An Analysis of Explosive Ordnance Disposal Support Facilities Aboard the AVENGER (MCM-1) Class Ships

by

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ABSTRACT

The United States Navy's AVENGER Class mine countermeasures ships are designed with facilities to support an explosive ordnance disposal detachment. However, the design and use of these facilities has not been endorsed by either the United States Navy's explosive ordnance disposal community, mine warfare community or crews of the AVENGER Class ships. This research paper investigates the above circumstances by discussing the missions and capabilities of an explosive ordnance disposal detachment and the MCM-1 Class ships in mine countermeasures operations. This study will conclude by recommending a definitive relationship between explosive ordnance disposal detachments and the AVENGER Class ships for mine countermeasures operations, including recommendations for actions necessary to achieve this relationship.

JARGON

This paper uses terms and acronyms which may be unfamiliar to the civilian reader. Therefore, whenever a distinctive military term or phrase is introduced, it will be immediately explained and defined. When an acronym is introduced, root words will be provided as a definition. Furthermore, each distinctive military phrase, term and acronym is again defined in the glossary, Appendix A. This paper will also use some terms uniquely associated with the shipbuilding contract, and these terms are included in the glossary.

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CHAPTER I

INTRODUCTION

Three AVENGER Class ships have been delivered to the United States Navy since September of 1987. Since that date, two of the three ships have completed significant mine warfare training but have failed to operationally test the installed explosive ordnance disposal (EOD) facilities with an EOD detachment. There are two primary reasons for this. First, several management level officials of both the ship's crew and the local EOD community object to the tactics of deploying an EOD detachment aboard the MCM-1 Class ships. Second, these same key individuals have reported that the installed EOD facilities are unsatisfactory and unusable.

Subject and Goals

The purpose of this thesis is to investigate possible deficiencies in the ship's EOD facilities and the tactics of deploying EOD forces on board. The researcher will define the mine warfare missions of the MCM-1 Class ships and the EOD community, and then seek to define a cooperative and feasible relationship between the two. The goal of this thesis is to recommend a relationship between the MCM-1 Class ships and EOD community which is both feasible and tactically effective. This relationship will then be used to determine what EOD capabilities and support facilities should be aboard

the MCM-1 Class ships.

Background

The AVENGER Class

The United States Navy currently has contracts with two Wisconsin shipbuilders for the construction of fourteen mine countermeasures (MCM) ships. The MCM is a new class of ship for the U.S. Navy, and its mission is to render enemy sea mines ineffective. The USS AVENGER (MCM-1) is the first of this class; and therefore, in accordance with Navy custom, her name is used to represent the entire class. Thus, all fourteen ships will collectively be called the "AVENGER Class." The USS DEFENDER (MCM-2) is the second ship of the class and was delivered to the Navy in September of 1989. The USS SENTRY (MCM-3) and the USS GUARDIAN (MCM-5) have also been delivered to the Navy. The author of this thesis is the USS DEFENDER's Mine Countermeasures Officer, and is also a qualified Naval Diving Officer.

Defining Mine Countermeasures

Mine countermeasures (MCM) is a specialized discipline within the U.S. Navy and has two basic methods: minesweeping and minehunting. The first is an attempt to "sweep" a safe passage through a minefield. This procedure can be accomplished by either physically dragging the ocean floor or water depth, or by towing acoustic or magnetic devices which simulate larger ships. The goal is either to physically remove or detonate all mines within a defined route. Minehunting, on the other hand, involves hunting for and subsequently rendering harmless each mine individually.

Minesweeping depends upon the ability of military intelligence to predict with accuracy what type of mines are present, and what means of minesweeping are appropriate. The final measure of success is clear, safe shipping lanes. This method is always a high-stakes gamble because the minesweeper crew never knows exactly how many mines are present or whether all mines were destroyed. This gamble becomes especially risky when billion dollar aircraft carriers begin transiting the "safe" shipping lane.

Minehunting is a more thorough method of clearing a safe course. It is a tedious, meticulous and, consequently, slow investigation of every possible mine-like object near the desired channel. Nevertheless, because of its effectiveness, minehunting has become the modern standard for

mine countermeasures operations. The tools required for minehunting are sonar for searching, detecting, and classifying mine-like objects, and some means of rendering harmless those mines that are discovered. Mines can be destroyed by dispatching a small rubber zodiac boat equipped to drop a time-delayed bomb, deploying a remotely operated vehicle (ROV), or deploying an explosive ordnance disposal dive team.

Defining Explosive Ordnance Disposal

Explosive ordnance disposal (EOD) is any process of disposing or handling explosive ordnance. The Chief of Naval Operations (CNO) has assigned the Navy responsibility for EOD operations in all water areas and aboard all Navy installations. (Operations Navy Instruction 8027.1E, 1981)

Individuals assigned to EOD units as officers or enlisted persons undergo strenuous training in order to qualify as EOD technicians. They are ordnance specialists and belong to a relatively small professional community within the Navy. Within the EOD community are two units dedicated to mine countermeasures: EOD Mobile Unit Six located in Charleston, South Carolina; and EOD Mobile Unit Three in Coronado, California. These Mobile Units are further subdivided into several four-man detachments which can be assigned to perform specific EOD operations anywhere

in the world.

EOD Capabilities Aboard the AVENGER Class

The AVENGER Class is intended to be the U.S. Navy's most capable mine countermeasures platform. Each ship is able to perform all of the minesweeping operations currently performed by the Navy's veteran minesweepers. Additionally, the AVENGER Class ships possess a state-of-the-art mine hunting toolbox which includes a variable depth sonar system, a remotely operated vehicle, and support facilities for an explosive ordnance disposal dive team. EOD divers, however, are not assigned to the MCM ships; rather, divers are detached from shore-based EOD MCM Mobile Units and become temporary crew members while required for mine hunting operations.

A mine hunt is initiated by the MCM ship searching the sea floor or water volume with its variable depth sonar. When a possible mine is detected, it is scrutinized and classified as either mine-like or not. EOD divers can then investigate and positively identify the suspected mines. The divers can also destroy the mine, or render it safe and exploit it to determine how it works.

In order to perform their mission, the EOD divers are provided the following support facilities aboard the MCM-1 Class ships: (1) an exclusive EOD work space and storage

area, (2) a supply of breathing gases to fill their underwater breathing apparatuses, and (3) small boats which can be deployed from the MCM-1 Class ship and used by the divers to approach the mine's immediate vicinity.

