINEER DIVING TEAM

2-1. A diving team is normally assigned to the ASCC and attached to the senior engineer command (ENCOM) to support commanders in ports, harbors, and coastal zones. The team may be attached or assigned to a subordinate headquarters or task-organized with supporting units to provide direct-support diving capabilities. It is capable of providing salvage, construction, or survey support.

2-2. Engineer diving team missions include the following:

- Perform scuba and SSD to a maximum depth of 190 feet.
- Assist in constructing or repairing port facilities, logistics over-the-shore (LOTS) facilities, floating barriers, or bridges.
- Repair damaged piers, docks, wharves, seawalls, breakwaters, bridges, locks, dams, pipelines, canals, or levees.
- Clear underwater obstructions and mark navigational waterways.
- Reduce and emplace underwater obstacles and mines.
- Conduct underwater demolition.
- Install, maintain, and repair offshore petroleum discharge pipelines and ship mooring systems.
- Recover sunken material or vessels.
- Install and maintain vessel moorings.
- Inspect and repair watercraft.
- Collect underwater-terrain data in seas, ports, and rivers in support of port openings, LOTS operations, and river crossings.
- Install and maintain the underwater portion of offshore petroleum and water distribution systems.

- Support engineer light diving teams (TOE 05530LC00) on the battlefield.
- Emplace and install underwater security systems.
- Perform security swims on vessels and facilities.
- Perform hyperbaric-chamber operations and emergency diving medical treatments.
- Perform intermediate maintenance on diving life-support equipment, and maintain repair parts for diving equipment.
- Provide technical expertise and staff planning support to ASCC through brigade commanders.

NOTE: While diving teams are trained to perform underwater demolition operations, they do not perform underwater EOD operations. Specially trained Navy EOD personnel must undertake these missions.

2-3. An engineer diving team is a 25-soldier team that has sufficient personnel and equipment to conduct multiple diving operations concurrently. *Figure 2-1* is an example of the organization of an engineer diving team. The responsibilities of soldiers in the team are discussed below.

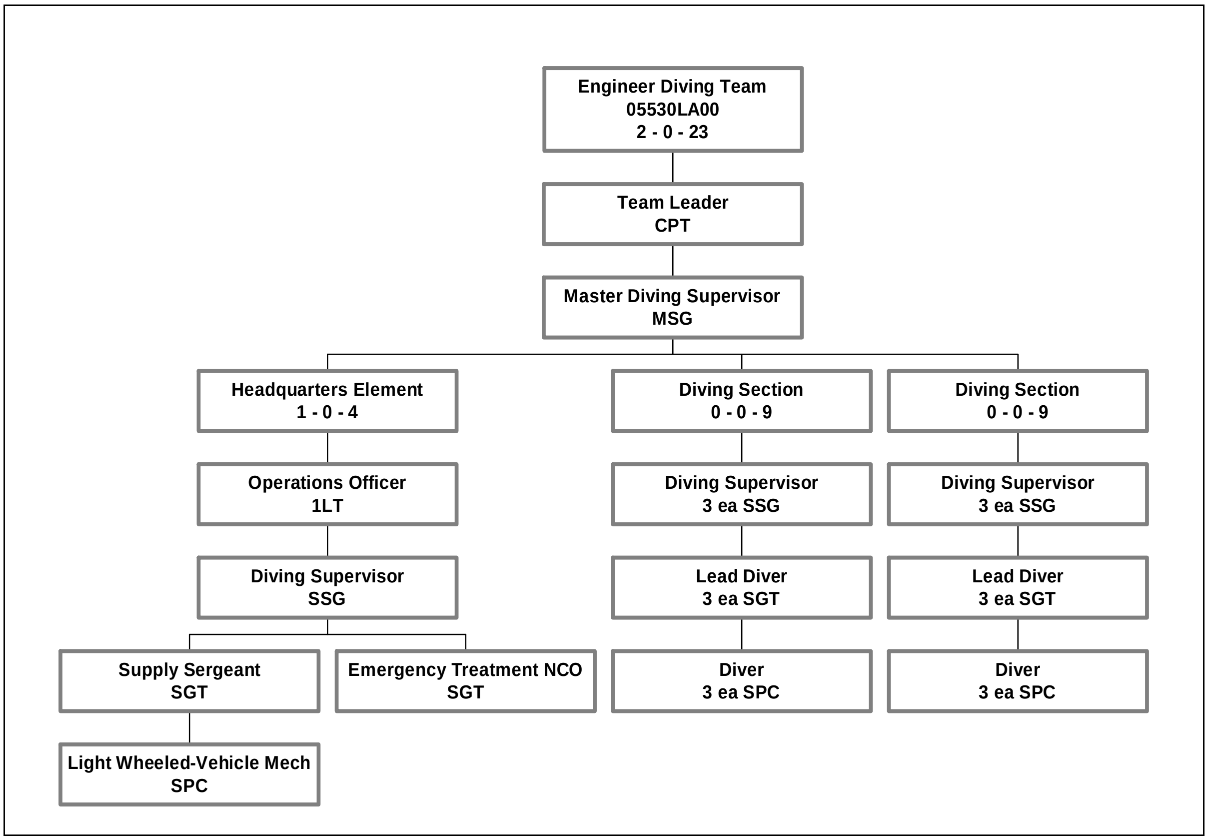

Figure 2-1. Organization of an Engineer Diving Team

TEAM COMMANDER—CPT (21B5V) (MUST BE A QUALIFIED DIVING OFFICER)

2-4. Performs as the diving officer during diving operations. Responsible for all diving operations under his command. Acts as the liaison to higher headquarters for diving matters.

OPERATIONS OFFICER—1LT (21B5V) (MUST BE A QUALIFIED DIVING OFFICER)

2-5. Performs as the operations officer and coordinates all diving missions. Assigns diving missions to sections within the team. Plans and schedules all training. Performs equivalent duties as an executive officer.

MASTER DIVING SUPERVISOR—MSG (21D50) (MUST BE A QUALIFIED MASTER DIVER)

2-6. Performs as the qualified master diver for the diving team. Ensures that all diving operations are conducted safely. Supervises deep-sea diving missions and dives that are conducted deeper than 100 feet of seawater (FSW). Formulates demolition plans for training and operational missions. Assists the commander in planning, scheduling, and executing training and operational missions. Provides expertise to staff planners and diving teams. Writes and develops doctrinal, regulatory, training, and safety material related to the accomplishment of diving missions. Supervises emergency medical or hyperbaric treatment for diving-related illnesses. Performs equivalent duties as a detachment sergeant/first sergeant. Supervises operator through intermediate levels of maintenance on diving life-support equipment.

DIVING SUPERVISOR—SSG (21D30) (MUST BE A QUALIFIED FIRST-CLASS DIVER)

2-7. Performs as a senior diver and supervises diving operations. Directs preparation and operation of diving equipment and watercraft support platforms. Supervises calculations for, training in, and use of explosives. Supervises use of underwater hydraulic- and electric-power equipment and other special underwater tools. Supervises recompression chamber and life-support equipment during diving and emergency operations. Works closely with the master diver and the diving officer during preparation of the operations order; conducts the detailed planning of the diving operation. Supervises operator through intermediate levels of maintenance on diving life-support equipment.

SUPPLY SERGEANT—SGT (92Y20)

2-8. Performs as the supply sergeant for the team. Maintains diving supplies and repair parts. Performs operator through intermediate direct-support level maintenance. Coordinates depot-level repair for diving life-support equipment. Receives, inspects, inventories, loads, unloads, segregates, stores, issues, delivers, and turns in organization and installation supplies and equipment. Operates the unit-level computer (ULC). Prepares all unit/organizational supply documents. Maintains the automated supply system for accounting of organizational and installation supplies and equipment. Issues and receives small arms. Secures and controls weapons and ammunition in security areas. Schedules and performs preventive and organizational maintenance on weapons. Inspects completed work for accuracy and compliance with established procedures. Reviews and annotates changes to the unit material condition status report. Posts transactions to organizational and installation property books and supporting transaction files. Determines the method of obtaining relief from responsibility for lost, damaged, or destroyed supply items.

LEAD DIVER—SGT (21D20) (MUST BE A QUALIFIED SALVAGE DIVER)

2-9. Performs as a lead diver during underwater work. Performs operator through intermediate levels of maintenance on diving life-support equipment. Prepares pumps and patching materials for salvage operations. Prepares explosives for placement. Prepares rigging and lifting devices for salvage of submerged objects. Assists the diving supervisor in preparing equipment for diving operations. Performs as the primary operator on air systems and underwater-support equipment during diving and recompression chamber operations.

ENGINEER DIVING MEDICAL TECHNICIAN—SGT (91W20) (MUST BE A SCHOOL-TRAINED DIVING MEDICAL TECHNICIAN)

2-10. Performs as a diving medical technician (DMT) inside the recompression chamber. Assists the diving supervisor in diagnosing and treating diving-related illnesses and injuries. Performs maintenance on the recompression chamber facility. Coordinates training and medical supplies with the ASCC diving medical physician. Assists the commander and operations officer in planning and scheduling medical-training requirements for team members. Screens medical records and monitors the medical condition of all team members. Maintains medical supplies and equipment.

DIVER—PVT/SPC (21D10) (MUST BE A QUALIFIED SECOND-CLASS DIVER)

2-11. Performs as a diver doing underwater work as directed from the supervisor or lead diver. Performs operator through intermediate levels of maintenance on diving life-support equipment. Operates power support equipment, emplaces demolitions, and performs as secondary air-systems operator during diving and recompression chamber operations.

LIGHT WHEELED-VEHICLE MECHANIC—SPC (63B10)

2-12. Performs as a light wheeled-vehicle mechanic. Maintains power-assisted brake systems, wheeled-vehicle suspension systems, wheeled-vehicle wheel/hub assemblies, wheeled-vehicle mechanical (manual) steering systems, wheeled-vehicle hydraulic (power) steering systems, and wheeled-vehicle crane/hoist/winch assemblies. Performs maintenance on non-life-support diving equipment.

NOTE: The operations officer may become a diving section team leader during extended/split diving operations.

ENGINEER LIGHT DIVING TEAM

2-13. The engineer light diving team mission is to provide diving support to offense, defense, stability, and postconflict support operations. The light diving team may be attached to an engineer brigade or group headquarters for command and control (C2) and logistical support.

2-14. Engineer light diving team missions include the following:

- Perform scuba and SSD to a maximum depth of 190 feet.
- Provide river crossing site reconnaissance.
- Emplace and reduce underwater obstacles and mines.
- Conduct underwater demolitions.
- Collect underwater terrain data.
- Repair damaged bridges, locks, dams, pipelines, canals, and levees.
- Construct underwater bridge structures, obstacles, and floating barriers.
- Conduct search and recovery operations
- Clear and mark inland navigational waterways.
- Support the engineer diving team in ports, harbors, and coastal zones. However, they will lack some of the equipment required to perform heavy salvage operations.
- Inspect and repair Army watercraft.
- Inspect and repair offshore petroleum discharge pipelines and ship mooring systems.
- Emplace and install underwater security systems.
- Perform security swims on vessels and facilities.
- Inspect and repair piers, wharves, and quay walls during port construction or rehabilitation operations.
- Provide technical expertise and staff planning support to commanders.

NOTE: While light diving teams are trained to perform underwater demolition operations, light diving teams do not perform underwater EOD operations. Specially trained Navy EOD personnel must undertake these missions.

2-15. The light diving team is a 22-soldier team that has sufficient personnel and equipment to conduct multiple diving operations concurrently. *Figure 2-2*, page 2-6 is an example of the organization of an engineer light diving team. The responsibilities of the soldiers in the team are discussed below.

DIVING TEAM LEADER—1LT (21B5V) (MUST BE A QUALIFIED DIVING OFFICER)

2-16. Performs as the diving officer during deep-sea diving operations. Responsible for all diving operations under his command. Acts as the liaison to higher headquarters for diving matters. Assists and performs as a backup to the diving supervisor and master diver during diving operations. Performs equivalent duties as a platoon leader.