Integrated Tactics

Tactics is defined as the art of directing and deploying one's forces against the enemy. Integrated tactics employs multiple assets allied against a common enemy. The result of integrated tactics is a single force which is more effective than its individual components. This study focuses on the tactical employment of the MCM-1 Class ship, specifically the integrated operations involving the MCM ship and an EOD dive detachment. This study will explore capabilities, limitations, and mission requirements, and eventually conclude by defining a tactically effective relationship between the MCM-1 Class ships and an EOD detachment.

The Problem

EOD divers from EOD Mobile Unit Six in Charleston, South Carolina have toured the USS AVENGER and expressed reservations about the support facilities and the tactics of deploying an EOD detachment aboard the MCM-1 ships. Four

general complaints are summarized as follows:

(1) the EOD work space is too small,

(2) the EOD storage area is insufficient,

(3) the gas supply system designed to fill their breathing apparatus is unworkable and unsafe, and

(4) EOD teams would prefer to operate aboard another platform, independent of the MCM (EODMUSIX Detachment, Officer in Charge, personal communication, June 1988).

There has been unofficial discussion of dismantling the EOD facilities, but to date, the divers' negative feedback has not stimulated any official design changes for the ship's EOD support facilities. Thus, construction proceeds on facilities which are, at best, less than ideal from the perspective of the intended user, the EOD team.

Why a Management Concern?

The goal of this thesis is to determine a cooperative relationship between EOD and the MCM-1 Class ships which is both feasible and tactically effective. It is appropriate that management investigate this integration of MCM forces because management is responsible for coordinating the combined forces and achieving effective tactical results. A thorough understanding of the pros, cons, capabilities, limitations, and goals of the integration will help management lead the combined force more effectively toward

success. Unit effectiveness has always been management's responsibility, and thus the conclusions of this thesis are intended to improve management's performance in the coordination of forces and the creation of an effective combined unit.

This researcher's responsibilities as the DEFENDER's (MCM-2) Mine Countermeasures and Diving Officer includes coordinating EOD operations and providing required EOD support facilities. Thus, it is appropriate that this researcher investigate the previously expressed shortcomings of the EOD support facilities and the integration of forces. Additionally, addressing these perceptions now before more ships are completed may make it possible to amend future ship construction, if this is deemed desirable.

When the construction of a Navy ship is completed, she is commissioned a United States Ship (USS) and joins the U.S. Navy fleet. Throughout the construction of a Navy ship, the ship's officers or managers have many unique responsibilities. The <u>precommissioning crew</u> is responsible for preparing administration and performing quality assurance during construction. The precommissioning crew's responsibility for quality assurance includes physical construction as well as the ship's proposed mission assignments. In other words, they investigate whether the ship will actually be able to perform the missions for which she was designed. Thus, this investigation into the

feasibility of EOD and MCM-1 Class integrated tactics is a valid subject for the precommissioning crew's management.

Additionally, management's investigation of the ship's future assignments can ensure that the construction process is appropriate and realistic. This will minimize wasted man hours, ensure proper utilization of government funds, and ensure effective utilization of very limited shipboard space.

Research Purpose

Given the reports of significant deficiencies, the author considered four possible conditions giving rise to such reports:

(1) current tactics and support facilities are adequate, and thus reported deficiencies are a result of poor communication and coordination between the ship construction project manager and the EOD community,

(2) current tactics are sound, but shipboard facilities are insufficient,

(3) shipboard facilities are adequate, but current tactics are unacceptable or unrealistic, or

(4) both tactics and shipboard facilities are unsatisfactory.

The purpose of this research is to determine which of these conditions in fact prevails.

Research Procedures

This study was pursued in three sequential steps.

(1) Determine specifically what EOD capabilities are currently available aboard the AVENGER Class ships, and also what capabilities an EOD detachment would desire aboard the ships.

(2) Judge the acceptability of current facilities and the feasibility of attaining the capabilities desired by an EOD detachment.

(3) Recommend what capabilities should be retained, added to, or deleted from the AVENGER Class ships.

Literature Review

A review of mine warfare literature pertaining to EOD MCM operations is presented in Chapter II of this report. The literature review established a foundation for understanding the individual roles played by EOD forces and the MCM-1 Class ships in mine countermeasures operations by defining terms, specifications, support requirements, missions and tactics.

Research and Methodology

Chapter III of this study describes the author's methodology for conducting research. The research addressed those topics which must be understood in order to evaluate reported deficiencies and formulate recommendations for future AVENGER Class ships. This process was divided into two steps. First, the research examined and defined the roles of EOD and the MCM-1 Class ships within mine warfare. These findings are presented in Chapter IV of this thesis. Secondly, the research explored the acceptability of current facilities and conditions, and also explored the feasibility of proposed modifications. This information is discussed in Chapter V of the thesis.

The research focused on the topics listed below.

Define the Role of EOD Within Mine Warfare

(a) Define the capabilities and limitations of EOD dive teams through interviews with representatives of EOD units.

(b) Define desired as well as required EOD support facilities and operating platforms through interviews with various members of EOD units.

(c) Predict future employment of EOD units within mine warfare environments through interviews with representatives of EOD units and the Mine Warfare

Command.

(d) Determine specifically what role EOD dive teams should play aboard the AVENGER Class ships, and whether the divers should be assigned to the ship full time, part-time, or not at all. These questions addressed the minimum EOD diving capabilities required to achieve the ship's tactical mission, as well as what additional EOD dive capabilities could improve the ship's mission effectiveness. The researcher reviewed these topics with the USS DEFENDER's Commanding Officer, the U.S. Navy's Atlantic Fleet EOD/MCM Officer, the Navy's Mine Warfare Command staff, and several other individuals having personal knowledge of mine warfare and the AVENGER Class ships.

(e) Investigate the availability of EOD personnel for manning the MCM-1 Class ships permanently vice temporarily.

(f) Investigate shipboard responsibilities of divers permanently assigned aboard MCM ships of other Navies.

Judge Feasibility

(a) Shipboard accommodations.

The researcher sought to determine whether the ship could provide sufficient accommodations for an assigned dive team by comparing the ship's total berths and

normal crew requirements.

(b) Material. The researcher reviewed the following questions with representatives of EOD units and the MCM-1 crew. Is the present EOD locker aboard the MCM-1 Class sufficient? How could it be improved? What equipment does a dive team need to store in the locker? Is this gear portable, or must it be permanently installed?

(c) Tactics. Using the defined missions and tactics of the MCM ships and the EOD detachments, the researcher investigated how the two could cooperate to best ensure mission achievement.