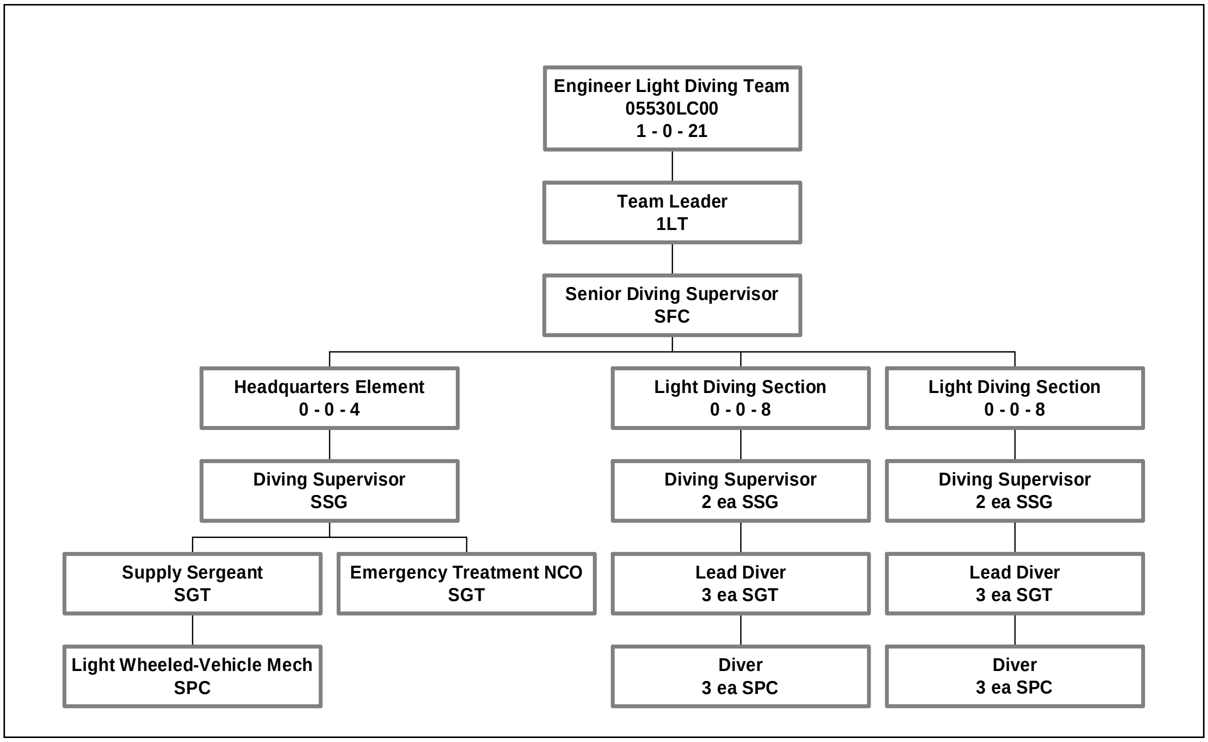

Figure 2-2. Organization of an Engineer Light Diving Team

SENIOR DIVING SUPERVISOR—SFC (21D40) (MUST BE A QUALIFIED MASTER DIVER)

2-17. Performs as the qualified master diver for the light diving team. Ensures that all diving operations are conducted safely. Supervises deep-sea diving missions and dives conducted deeper than 100 FSW. Formulates demolition plans for operational and training missions. Assists the commander in planning, scheduling, and executing training and operational missions. Provides expertise to staff planners and diving teams. Writes and develops doctrinal, regulatory, training, and safety material related to the accomplishment of diving missions. Supervises emergency medical or hyperbaric treatment for diving-related illnesses. Supervises operator through intermediate levels of maintenance on diving life-support equipment. Performs equivalent duties as a platoon sergeant.

DIVING SUPERVISOR—SSG (21D30) (MUST BE A QUALIFIED FIRST-CLASS DIVER)

2-18. Performs as a senior diver and supervises diving operations. Directs the preparation and operation of diving equipment and watercraft support platforms. Supervises the calculations for, training in, and the use of explosives. Supervises the use of underwater hydraulic- and electric-power equipment and other special underwater tools. Supervises recompression chamber and life-support equipment during diving and emergency operations. Works closely with the master diver and the diving officer during preparation of the operations order; conducts the detailed planning of the diving operation.

Supervises operator through intermediate levels of maintenance on diving life-support equipment.

LEAD DIVER—SGT (21D20) (MUST BE A QUALIFIED SALVAGE DIVER)

2-19. Performs as a lead diver during underwater work. Performs operator through intermediate levels of maintenance on diving life-support equipment. Prepares pumps and patching materials for salvage operations. Prepares explosives for placement. Prepares rigging and lifting devices for salvage of submerged objects. Assists the diving supervisor in preparing equipment for diving operations. Performs as the primary operator on air systems and underwater-support equipment during diving and recompression chamber operations.

SUPPLY SERGEANT—SGT (92Y20)

2-20. Performs as the supply sergeant for the team. Maintains diving supplies and repair parts. Performs operator through intermediate direct-support level maintenance. Coordinates depot-level repair for diving life-support equipment. Receives, inspects, inventories, loads, unloads, segregates, stores, issues, delivers, and turns in organization and installation supplies and equipment. Operates the ULC. Prepares all unit/organizational supply documents. Maintains the automated supply system for accounting of organizational and installation supplies and equipment. Issues and receives small arms. Secures and controls weapons and ammunition in security areas. Schedules and performs preventive and organizational maintenance on weapons. Inspects completed work for accuracy and compliance with established procedures. Reviews and annotates changes to unit material condition status report. Posts transactions to organizational and installation property books and supporting transaction files. Determines the method of obtaining relief from responsibility for lost, damaged, or destroyed supply items.

ENGINEER DIVING MEDICAL TECHNICIAN—SGT (91W20) (MUST BE A SCHOOL-TRAINED DIVING MEDICAL TECHNICIAN)

2-21. Performs as DMT inside the recompression chamber. Assists the diving supervisor in diagnosing and treating diving-related illnesses and injuries. Performs maintenance on the recompression chamber facility. Coordinates training and medical supplies with the Army diving medical physician. Assists the commander and operations officer in planning and scheduling medical-training requirements for team members. Screens medical records and monitors the medical condition of all team members. Maintains medical supplies and equipment.

DIVER—PVT/SPC (21D10) (MUST BE A QUALIFIED SECOND-CLASS DIVER)

2-22. Performs as a diver doing underwater work as directed by the supervisor or lead diver. Performs operator through intermediate levels of maintenance on diving life-support equipment. Operates power support equipment, emplaces demolitions, and performs as secondary air-systems operator during diving and recompression chamber operations.

LIGHT WHEELED-VEHICLE MECHANIC—SPC (63B10)

2-23. Performs as a light wheeled-vehicle mechanic. Maintains power-assisted brake systems, wheeled-vehicle suspension systems, wheeled-vehicle wheel/hub assemblies, wheeled-vehicle mechanical (manual) steering systems, wheeled-vehicle hydraulic (power) steering systems, and wheeled-vehicle crane/hoist/winch assemblies. Performs maintenance on non-life-support diving equipment.

Chapter 3

Employment of Engineer Divers

The primary objectives of engineer diving operations are to conduct general engineering operations and to support mobility and countermobility operations anywhere on the noncontiguous battlefield. Engineer divers are also an integral part of a task organization that provides the means (for example, port construction/repair and bridging) for movement of logistics from port harbors, beachfronts, and rivers to forward units.