Costs

The researcher reviewed the construction costs of the EOD facilities as currently designed aboard the MCM-1 Class ships, and additional costs for proposed deviations from the current configuration. This included personnel costs, equipment costs, and shipyard contract costs. The researcher also investigated the availability of desired funds by corresponding with the representatives of the Naval Sea Systems Command who are responsible for managing the AVENGER Class ship construction funds appropriated by the U.S. Congress.

The Study's Population

The study involved a population of both civilians and military, and all levels of the DEFENDER (MCM-2) chain of command. The organization responsible for overall project management, Naval Sea Systems Command (Code PMS 303), as well as the local project manager, the Supervisor of Shipbuilding, was consulted. The operating units, the crews of the MCM and MSO ships, in addition to EOD mobile units were consulted as well their chains of command. The U.S. Navy's Mine Warfare Command, which advises higher echelons on mine warfare matters, was also consulted.

Recommendation

This study concludes with a recommendation for an effective relationship between EOD and the MCM-1 Class ships. This recommended relationship defines required levels of shipboard support.

CHAPTER II

LITERATURE REVIEW

Chapter I of this thesis introduced the topic and provided a broad background of the situation. This chapter expounds upon this background information and discusses specifics which must be examined in order to evaluate the research questions and arrive at a recommendation.

Key Issues

This literature review addresses the following key issues:

(1) The tactical mission of the AVENGER Class ships as defined by the U.S. Navy's Top Level Requirements (TLR) and Required Operational Capabilities (ROC), which are the general guidelines used to design the ship.

(2) The requirements for the DEFENDER (MCM-2) EOD locker as delineated in the ship's specifications or contract between the U.S. Navy and the shipbuilder, Marinette Marine Corporation.

(3) Other information related to the ship's specifications: oxygen handling and stowage, gas transfer system, and certification requirements for diver life support systems.

(4) The mission, organization, capabilities, and support requirements of the EOD community in regard to mine warfare.

(5) Current U.S. Navy and allied tactical doctrine for mine countermeasures operations.

(6) The capabilities and tactical doctrine of foreign MCM platforms.

Review of Literature

MCM-1 Class: TLR, ROC & POE

In general terms, "the design of a warship originates in the decision of the mission or the envelope of missions, the ship is to perform in the overall scheme of national defense. This requires a determination of the capabilities the ship must have to execute its assigned mission(s) and from the capabilities required comes the need to achieve a balance of ship characteristics that will optimize those capabilities." (Batcheller, 1990)

The administrative starting point for the creation of a new U.S. Navy ship is the publication of Top Level Requirements (TLR) for that particular proposed ship by the Chief of Naval Operations. The TLR outlines the intended role of the ship within the scope of national defense. The TLR for MCM-1 Class ships are published in a Chief of Naval Operations confidential instruction (Operations Navy

Instruction C9010.326) and calls for the MCM-1 Class to search for, detect and neutralize mines. Specifically regarding EOD operations, it is an essential mission requirement that the MCM-1 Class provide limited support to an embarked EOD detachment.

The determination of the future ship's Required Operational Capabilities and Potential Operating Environments (ROC & POE) is the next step after defining TLR. The MCM-1 Class ROC & POE is disseminated in a confidential Chief of Naval Operations instruction. (Operations Navy Instruction C3501.164) The MCM-1 Class ROC paraphrased from this instruction include the ability to conduct mine hunting operations in coastal and open ocean waters 24 hours a day, and provide protection to shipping against mining threats.

Ship Specifications

The ship's specifications are the third administrative stage in a ship's creation. The first step, TLR, identified the ship's intended role in a broad context. The second step, ROC and POE, defines specific operational capabilities and environments based upon the assigned role. The third step, ship specifications, defines in detail how the ship must be built in order to achieve its expected capabilities.

EOD Locker. The MCM-1 Class ship specifications call for an EOD locker in order to satisfy the ship's requirement to support an EOD detachment. The space is to provide limited storage shelves, a hanging rack, a safe, a workbench, and a supply of helium and oxygen breathing gases. The EOD locker is located on the ship's starboard side 01 level and is intended to provide a space where the EOD technicians can maintain their diving equipment, store their equipment, and refill their breathing apparatus using a portable gas transfer system (GTS) in conjunction with the provided gas supply. The MCM-1 Class specifications for the EOD locker and associated compressed gas system are detailed below.

> Section 672. Storerooms. Explosive Ordnance Disposal (EOD) Locker.
>
> 1 Workbench, wood, 36 inches wide, 70 inches long and 36 inches above the deck, with three drawers, each 4 inches high, 20 inches wide and 25 inches deep. Workbench to be manufactured to suit and built-in.
>
> 1 36 inch section of removable jackrod, 78 inches above the deck, for diving suit.
>
> 1 Type No. 6 Safe Locker, 36 inches wide.
>
> 1 Type K, Rack.
>
> 1 Shelf 24 inches wide, 70 inches long. Bottom shelf 36 inches above workbench, 21 inches between shelves (MCM-2 Ship Specifications, 1982, p 881).

> Section 671. Special Stowage Arrangement.
>
> Helium and oxygen bottle stowage for EOD locker. Permanent stowage shall be provided...for four helium bottles and two oxygen bottles plus one spare (total of seven bottles). The four helium bottles and two oxygen bottles shall be hard piped to the EOD locker.... The spare bottle will be strictly stowage and not hard piped (bottle may be helium or oxygen). All bottles are to be nominal 200 cubic feet capacity (Specifications, 1982, p.

878a).

Section 552. Compressed Gas Systems.

552a Scope. This section contains general requirements for arrangement and installation of compressed gas piping support services for EOD equipment (Specifications, 1982, p 688).

EOD Support Systems. Piping manifolds shall be provided for the helium and oxygen bottles stowed adjacent to the EOD locker. One manifold shall be provided to connect two...(nominal 200 SCF) oxygen cylinders together via suitable stop valves.... A pressure gauge shall be installed to determine the pressure in either gas cylinder. A line shall be run from this manifold to the EOD locker and shall terminate with a stop valve.... A pressure gauge shall be installed to sense the pressure upstream of this stop valve.

A second manifold shall be provided to connect four (nominal 200 SCF) helium cylinders together via suitable stop valves.... A pressure gauge shall be installed to determine the pressure in any of the four cylinders. A line shall be run from this manifold to the EOD locker and shall terminate with a stop valve.... A pressure gauge shall be installed to sense the pressure upstream of this stop valve. Suitable fittings shall be provided to connect the helium and oxygen supply lines to the portable gas transfer system (Specifications, 1982, p. 688).