COMMAND AND CONTROL

3-1. Engineers at the ASCC headquarters and the theater support command (TSC) formulate the plans and requirements for port facilities (location, capacity, wharfage, and storage). TSC is responsible for port operations, including liaison with the Navy, Coast Guard, and other military and authorized civilian agencies from the United States (US) and allied countries.

3-2. ENCOMs provide C2 to ASCC engineer force and manage construction and repair tasks that cross-service boundaries and require divers. The ENCOM is the echelons above corps (EAC) engineer headquarters responsible for constructing, maintaining, and repairing the sustainment base. When tasked, responsibilities include providing support to other allied military forces in joint or combined AOs. The number and type of engineer units in the ENCOM depend on the size of the sustainment base, availability of host nation support, and perceived threat to the rear area. Engineer diving units are normally assigned to the ENCOM. If more than one ENCOM is in the AO, the units are assigned to the senior Army ENCOM. Diving assets may be further task-organized to subordinate headquarters for C2 based on mission, enemy, terrain, troops, time available, and civilian considerations (METT-TC).

ENGINEER DIVING SUPPORT PRIORITIES

3-3. Engineer diving expertise is required throughout the AO. The ENCOM commander allocates assets in the communications zone (COMMZ) and combat zone (CZ) according to the priorities established by the combatant commander. Since there are only a limited number of divers, the ENCOM commander may choose to allocate diving assets only to the most critical mission sites. Early integration of divers into the planning process is critical to successful diving missions.

3-4. Engineer diving tasks in the CZ usually support engineer mobility and countermobility functions. In the COMMZ, the tasks usually center on sustainment operations, such as port opening, heavy salvage, LOTS, and ship husbandry. Divers also assist in immediate and interservice recovery operations.

DIVING SUPPORT REQUEST PROCEDURES

3-5. After completing the engineer estimate, the ENCOM commander assigns divers to the appropriate organizational level. If an area support group (ASG) requires diving assets for underwater missions, the requests are forwarded through normal channels to the combatant command. Requests must include the mission details and the estimated time for work completion. The ASCC commander, who assigns diving priorities, will task approved requests to the ENCOM. For short-term missions, diving assets are assigned in direct support through command channels to the ASG. For long-term or complex missions, divers are normally attached to a company or battalion-size unit. For example, if an ASG port construction company needs diving assets for port repair, the ENCOM commander will assign the assets in an attached command relationship through command channels to the construction company.

DIVER SUPPORT OF UNITED STATES AIR FORCE OPERATIONS

3-6. Engineer divers can support Air Force immediate recovery operations for downed aircraft in ports or water locations near the shore. The Combined Forces Air Command (CFAC) Air Force manager for these operations is the survival recovery center (SRC). The SRC coordinates closely with the ENCOM. Air Force requests for immediate recovery operations go directly to the ENCOM, which responds according to combatant command mission priorities. Immediate recovery operations are usually assigned to divers as an on-order, direct-support mission.

DIVER SUPPORT OF UNITED STATES NAVY OPERATIONS

3-7. Engineer divers may support Navy operational commitments for construction, salvage, or watercraft maintenance. Navy maintenance organizations may request diving support through command channels to the ENCOM, detailing the urgent need for divers to support naval operations.

3-8. If divers are on site supporting Army terminal operations, the Army water terminal commander may temporarily place the Army diving assets in direct support of a specific naval-maintenance unit. This is based on work priorities and higher-command guidance.

DIVER SUPPORT OF THE HOST NATION

3-9. Host nation support is common during port construction and repair. Engineer divers are requested through the combatant command. The request must include the mission details and the estimated time for work completion. If the request is approved, the ASCC will task the ENCOM to support the mission.

3-10. Divers may also support host nation immediate recovery operations for civilian aircraft or equipment downed in ports or bodies of water near the shore. Civilian authorities request divers directly from the nearest engineer battalion, brigade, or ASG. These units forward requests to the ENCOM for approval. The assignment of diving support is according to command guidance and workload. Immediate recovery operations are usually assigned to divers as an on-order, direct-support mission.

Chapter 4

Considerations

There are many factors that affect the operation of engineer diving teams. The primary considerations are the diving modes, environmental considerations, manning, equipment, external support, safety and risk assessment, and security.

DIVING MODES

4-1. Engineer divers use two distinct modes of diving—scuba and surface-supplied. These modes are discussed below.

SCUBA

4-2. Scuba operations are normally conducted to give the diver greater mobility to cover a larger area. Under normal conditions, a scuba mission requires a minimum staffing level of five personnel.

4-3. Missions for scuba diving include the following:

- Search and recovery.
- Inspection.
- Ship husbandry.
- Hydrographic surveys.
- Obstacle emplacement and reduction.
- Wet-gap crossing support.
- JLOTS support.

4-4. Advantages of utilizing scuba operations include the following:

- Rapid deployment.
- Portability.
- Minimum support requirements.
- Excellent horizontal and vertical mobility.

4-5. Disadvantages of utilizing scuba diving include the following:

- Limited endurance (depth and duration).
- Limited physical protection in a contaminated environment.
- Influenced by the current.
- Lack of voice communication.

SURFACE-SUPPLIED

4-6. Engineer divers working on heavy-salvage or increased-exposure missions require an uninterrupted air supply and physical protection from in-water hazards. SSD equipment provides air to the diver via a hose fed from a compressor or air bank located on the surface. Additionally, SSD equipment includes a diving helmet and chafing gear worn by the diver to provide protection from the elements. Under normal conditions, a surface-supplied mission requires a minimum of 10 personnel.

4-7. Missions for SSD include the following:

- Clearance.
- Inspection.
- Light or heavy salvage.
- Ship husbandry.
- Port construction or rehabilitation.
- Obstacle emplacement or reduction.
- JLOTS support.

4-8. Advantages of utilizing SSD include the following:

- Unlimited air supply (longer duration).
- Maximum physical and thermal protection (safety).
- Communication capabilities.

4-9. Disadvantages of utilizing SSD include the following:

- Limited organic lift assets to move equipment (logistics support is required).
- Larger deployable footprint than scuba.

ENVIRONMENTAL CONSIDERATIONS

4-10. The mission, available divers, and weather help determine the type of diving and the equipment used. SSC provides the best safety for the diver and enhances the supervisor's ability to control and direct the divers underwater. Special equipment may be required to provide additional protection for the diver in extremely cold or polluted waters. Factors that influence the selection of diving teams include the following:

- Current.
- Tide.
- Visibility.
- Bottom condition and type.
- Sea state and wave height.
- Air temperature.
- Water temperature.
- Depth.
- Pollutants.

CURRENT

4-11. A divers ability to work is directly affected by the current. Scuba divers primarily swim to and from the objective and cannot swim or work against a current greater than 1 knot or 0.5 meters per second (mps). The higher the current the diver is experiencing, the quicker he will tire and use his available air supply. Surface-supplied divers are normally lowered to the sea floor and then walk to and from the objective. They have an unlimited air supply and may wear additional weights. They can travel and work in currents up to 2.5 knots or 1.3 mps. The current also affects the stability of the diving platform and must be accounted for when positioning the vessel or platform. Normal working limitations are shown in *Table 4-1*.

Table 4-1. Normal Working Limitations

Equipment Type	Depth (ft)	Water Current (knots)	Water Current (mps)
Surface-supplied	190	2.5	1.3
Scuba	130	1.0	0.5

TIDE

4-12. The tide can influence the current the diver is experiencing and limit the available times to dive. Divers may have to time their dives to correspond with the periods of lower tidal flows. In some parts of the world, tidal flows can reach many mps and change drastically within a 1-hour period. The tide can also affect the depth of the dive. While certain portions of the world have a tidal range of only inches between high and low tide, other parts of the world can have a tidal range of over 30 feet between high and low tide. Extreme tidal flows also affect the positioning of the diving platform and its ability to maintain position.

VISIBILITY

4-13. Divers frequently work in water that has near-zero visibility. In this case, the diver is operating strictly through sense of touch. The use of underwater lights may increase the visibility somewhat, but due to the suspended particles in the water, light is often reflected right back at the diver, negating any benefit. This lack of visibility can affect how long it takes to perform an assigned mission. Searches for relatively small objects will take considerably longer in zero visibility water since the divers may be forced to crawl on their hands and knees over the entire search area. Underwater construction and cutting and welding operations will take longer as well since the diver must be extremely careful since operating by feel. If the water is extremely cold, efficiency will decrease because the diver loses his sense of touch. Thick gloves or mittens may be required for these operations, which will also decrease efficiency.

BOTTOM CONDITION AND TYPE

4-14. The condition and type of the bottom can drastically affect how efficiently a diver can work by hindering both visibility and underwater mobility. See *Table 4-2*, page 4-4, for a listing of bottom types and the effects on divers.

SEA STATE AND WAVE HEIGHT

4-15. The term sea state generally refers to the condition of the waves and wind. Not only can divers be directly affected by the sea state, but so can the

Table 4-2. Bottom Conditions and Effects Chart

Type	Characteristics	Visibility	Diver Mobility on Bottom
Rock	Smooth or jagged, minimum sediment	Generally unrestricted by diver movement	Good. Exercise care to prevent line snagging and falls from ledges.
Coral	Solid, sharp and jagged, found in tropical waters only	Generally unrestricted by diver movement	Good. Exercise care to prevent line snagging and falls from ledges.
Gravel	Relatively smooth, granular base	Generally unrestricted by diver movement	Good. Occasional sloping bottoms of loose gravel impair walking and cause instability.
Shell	Comprised principally of broken shells mixed with sand or mud	Shell-sand mix does not impair visibility when moving over the bottom. Shell-mud mix does impair visibility. With higher mud concentrations, visibility is increasingly impaired.	Shell-sand mix provides good stability. High mud content can cause sinking and impaired movement.
Sand	Common type of bottom, packs hard	Generally unrestricted by diver movement	Good
Mud and silt	Common type of bottom, composed of varying amounts of silt and clay, commonly encountered in river and harbor areas	Poor to zero. Work into the current to carry silt away from the job site, minimize bottom disturbance. Increased hazard presented by unseen wreckage, pilings, and other obstacles.	Poor. Can readily cause diver entrapment. Crawling may be required to prevent excessive penetration. Fatiguing to the diver.

diving platform. Wave action can affect everything from the stability of the moor to the vulnerability of the crew to seasickness or injury. Unless properly moored, a ship or boat drifts or swings around an anchor, fouling lines and dragging divers, potentially causing serious injury or death.

4-16. Divers are not particularly affected by the action of surface waves unless operating in surf or shallow waters or if the waves are exceptionally large. Surface waves may become a serious problem when the diver enters or leaves the water and during decompression stops near the surface.

WATER TEMPERATURE

4-17. A diver's physical condition, amount of body fat, and thermal protection equipment determine how long of exposure to extreme temperatures can be endured safely. In cold water, ability to concentrate and work efficiently will decrease rapidly. In water temperatures between 73°F and 85°F, divers can work comfortably in their wet suits, but will chill in 1 to 2 hours if not working strenuously. In water temperatures above 85°F, the divers may overheat. The maximum water temperature that can be endured, even at rest, is 96°F. At temperatures below 73°F, unprotected divers will be affected by excessive heat loss and become chilled within a short period of time. In cold water, the sense of touch and the ability to work with the hands are affected.

DEPTH

4-18. The depth of the dive limits the amount of time a diver can stay underwater. Dives are classified as decompression or no-decompression dives. The depth and duration of the dive determines which type of dive takes place. The time a diver can spend underwater is limited by physical and environmental considerations.

Decompression Diving

4-19. Decompression requirements are a major concern to a diving team. Decompression obligations limit the amount of time a diver can remain on the bottom. As water depths increase, the amount of time a diver may safely spend underwater decreases.

4-20. FM 20-11 includes decompression tables that are used to determine the rate of ascent and the time required to stop for decompression. These tables must be followed during ascent to ensure that the diver receives adequate decompression and mitigate the possibility of diving-related injuries. Decompression sickness may range from slight pain to extensive paralysis; severe cases may result in complete stoppage of major organ functions and death.

4-21. Special considerations for decompression diving are as follows:

- Divers are limited to the number of dives they can safely perform in any given period.
- Decompression dives must be performed using SSD equipment.
- Planned decompression dives require the presence of a master diver and a diving officer.
- A recompression chamber must be available at the site during decompression dives.

No-Decompression Diving

4-22. No-decompression diving tables in FM 20-11 limit the maximum time a diver can spend at a specified depth without requiring decompression stops during ascent. Safe ascent can be made directly to the surface, at a prescribed rate, with no decompression stops. No-decompression dives can be performed in scuba or SSD equipment.