522b. Cleaning. The EOD compressed gas piping system shall be cleaned in accordance with the requirements of MIL-STD-1330 (Specifications, 1982, p. 689a).

522c. Testing. The EOD compressed gas piping system shall be hydrostatically tested in accordance with the requirements of MIL-STD-1330 (Specifications, 1982, p. 689b).

RFP #69. Oxygen Monitoring. The EOD locker shall have a wall-mounted oxygen monitoring system similar to Bacharach Instrument Model No. KD 930 or equal. The systems shall be located near the work bench area and the alarm point shall be set at 22 percent oxygen level (Specifications, 1982, p. 15).

> Section 551. Low Pressure Air....ships service air hose outlet for pneumatic tools in the EOD locker (Specifications, 1982, p 683).

Oxygen

Personnel protection measures and other safety precautions applicable to oxygen are discussed in NAVSEA technical manual S9086-SX-STM-000/CH550 section 6. The following paragraphs highlight portions of this technical manual relevant to the MCM-1 Class EOD gas system.

> Gaseous oxygen is colorless and odorless and has a specific gravity of 1.105 compared to air. It is not flammable but strongly supports and rapidly accelerates the combustion of all flammable materials. Gaseous oxygen will cause combustible materials (notably oil and grease) to burn spontaneously and may cause some substances to burn that are not normally considered combustible (e.g., steel wool, thin gauge metals, and certain types of cloth). Any substance that burns in a normal atmosphere will burn more rapidly and with higher flame in concentrated oxygen. Oxygen by itself can neither burn nor explode; a fuel is required.
>
> > Note: Always call oxygen by its proper name. Oxygen should never be called air and should never be used in place of compressed air (Naval Sea Systems Command (Navsea), 1982b, CH550-6.5).
>
> Only qualified personnel with full knowledge and understanding of the applicable safety requirements and hazards associated with oxygen handling shall be permitted to handle gaseous oxygen aboard ship (Navsea, 1982b, CH550-6.7). Ideally, all operating personnel, as well as supervisory personnel, will be graduates of the Cryogenics school...personnel who are not Cryogenics school graduates shall participate in oxygen...handling only after demonstrating a

thorough comprehension of the processes and equipment involved (Navsea, 1982b, CH550-6.8).

Only aviator's breathing oxygen...is acceptable for use as diver's breathing gas. Gaseous oxygen shall contain not less than 99 percent oxygen by volume with remaining impurities as stated therein (Navsea, 1982b, CH550-7.15).

Stow oxygen containers only in designated, well ventilated spaces (Navsea, 1982b, CH550-7.17). Oxygen system piping and fittings shall comply with MIL-STD-777 (Navsea, 1982b, CH550-7.18) which discusses general piping specifications including fabrication and assembly.

In diving-related operations, it is necessary to transfer oxygen to various locations. During transfer, it is necessary to control oxygen flow and pressure. In U.S. Navy diving systems, there are three primary means of controlling the transfer of oxygen:

(1) Cascade: The use of oxygen piped from high-pressure gas banks through a pressure reducer to supply required flow rate and pressure at various outlet stations.

(2) Oil-free transfer pumps and compressors: The use of nonlubricated transfer pumps and compressors as booster pumps to top off flask pressure.

(3) Mixmaker: The use of a gas-mixing console to mix various gases needed for diving operations (Navsea, 1982b, CH550-7.19).

Both in-place oxygen piping systems and individual components shall be cleaned as required by and in accordance with MIL-STD-1330. Certification of systems and components shall be in accordance with MIL-STD-1630 (Navsea, 1982b, CH550-7.21).

Oxygen charging (Navsea, 1982b, CH550-7.22). The Commanding Officer shall designate an Officer In Charge (OinC) of the oxygen charging operation (Navsea, 1982b, CH550-7.23). This officer is responsible for ensuring that:

all combustible materials within 50 feet of the charging connections are removed; no smoking signs are posted prominently; approved fire fighting agents are readily available; and oxygen leak detection and monitoring instruments are accurately calibrated and properly operated and are located in the vicinity of the manifolds, flasks, and cylinder

stowage compartments (Navsea, 1982b, CH550-7.24).

> MIL STD-1330C. The standard provides a procedure for cleaning and testing oxygen...gas piping systems. Explosions are known or suspected to have occurred in high pressure oxygen gas systems which were not properly maintained. To ensure safe operation of these systems, the accumulation of hydrocarbons in the systems must be eliminated; subsequently, the systems must be cleaned for oxygen service (Navsea, 1985, p iii).

Oxygen Analyzer. Naval Sea Systems technical manual S9086-SX-STM-000 Chapter 550 requires that an "oxygen leak detection and monitoring instrument [be] located in the vicinity of the oxygen manifolds, flasks, and cylinder stowage compartments" (Navsea, 1982, p 68). Accordingly, the ship's specifications (as modified by Request For Proposal #69) call for a Bacharach Model KD900W Gas Detection/Alarm System to be installed inside the EOD locker. The Bacharach system includes a wall-mounted control cabinet and a remote mounting oxygen detector assembly (Peterson Builders Incorporated, 1985).

The Bacharach "oxygen cell is a time-proven sensor, used to provide fast, reliable measurements of oxygen in gaseous samples. Applications include measurement of the oxygen content in confined and unventilated spaces.... The cell is incapable of releasing sufficient electrical energy to cause ignition of the most easily ignited combustible gas-in-oxygen mixtures" (Bacharach, 1972a, p 1). Maintenance on the cell can be accomplished in a few minutes,

and involves cleaning and reactivation by replacing zinc electrode and electrolyte. Maintenance requirements are listed below.

(1) Daily: Note meter reading and investigate any abnormal reading deviating from 21% oxygen.

(2) Weekly: Check oxygen reading while the oxygen cell is exposed to normal atmospheric air. Adjust meter reading to 21% oxygen using the span adjusting screw.

(3) As required: Clean, service, or replace oxygen detection cell. Reactivation recommended two or three times annually. Replace any burned-out indicator lamps.

(4) For prolonged storage, it is recommended that the electrolyte be drained and cell be well rinsed and stored in a dry environment (Bacharach, 1972b).

Gas Transfer System

Aboard the MCM-1 Class ships, EOD detachments will use the Gas Transfer System (GTS) (part number 5367002) to charge their MK16 underwater breathing apparatus. The GTS is basically a booster pump which takes a low pressure gas source and pumps it into high pressure spheres. The GTS is driven by an external pressurized air source from 80 to 3000 PSIG. It is a lightweight portable system, intended to be easily transported and deployable aboard most U.S. Navy ships. The GTS, however, is magnetic, which is an

undesirable, although not necessarily an unacceptable, property aboard a MCM vessel.

The Naval Sea Systems GTS technical manual states that the GTS should be located in a well ventilated area away from potential fire hazards, and placed on a table at least 48 inches by 36 inches (Naval Sea Systems Command, 1982a). The EOD locker's workbench provides sufficient table top space to accommodate the GTS. Accessories required in addition to the GTS include a gas supply, an air drive supply, connecting whip, and fill bottles.

The EOD locker aboard the MCM ships provides the necessary gas supply and the air drive supply. A limited gas drive supply could also be provided with a pressurized SCUBA cylinder. EOD would provide the fill containers from the MK16 breathing apparatus. The required power source for the GTS, low pressure air, is provided in the EOD locker using ship's service air pressurized to approximately 100 PSI added to the ship specifications (via RFP #289 and Engineering Change Notice 07-551-3) (Marinette Marine Corporation, 1988).

Certification

Certification is a process which determines that a system upon which the lives and well-being of Naval personnel is dependent is adequate from a safety standpoint. The

process verifies that the system maintains acceptable levels of safety throughout its specified operating range when used in accordance with approved operating and maintenance procedures. Certification procedures and guidelines applicable to Deep Submergence Systems, including diving equipment and integrated systems like the EOD MK 16 underwater breathing apparatus which are worn by a man, are published in the Naval Material Command Publication 9290, "System Certification Procedures and Criteria Manual for Deep Submergence Systems".

There is no requirement in the ship's specifications to certify the MCM-1 Class ship's EOD compressed gas system. Nevertheless, it is pertinent to review the procedures for system certification because representatives of both the EOD community and the MCM-1 crew has identified lack of certification as a deficiency of the ship's EOD locker. There is not, however, a specific Navy regulation which definitively requires certification.

The basis for determining if a system is adequately safe is based on information and justification submitted by an applicant, who may be the system operator or builder. This information is recordable evidence in the custody of, or submitted by, the applicant. It is "no more than that normally expected to be generated by a prudent designer and builder" (Naval Material Command, 1976). However, system certification does necessitate the recording of pertinent

information throughout design, construction, and operation. The following areas are addressed:

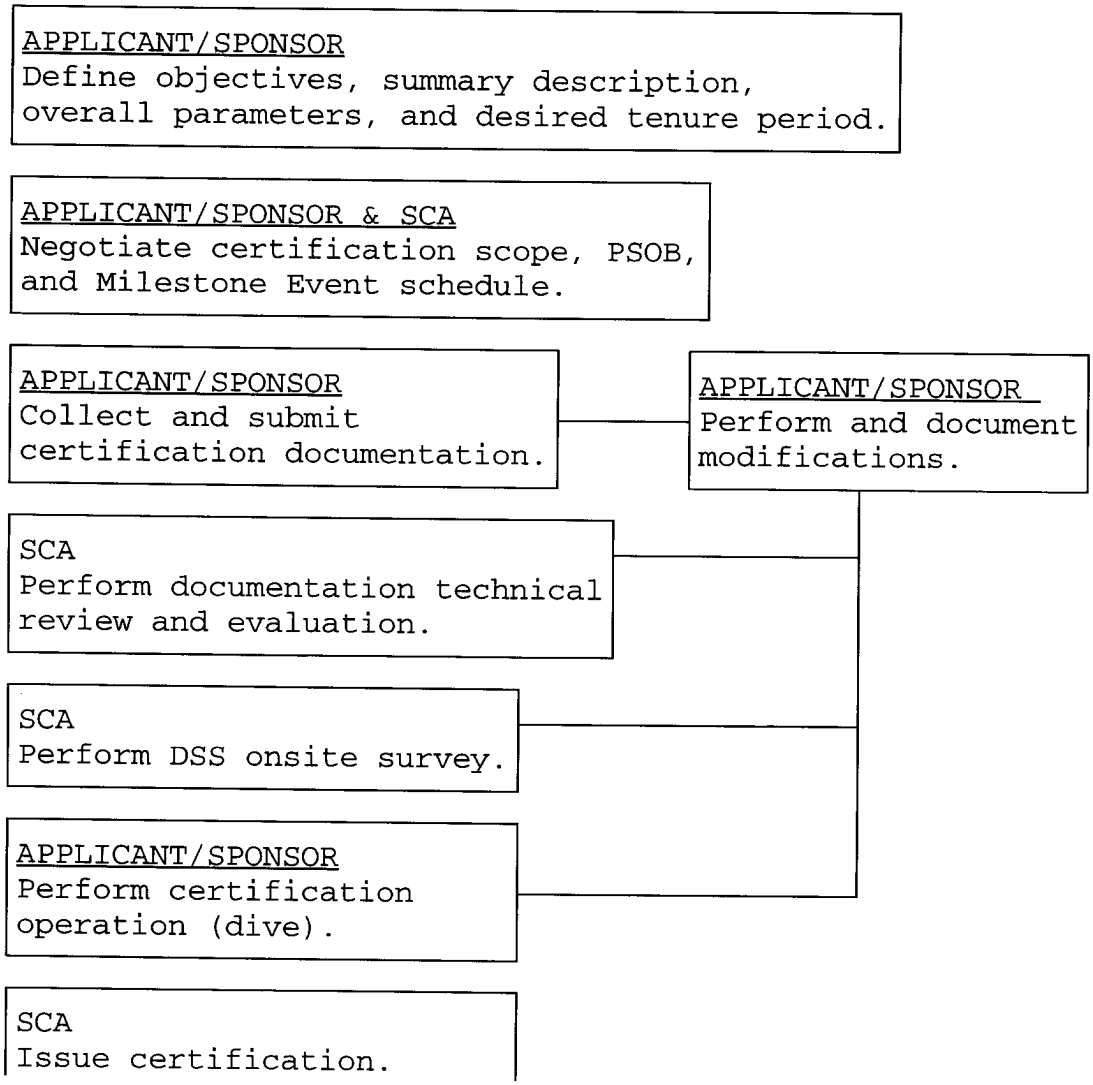
(1) design,
(2) material,
(3) construction/fabrication/assembly,
(4) quality assurance,
(5) testing,
(6) operability, and
(7) maintenance.

The certification procedure is illustrated by Figure 1. The applicant would be the activity requesting certification, possibly the shipyard. The system certification authority (SCA) reviews the application and has authority to grant certification. Scope is a list of those systems required to ensure and preserve the safety and well-being of its operators and divers. It encompasses all of the systems needed to ensure continuous physical well-being and safety, including normal and emergency procedures for operation and maintenance, sub-systems, and hardware. A Pre-survey Outline Booklet is a detailed checklist which expands each scope item into specific requirements for recordable evidence.