Altitude Diving

4-23. Divers may be required to dive in bodies of water at higher altitudes. Planning should address the effects of the atmospheric pressures that may be much lower than those at sea level. Standard decompression tables are authorized for use at altitudes up to 300 feet above sea level without corrections. Refer to FM 20-11 for the corrections and altitude diving protocols for altitudes above 300 feet. Transporting divers out of the diving area, which may include movement into even higher elevations either overland or by plane, requires special consideration and planning.

POLLUTION

4-24. Several forms of pollution that can impact a diver are as follows:

- Thermal pollution.
- Chemical contamination.
- Biological contamination.

MANNING

4-25. Diving operations require from 5 to 15 personnel. Requirements depend on the mission, diving mode, and environment. Engineer diving teams are structured to work independently, because the availability of outside diving support is limited. All assigned divers are required to support station functions, such as operating the recompression chamber, handling hoses, and operating winches and compressors. Additionally, engineer diving teams must provide their own drivers, mechanics, boat operators, medics, and radio operators. For many underwater engineer construction and salvage missions, two divers are normally required to work in 60 FSW. Safety is a key consideration for manning requirements. If a diving team cannot be manned to safely operate in a hazardous work environment, mission accomplishment and diver safety may be compromised. The minimum staffing levels required for various types of air diving operations are shown in *Table 4-3* and AR 611-75.

EQUIPMENT

4-26. Divers have, or use a large selection of equipment in order to accomplish their missions. This equipment is discussed below.

SCUBA

4-27. Divers use scuba to perform inspections and light work. The minimum equipment required for scuba includes the following:

- Open-circuit scuba tank and regulator.
- Mask.
- Life preserver/buoyancy compensator.
- Fins.
- Knife.
- Watch.
- Weight belt.
- Submersible pressure gauge.
- Wristwatch.
- Depth gauge.
- Thermal protection (such as a wet suit or dry suit) as needed.

Table 4-3. Recommended Staffing Levels for Air Diving

	Scuba Operations			Surface-Supplied Operations		
Position	**Mine Countermine**	**One Diver**	**Two Divers**	**One Diver**	**Two Divers**	**High-Risk/ Decompression**
Diving officer	N/A	N/A	N/A	N/A	N/A	1[1]
Master diver	N/A	N/A	N/A	N/A	N/A	1
Diving supervisor	1[1,2]	1[1,2]	1[1,2]	1[1,2]	1[1,2]	1[2]
Diver	1	1	2	1	2	2
Standby diver	1	1	1	1	1	1
Diver tender	1[3]	1	2[4]	2[4]	4[4]	4
Standby tender	1[3]	1	1	2[4]	2[4]	2
Comms and logs	0[6]	1[6]	1[6]	1	1	1
Console operator	N/A	N/A	N/A	1	1	1
DMO	N/A	0[7]	0[7]	0[7]	0[7]	0[7]
Engineer DMT	N/A	N/A	N/A	1	1	1
Minimum staffing	3	5	6	8	10	14
Normal staffing	5	6	8	10	13	15

NOTES:

1. A diving officer, master diver, and recompression chamber must be on site during any anticipated decompression dives, high-risk diving operation, or dives to depths greater than 130 feet.

2. Diving supervisors must be appointed in writing by the commander and hold the rating of master diver (MOS 21D40/50), first-class diver (MOS 21D30), or diving officer (21B5V) in organizations and/or activities authorized these positions by TOE or TDA.

3. Minimum staffing level for mine/countermine diving operations will not be used during training. With live mines, the diver is generally untended and the standby diver is tended by the diving supervisor.

4. During routine dives to 60 feet or less, the supervisor can authorize the use of one tender per surface-supplied diver or two-diver operations.

5. A "comms and logs" is responsible for communicating with divers and documenting the action for each diver in a record book.

6. The diving supervisor may fill the requirement of the comms and logs for scuba operations.

7. A DMO is required to be on call for all planned decompression dives and any dive deeper than 170 feet.

8. Minimum staffing levels will only be used when normal staffing levels are not possible and the commander determines that the operation can be conducted safely.

9. Normal staffing levels do not include the safety boat crew or personnel required for special equipment or tools. Additional personnel requirements will be situational or mission dependent.

SURFACE-SUPPLIED DIVING EQUIPMENT

4-28. Divers use SSD equipment to perform heavy work, such as salvage, welding, or construction. SSD is also used whenever there is the potential for decompression, since it has a virtually unlimited air supply. The SSD set consists of a helmet, an umbilical/air hose, and a communications system. The SSD gives the diver the ability to speak directly to the surface personnel to give real-time feedback of inspections and work.

Compressors and Air Supply

4-29. Divers have several different compressors to supply air for either scuba or SSD. Divers also have the Special Divers Air Support System (SDASS) that is used to store and deliver air to surface-supplied divers.

Recompression Chamber

4-30. The recompression chamber is used to treat decompression sickness (also referred to as the "bends") or during surface decompression diving operations. A recompression chamber is a steel or aluminum cylinder that is large enough to accommodate a diver and necessary medical support personnel. The chamber may be used to treat diving injuries, such as decompression sickness or air-gas embolisms. When pressurized with air, the chamber can simulate the pressure placed on the human body by a corresponding depth of water. Repressurizing the stricken diver in the chamber reduces the size of the lodged air bubbles. The stricken diver breathes 100 percent oxygen, which further aids in bubble resolution. FM 20-11 has special treatment tables that dictate the times and depths required for the treatment of diving injuries. The chamber can also be used to perform surface decompression for certain types of decompression dives.

Underwater Tools

4-31. Divers have a large variety of hand- and hydraulic-powered tools that are used in construction and salvage. The hydraulic tools include drills, jackhammers, impact wrenches, and chain saws. The teams have the power supply for the tools and are virtually self-sufficient. Engineer diving teams also have specialized cutting and welding equipment for underwater operations.

Cameras

4-32. Diving teams employ underwater cameras, video equipment, and remotely operated vehicles that allow them to take digital pictures or movies of ongoing work. These pictures or movies can then be sent to commanders to provide an accurate picture of the underwater conditions.

Hydrographic-Surveying and Sonar Equipment

4-33. Engineer diving teams are equipped with side-scan sonar and hydrographic-surveying equipment. This equipment is ideal for conducting surveys of river, port, and harbor bottoms. Obstacles and hazards to navigation can be identified and charts created so that vessel captains and crossing site commanders can safely plan and conduct operations.

EXTERNAL SUPPORT

4-34. Diving teams may require support from other units. These units are discussed below.