Approval of operating and emergency procedures is a portion of the certification process and is the responsibility of the Supervisor of Diving (Naval Sea Systems Command Code OOC3). The applicant must furnish validated copies of all operating and emergency procedures and system schematics and drawings. Drawings are used as approving procedures (Naval Sea Systems Command, 1986).

After a certified system has been successfully tested, cleaned, and cleanliness verified in accordance with the Naval Material Publication 9290, strict adherence to reentry controls will ensure certification is maintained. Reentry controls ensure that personnel responsible for deep

MAJOR CERTIFICATION EVENTS



APPLICANT/SPONSOR
Sustain certification
throughout tenure.

FIGURE 1

submergence system maintenance are thoroughly trained in the certification requirements and will provide an audit trail of any work which may affect the system's certification (EOD Mobile Unit Six Instruction 9090.1, 1987).

Explosive Ordnance Disposal

Overall Mission

The Navy's EOD community is made up of approximately six hundred highly trained technicians and assistants. The Chief of Naval Operations has made the EOD community responsibile for the disposal of and handling of explosive ordnance aboard all Navy installations and in all water areas (Operations Navy Instruction 8027.1E, 1981). Naval Warfare Publication 15-3 states that EOD's primary mission is to "counter unexplored ordnance threat". A secondary mission is

the gathering of intelligence about foreign ordnance. The community is split between West and East Coast groups, EOD Group One and Two, respectively. Groups are then subdivided into Mobile Units, and further divided into detachments. The EOD detachment is the community's workhorse which responds to explosive ordnance situations as required.

In addition to the EOD missions already discussed, Naval Warfare Publication 15-3 specifically assigns the EOD community the responsibility to "render EOD services necessary to accomplish Navy mine warfare and mine countermeasures operations, programs, and exercises". This includes intelligence gathering and technical evaluations necessary to determine desired minesweeping techniques. (Naval Warfare Publication 27-1-1A, 1987)

Detachment

An EOD detachment is comprised of a minimum of one officer and three enlisted personnel. This is the minimum work force required to safely conduct all types of EOD operations, and is mandated by EOD Group Two Instruction 8027.5. All EOD detachment members should be qualified Navy divers, but one enlisted member may be a non-EOD qualified Navy SCUBA diver who has received special EOD training (EOD Group Two Instruction 8027.5).

Personnel making up the Navy's EOD community are "highly skilled personnel in the use of complex technology" (Naval Warfare Publication 15-3). EOD technicians, both officer and enlisted, undergo a year of strenuous training before joining a detachment. EOD assistants are divers who have received less comprehensive training. A detachment must be made up of at least three technicians, while the fourth required member may be an EOD assistant or any qualified Navy diver (Naval Warfare Publication 15-3). EOD Group Instruction 8027.5 requires a non-EOD technician receive special training at the group before replacing the detachment's fourth EOD technician. Naval Warfare Publication 15-3 mandates that EOD detachments required in combat areas will be comprised of two or more detachments, each with a minimum of four persons.

Mine Countermeasures

EOD Mobile Unit Six in Charleston, South Carolina, and EOD Mobile Unit Three in Coronado, California, specialize in mine countermeasures. Specific tasks which EOD can perform in a mine warfare environment include searching for and detecting mines, positively identifying mines, rendering mines safe, evaluating mines while still in the field for intelligence information, recovering mines and exploiting their internal workings for detailed intelligence, and

disposing of mines (Naval Warfare Publication 27-2A). All of these tasks, except recovery for internal exploitation can also be performed by the MCM ship's remotely operated vehicle.

Diving Capabilities

EOD technicians are currently capable of diving up to 190 feet. This limit is Navy-wide for non-surface supplied diving. Beyond 190 feet, the increased pressure of the water places burdens on the diver's anatomy which are deemed too excessive unless he is in communication with a surface tender. Furthermore, the diver's time limit at depth is inversely proportional to the depth. Deep dives must be shorter than shallow dives because of physiological effects of water pressure. The diver's duration underwater is also reduced by colder water temperatures, water currents, and repetitive dives.

EOD detachments are capable of deploying anywhere worldwide on short notice. Each detachment has prestaged equipment ready for deployment, and also access to Fly Away Diving Lockers (FADL) which contain gas charging facilities

and a recompression chamber.

MK 16 Underwater Breathing Apparatus

The unique aspect of Navy EOD is its focus on underwater operations. In order to perform in this environment, the Navy has developed the MK 16 Underwater Breathing Apparatus for the EOD community. The MK 16 is similar to common SCUBA (Self Contained Underwater Breathing Apparatus) in that it is a limited supply of breathing gas carried on the back of a diver. The MK 16, however, is more sophisticated than SCUBA, and possesses several unique advantages designed specifically for EOD operations. (1) It is nearly non-magnetic, and therefore minimizes the chance of detonating magnetically fuzed mines. (2) The breathing gas is a mixture of a helium and oxygen diluent and oxygen, and therefore a diver is capable of diving deeper than if breathing air. (3) The MK 16 is a closed circuit which emits no bubbles upon exhalation which could disrupt the diver's field of vision. The above factors are critical for EOD divers operating in the immediate proximity of underwater mines (Naval Ships Technical Manual SS600-AH-MMA-010, 1 May 1985).

EOD Support Requirements

The EOD detachment is equipped to respond to any situation on short notice. Required support equipment is prestaged in mobile fly-away trailers. Detachment Twelve of EOD Mobile Unit Six has separate checklists for beaching trailers (for recovering mines) and dive trailers (including GTS and gas supply). They also have separate checklists for deploying dive boats, specialized EOD publications (as situation warrants) and explosives. Additional support requirements which the EOD detachment would request from external sources include: helicopter support in case of a diving accident, additional gas supply for underwater breathing apparatus, standby hyperbaric chamber, intelligence information, MSO/MSB/AMCM assistance for minehunting operations, and specially trained sea mammals.