MAINTENANCE

4-35. Diving teams are trained to perform operator through direct-support level maintenance on diving equipment. The teams have the capability to perform operator through intermediate-support level maintenance on their vehicles and motorized equipment, but require support for direct-support level maintenance.

MEDICAL

4-36. Diving teams have medical technicians specially trained in diving-related injuries but require support for more advanced forms of medical care. Senior-rated divers are trained to provide specialized treatment for many diving-related injuries. Advanced diving medical care is normally provided by a diving medical officer (DMO). A diving team requires either direct or indirect ability to contact a DMO. A DMO offers medical advice to the emergency treatment noncommissioned officer (NCO) and the master diver for treating severe diving injuries.

MATERIALS-HANDLING EQUIPMENT

4-37. The diving teams do not have the organic ability to pick up or move several pieces of their equipment. The recompression chamber, the underwater construction set, and SSD sets require materials-handling equipment (MHE).

MOBILITY

4-38. Engineer diving teams may require augmentation with external lift support to move unit equipment once deployed to an AO.

GENERAL

4-39. The diving teams are too small to have all of the general and administrative support they require. Divers depend on supported units for the following combat support and survivability needs:

- Enemy air attack suppression.
- Enemy indirect-fire suppression.
- Scatterable- and fixed-mine clearing.
- Nuclear, biological, and chemical (NBC) decontamination.
- Ammunition.
- Survivability position construction.
- Religious, legal, financial, personnel, and administrative support.
- Field feeding.
- Communication and security equipment maintenance.
- Power generation equipment maintenance.

SAFETY AND RISK ASSESSMENT

4-40. Many soldier tasks that are performed on the surface have some degree of risk associated with them. Performing those same tasks underwater often increases the associated risks. Many of these risks can be reduced or mitigated through the application of risk management. Following established diving doctrine as outlined in FM 20-11 reduces many of the risks associated with diving operations. The risk assessment of the type of work performed will identify the specific risks associated with a task and the appropriate countermeasure.

4-41. As the risk assessment is conducted, particular attention must be paid to underwater conditions. In many instances, little to nothing is known about a particular underwater environment. Surface conditions such as temperature, wind, and waves are not always indicative of the conditions the diver will be facing. Water temperature can vary as the diver descends or works in thermoclines. Currents can change direction and intensity as tidal flows change. Visibility can change as the diver works on the bottom or through ship traffic that stirs up the bottom.

4-42. Diving-related injuries, such as decompression sickness and arterial gas embolisms, have been known to occur in divers that have followed established safety procedures and diving protocols. The occurrence of these injuries does not in itself indicate that an unsafe act occurred. Any diving-related accident should be investigated according to the procedures outlined in AR 385-40.

4-43. Divers should not fly for at least 12 hours following a decompression dive or for 2 hours after surfacing from a no-decompression dive. If aircraft cabin pressure remains below an altitude of 2,300 feet, flying may be done after any type of air dive.

SECURITY

4-44. Engineer diving teams are extremely small and the units involved often do not have enough organic personnel to provide security during many operations. In most instances, every member of the team is involved in the current operation and other personnel must be tasked to provide security. Members of the surface crew that are trying to provide security while performing as a member of a diving team are placing themselves and the divers at risk by trying to perform two functions at once.

4-45. Diving teams do not possess any crew-served or large-caliber weapons and should not be used in an offensive capacity. During missions in an unsecured environment, divers require the support of security forces.

Appendix

Metric Conversion Chart

This appendix complies with current Army directives, which state that the metric system will be incorporated into all new publications. *Table A-1* is a conversion chart.

Table A-1. English-to-Metric Conversion Chart

Metric to English			English to Metric		
Multiply	**By**	**To Obtain**	**Multiply**	**By**	**To Obtain**
Length					
Centimeters	0.0394	Inches	Inches	2.5400	Centimeters
Meters	3.2800	Feet	Feet	0.0305	Meters
Meters	1.0940	Yards	Yards	0.9144	Meters
Velocity					
Knots	1.6880	Feet per second	Feet per second	0.5921	Knots
Meters per second	2.237	Miles per hour	Miles per hour	0.8684	Knots

Glossary

1LT	first lieutenant
AR	Army regulation
area engineer	An engineer representative from the engineer district or engineer division responsible for contracting construction projects with civilian contractors and monitoring their progress.
Army water terminal	An Army-controlled harbor or port facilities.
ARTEP	Army training and evaluation plan
ASCC	Army Service Component Command
ASG	area support group
attached engineer element	An element that is commanded by its supported unit, maintains liaison and communications with the supported unit, is task-organized by the supported unit, responds to support requests from the supported unit, has its work priorities established by the supported unit, has its spare work available to the supported unit, requests support from the supported unit, and receives logistical support from the supported unit. When attached, an engineer element is provided administrative and logistical support. However, some special logistical and administrative needs are still provided by the parent unit.
attn	attention
bearing pile	A long, slender column usually of timber, steel, or reinforced concrete driven into the ground to carry a vertical load.
buoy	A float anchored to mark objects or locations underwater.
C2	command and control
CFAC	Combined Forces Air Command
combat zone	The area required by combat forces for conducting operations, usually forward of the Army rear boundary.
comms and logs	The individual that is responsible for communicating with divers and recording each diver's descent events and time and bottom time. Calculates decompression obligation requirements. Completes dive summary records and official transcripts of the dives. Documents the action for each diver using a record book.
communications zone	The rear part of the AO behind the CZ that contains the LOC and supply supporting combat forces.
COMMZ	communications zone
CPT	captain
CZ	combat zone

DA Department of the Army

DC District of Columbia

dewater To remove water.

direct support An engineer element in a direct support role is commanded by its parent unit, maintains liaison and communications with supported and parent units, may be task-organized by the parent unit, provides dedicated support to a particular unit, responds to support requests from its supported unit, has its work priority established by the supported unit, has its spare work effort available to the parent unit, requests additional support from the parent unit, and receives logistical support from the parent unit.

DMO diving medical officer

DMT diving medical technician

dolphin system A cluster of closely driven piles used as a fender for a dock or as a mooring or guide for boats.

dry dock An enclosed dock that can be dewatered to provide a stable, dry platform for use during the repair of ships.

ea each

EAC echelons above corps

ENCOM engineer command

EOD explosive ordnance disposal

F Fahrenheit

fender system A system of wood or rubber devices designed to absorb the shock of ship movement and protect the pier structure.

flattening The removal of the superstructure and then crushing the hull with demolitions into the port bottom.