The support requirements for the EOD detachment depend upon the situation, but generally "EOD MCM detachments... will normally operate from, and be supported by, an MSO or other MCM ship" (Naval Warfare Publication 27-2A). The key is that the support ship must have sufficient space to receive the EOD detachment's deployable trailers and be available on short notice in the required operating area (Naval Warfare Publication 27-2A). Note that it took two and a half months to tow an MSO 12,000 miles from the U.S. West Coast to the Persian Gulf. MCM experimental tactics (Fleet Tactical Note 6021-88) state that the MCM support asset

should provide personnel support, communications, explosive storage, and a recompression chamber. Naval Warfare Publication 27-2A states a chamber should be on-site and available for immediate use. Note that Naval Warfare Publications identify MSO and MCM ships as likely EOD support platforms, but do not mandate the necessary support facilities or services. Table 1 reproduces Appendix C of Naval Warfare Publication 15-3B which lists the minimum shipboard space requirements for embarked EOD detachments, and also indicates which of these requirements is satisfied aboard the MCM-1 Class ships.

Gas Transfer System. Support requirements also may include a supply of breathing gases (helium and oxygen) which can be used to refill the MK 16 gas spheres. The Gas Transfer system is used to refill the gas spheres.

Tactics

Mine warfare tactics are delineated in Naval Warfare Publications 27-1-1A, 27-2A, 27-1-4, and also in Allied Tactical Publications (ATP) 6 and 24A. In general, these mine warfare publications view EOD as an MCM asset. EOD is assigned the task of providing positive identification of probable mine-like objects, intelligence, and disposal. Each Naval Warfare Publication states that EOD MCM detachments

will normally operate from and be supported by an MSO or other MCM vessel (Naval Warfare Publication 27-2A).

Commander David Resing, an EOD technician, argues that the U.S. Navy needs to stress the integration of various MCM assets with each asset focusing on its specialty. EOD should concentrate on identifying, neutralizing, and exploiting mines located in relatively shallow harbor

MINIMUM SHIPBOARD SPACE REQUIREMENTS FOR EMBARKED EOD DETACHMENTS

		Available on board MCM-1	
		Y	N
I. **Size and Quantity of Compartments** Two compartments, 20 feet by 10 feet, 200 square feet each, located adjacent to each other.			
II. **Requirements Within Spaces**			
A. Space #1 (Office and Working)			
1. Desk (yeoman type) with typewriter			N
2. Filing cabinet, Type I (4 drawer)			N
3. Security container		Y	
4. Book Rack		Y	
5. Metal Stowage shelves		N	
6. Work bench with 4 inch jaw vise	Y		
7. Stowage rack and bin			N
8. Stowage locker			N
9. Deep sink with fresh water		N	
10. Air conditioning and heating		Y	
11. Electrical outlets (2-110/1-220)			N
12. Fluorescent lighting		Y	
13. Communications systems			
(a) SS telephone			N
(b) 1 MC		Y	
(c) 30 MC	N/A		
(d) 5 JG		N/A	
(e) 46 MC	N/A		
B. Space #2 (Stowage)			
1. Metal stowage shelves			N
2. Stowage rack and bin			N

3.	Stowage fixture for SCUBA bottles, diving compressor, outboard motor, and small inflatable boat.			N
4.	Air conditioning and heating		Y	
5.	Jack rod hanger for diving suits		Y	
6.	Electric outlets (1-110v)		Y	
7.	Fluorescent lighting		Y	
8.	Communications systems 1MC	Y		

TABLE 1

waters. ROV's should be used to supplement EOD divers in deeper waters (Resing, 1972).

Persian Gulf Ramifications

The Commanding Officer of Mine Group One in Seattle, Washington, hosted a Persian Gulf Ad Hoc Working Group in January, 1989, to discuss various ramifications and lessons learned from the Persian Gulf operations. Some specific agenda items which were discussed and are pertinent to this study were: (1) determine diver support craft requirements for Naval Warfare Publication 27, (2) finalize and approve ROV tactics, and (3) produce procedures for destruction of floating moored mines (Commander Mine Warfare Command Message R061440ZJAN89). A follow-up work group focusing on general MCM tactics was convened in April, 1989. This group focused on critiques of MCM commander's ability to achieve

the MCM objective and the status of MCM-1 Class tactics manual. Another work group convened in July of 1990 and worked to finalize a list of Persian Gulf lessons learned which will eventually be published as Naval Warfare Publication 28.

Foreign MCM Platforms

Commander David C. Resing has argued that the U.S. Navy needs to improve its MCM forces (Resing, 1987). This sentiment was expressed earlier by Rear Admiral Joseph Metcalf, then Deputy Chief of Naval Operations for Surface Warfare, in April of 1985 when he told Congress, "No element of our Navy is as deficient in capability against the threat as is the mine countermeasures force" (Truva, 1982). Commodore Wesley McDonald expressed in 1985, when he commanded the U.S. Navy's Mine Warfare Command, that the U.S. possesses an insufficient number of MCM vessels (Proceedings, 1985). Meanwhile, the Soviets have 300 MCM vessels and the world's largest stockpile of mines (approximately 400,000) (Anderson, 1987).

NATO mine warfare forces, on the other hand, have received more consistent emphasis than their U.S. counterparts. Petty Officer Bray, an EOD technician, stated that in 1984 the U.S. MCM forces were at an all time low (Bray, 1987). In 1973, NATO established the Standing Naval

Force Channel which focuses on MCM. Key members include Belgium, Germany, the United Kingdom, and the Netherlands. Lesser participants include Denmark, Norway, and the United States. Unlike any U.S. MCM asset, several NATO MCM vessels, including the British, West German, French and Italians, have EOD personnel as permanent crew members. Additionally, Japan, East Germany, and the Soviet Union have MCM vessels with EOD divers permanently attached.

LERICI Class Mine Hunters

The LERICI Class mine hunter is constructed by the Italian company Intermarine and sold vigorously in foreign markets (Palmer, 1986). The EOD support facilities aboard this class of ship are representative of many foreign platforms which have divers as permanent assets. No U.S. MCM platform has similar support facilities, including the AVENGER Class. The LERICI Class ships have EOD divers permanently assigned. When not diving, they perform "equipment maintenance and other routine shipboard duties" (Amorosa, personal communication, 1989). Diver support equipment and systems aboard the LERICI Class include:

(1) two inflatable boats,
(2) air compressor for charging SCUBA cylinders and recompression chamber,

(3) mixing pump for mixing oxygen and air,
(4) SCUBA charging station,
(5) diving office,
(6) decompression chamber,
(7) pilot house for guiding boats to targets, and
(8) shipboard embarkation/debarkation ladders for deploying divers off of ship's stern. (Amorosa, personal communication, 1982)

CHAPTER III

METHODOLOGY

This study strived to define integrated mine countermeasures tactics specifically involving EOD detachments and the AVENGER Class MCM vessel. The research answered current questions about precisely what support the MCM-1 Class ships can provide, and as a result, what the deployed EOD detachments' deployed operational capabilities are while onboard an MCM-1 Class ship. This chapter describes the methods used to investigate those factors which were introduced during previous chapters but needed to be explained further in order to achieve this study's purpose,

which was to define a definitive relationship between EOD detachments and the AVENGER Class ships.