FM field manual

FSW feet of seawater

ft foot; feet

HQ headquarters

hull The lowermost, watertight portion of a vessel that gives it buoyancy.

JLOTS joint logistics over the shore

JOA joint operational area

LOC lines of communication

LOTS logistics over the shore

MANSCEN Maneuver Support Center

marine railway A rail system extending below water designed to bring harbor craft out of the water for repair.

METT-TC mission, enemy, terrain, troops, time available, and civilian considerations

MHE materials-handling equipment

MOPP mission-oriented protective posture

mooring site An area designated for the temporary anchorage of vessels. The site is provided with mooring buoys and designed to allow sufficient space for vessels swinging on a moor.

MOS military occupational specialty

mps meters per second

MSG master sergeant

MTP mission training plan

N/A not applicable

NAVFAC naval facilities

NBC nuclear, biological, and chemical

NCO noncommissioned officer

OPDS offshore petroleum distribution system

pier A structure extending into navigable waters used as a landing and for the loading and unloading of vessels.

POL petroleum, oil, and lubricants

PVT private

quay wall The supporting structure for a stretch of paved bank or a solid artificial landing place beside navigational water for convenience in loading and unloading ships.

recompression chamber An apparatus that is pressurized with air to decompress a diver or treat a pressure-related diving illness after surfacing.

S3 Operations and Training Officer (US Army)

SALMS single-anchor, leg-mooring system

SDASS Special Divers Air Support System

SFC sergeant first class

SGT sergeant

ship channel The deeper part of a harbor, river, or strait that is designated, marked, and maintained to permit the safe passage of ships.

ship husbandry Work performed on vessels for repair or maintenance.

SPC specialist

SRC survival recovery center

SSD surface-supplied diving

SSG staff sergeant

surface-supplied air Diving equipment in which the breathing air is supplied through flexible rubber hoses to the diver from compressors or storage facilities on the water surface.

TDA table of distribution and allowances

timekeeper/recorder See comms and logs.

TOE table of organization and equipment

TRADOC United States Training and Doctrine Command

TSC theater support command

ULC	unit-level computer
US	United States
USAES	United States Army Engineer School
vessel superstructure	Any construction built above the main deck of a vessel.
wharf	A structure built along, or at an angle from, the shore of navigable waters so that ships may lie alongside to receive and discharge cargo.

Bibliography

AR 25-30. *The Army Publishing Program*. 16 March 2004.

AR 385-40. *Accident Reporting and Records*. 1 November 1994.

AR 611-75. *Management of Army Divers*. 1 October 2002.

Army Training and Evaluation Plan (ARTEP) 5-530-10-MTP. *Mission Training Plan for the Engineer Heavy Diving Team*. 11 October 2002.

ARTEP 5-530-12-MTP. *Mission Training Plan for the Engineer Light Diving Team*. 11 October 2002.

DA Form 2028. *Recommended Changes to Publications and Blank Forms*. 1 February 1974.

DA Pamphlet 611-21. *Military Occupational Classification and Structure*. 31 March 1999.

FM 3-0. *Operations*. 14 June 2001.

FM 3-34. *Engineer Operations*. 2 January 2004.

FM 3-34.2. *Combined-Arms Breaching Operations*. 31 August 2000.

FM 3-34.331. *Topographic Surveying*. 16 January 2001.

FM 3-34.343. *Military Nonstandard Fixed Bridging*. 12 February 2002.

FM 4-0. *Combat Service Support*. 29 August 2003.

FM 4-93.4. *Theater Support Command*. 15 April 2003.

FM 5-34. *Engineer Field Data*. 30 August 1999.

FM 5-100-15. *Corps Engineer Operations*. 6 June 1995.

FM 5-102. *Countermobility*. 14 March 1985.

FM 5-104. *General Engineering*. 12 November 1986.

FM 5-116. *Engineer Operations: Echelons Above Corps*. 9 February 1999.

FM 5-170. *Engineer Reconnaissance*. 5 May 1998.

FM 5-233. *Construction Surveying*. 4 January 1985.

FM 5-250. *Explosives and Demolitions*. 30 July 1998.

FM 5-480. *Port Construction and Repair*. 12 December 1990.

FM 5-482. *Military Petroleum Pipeline Systems*. 26 August 1994.

FM 10-67. *Petroleum Supply in Theaters of Operations*. 18 February 1983.

FM 20-11. *Military Diving*. 20 January 1999.

FM 20-32. *Mine/Countermine Operations*. 29 May 1998.

FM 55-60. *Army Terminal Operations*. 15 April 1996.

FM 90-13. *River Crossing Operations*. 26 January 1998.

FM 100-14. *Risk Management*. 23 April 1998.

FM 101-5. *Staff Organization and Operation*s. 31 May 1997.

FM 101-5-1. *Operational Terms and Symbols*. 30 September 1997.

NAVFAC P-990. *Conventional Underwater Construction and Repair Techniques*. May 1995.

NAVFAC P-991. *Expedient Underwater Repair Techniques*. Undated.

NAVFAC P-992. *UCT Arctic Operations Manual*. June 1994.

NAVSEA 0994-LP-017-3010. *Emergency Ship Salvage Material Catalog*. January 1987.

NAVSEA SW061-AA-MMA-010. *Use of Explosives in Underwater Salvage*. 1 March 1987.

NAVSEA SW060-AA-MMA-010. *Demolition Materials*. 15 August 1983.

NAVSHIPS 0994-012-4010. *Emergency Ship Salvage Material Manual*. April 1974.

S0300-A6-MAN-010. *US Navy Ship Salvage Manual, Volume 1 (Strandings)*. 4 July 1989.

S0300-A6-MAN-020. *US Navy Ship Salvage Manual, Volume 2 (Harbor Clearance)*. 1 March 1990.

S0300-A6-MAN-030. *US Navy Ship Salvage Manual, Volume 3 (Firefighting and Damage Control)*. 1 August 1991.

S0300-A6-MAN-040. *US Navy Ship Salvage Manual, Volume 4 (Deep Ocean Operations)*. 1 August 1993.

S0300-A6-MAN-050. *US Navy Ship Salvage Manual, Volume 5 (POL Offloading)*. 31 January 1991.

S0300-A6-MAN-060. *US Navy Ship Salvage Manual, Volume 6 (Oil Spill Response)*. 1 December 1991.

S0400-AA-SAF-010. *US Navy Salvage Safety Manual*. 25 December 1988.

STP 5-00B14-SM-TG. *Soldier's Manual and Trainer's Guide, MOS 00B, Diver, Skill Levels 1/2/3/4*. 12 December 2002.

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