Research Design

This study is predominantly analytical. The overall focus, integrated MCM tactics, was broken down into constituents which were then analyzed or described. This study's previous chapters introduced the problem and provided a framework for appreciating its ramifications. The following chapters address questions which required investigation.

Questions

The following questions are the result of breaking down the study's focus into individual constituents. The method for examining these questions is also provided.

(1) Are the MCM-1 Class ships capable of adequately supporting a deployed EOD detachment? The EOD support systems provided by the MCM-1 Class ships were scrutinized and evaluated through interviews with representatives of the shipbuilder, USS AVENGER crew members, EOD community, and other commands involved with EOD/MCM operations.

(2) What are an EOD detachment's capabilities and limitations within a mine warfare environment? An EOD detachment's capabilities and support requirements were examined through interviews with various members of the EOD community.

(3) How can EOD and MCM-1 capabilities be integrated into sound and effective tactics?

a. The employment of the EOD lockers aboard the USS AVENGER, USS DEFENDER, USS SENTRY and USS GUARDIAN since their respective commissionings was reviewed and evaluated.

b. The past experience of EOD and MSO/MCM forces in integrated tactical operations was reviewed through various interviews.

c. Actual MCM operations conducted in the Persian Gulf, and other combat areas were reviewed.

d. Revised MCM tactics generated from Persian Gulf experiences were evaluated.

e. Other new developments in mine warfare tactical planning were evaluated.

Variables

This section describes the variables used to investigate those factors which were introduced and defined in earlier chapters but demanded further examination. Specific variables critical to answering research questions

are identified, including a system for observing or measuring each variable. This includes a description of a survey employed, and how its results were interpreted. Also, any assumptions made by the researcher are identified. Finally, the limitations of this methodology toward answering the thesis' question is addressed. Pertinent variables are:

(1.) Capabilities of an EOD MCM Detachment.

The literature review addressed descriptive data about the diving capabilities of EOD detachments. This provided basic information concerning dive depths and durations, generic requirements for support equipment, and potential missions. All of these parameters, however, can vary considerably depending upon the immediate situation and environment. For example, the U.S. Navy Diving Manual lists maximum dive times for given depths (i.e. five minutes at ninety feet). These times, however, must be reduced if the water temperature is excessively cold or the job requires above average physical exertion. How much the diver's time underwater is reduced is a function of the EOD team leader's experience and judgment.

(2.) Tactics.

Tactics, the art of deploying and directing ones forces, must always be adapted to the situation. Thus, the tactics published in Naval Warfare Publications and other instructions or publications are intentionally general. It is left up to the individual detachment Officer In Charge to

determine appropriate tactics to achieve the objective.

(3.) Support Requirements.

Support requirements for an EOD detachment are directly dependent upon the employed tactics. Thus, support must be as flexible as tactics. The detachment's fly-away equipment list is all-encompassing and designed to provide adequate material support for whatever situation is present. Under known circumstances, this list can be tailored to provide only that material which is required. Experienced EOD personnel can identify "must have" items, items which can be prestaged aboard the MCM-1 vessels, and items which should be left behind. They can also judge the feasibility of using the MCM-1 and her support facilities for conducting EOD operations.

(4.) Integrating tactical use of EOD forces and ROV availability.

The development of the ROV has significantly impacted the employment of EOD divers. Specific procedures for the employment and coordination of ROV and EOD assets are still developing.

(5.) Alternate manning plans.

U.S. Navy EOD forces are employed as a labor pool, attached to MCM platforms only on an as-needed basis. This necessitates the concept of integrated tactics. Foreign MCM forces, however, have EOD divers as integral members of each platform. The feasibility of redefining U.S. manning

procedures along these lines is a possible variable which was explored.

Instruments

Interviews

The researcher investigated the aforementioned variables by interviewing individuals involved with U.S. mine warfare forces. Persons interviewed include:

1. Commanding Officers and Prospective Commanding Officers of MSO and MCM ships.
2. EOD detachment Officers In Charge, and other detachment members.
3. Representatives of Mine Warfare Command, Mine Group One, and other U.S. Navy commands involved in mine warfare.
4. Quality assurance and technical experts from the Supervisor of Shipbuilding staff.
5. Project managers and engineers from the shipyard.

Interviewees are referenced throughout the text only if they have agreed to such representation.

Survey

A written survey was used to gain an appreciation of how well EOD/MCM integrated tactics are understood and

practiced throughout the U.S. Navy's mine warfare community. The survey was distributed to all Commanding Officers, Officers in Charge, and mine warfare staff members involved in mine warfare. It was also distributed to many ships which normally are not involved with mine warfare but were identified during the literature review as possible support platforms for an EOD mine countermeasures detachment, and also to EOD commands not specializing in mine countermeasures. The chosen survey population was purposely diverse in order to gain an appreciation for the level of knowledge and opinions throughout the mine warfare community concerning integrated mine warfare tactics involving EOD detachments. The survey is provided in Appendix B. A list of commands to which the survey was distributed, and from which responses were received, is provided in Appendix C. Statistical results from the survey responses is provided in Appendix D.

Scope and Limitations

This study strived to define an effective and feasible relationship for the tactical employment of EOD forces aboard the MCM-1 Class vessels. The results of this study are also applicable to other U.S. mine warfare vessels (MSO, MSB, MCH, and COOP) even though each platform provides different support levels for EOD operations. This methodology could

also be applied to the future design and construction of mine warfare vessels.

Assumptions

It is assumed that the MCM-1 Class ship construction program will continue until its intended goal of fourteen ships is attained, despite large cost overruns and numerous delays.

CHAPTER IV

FINDINGS

This chapter discusses the results of interviews with personnel involved with mine countermeasures, and the statistical results of the mine warfare survey distributed for this study. Several predominant attitudes were discovered and will be explained throughout the chapter in sufficient detail to support the study's conclusions presented in Chapter V.

EOD'S MCM Role

This study's literature review provided the justification to state that the Navy's EOD community has a legitimate role within mine countermeasures strategy. EOD is the Navy's only asset which can perform all aspects of mine countermeasures. They are also the only means the U.S. Navy has of exploiting foreign ordnance for intelligence gathering. This study's survey was employed to analyze the opinions of the mine warfare community concerning the research questions presented in Chapter III. Several comments recorded on the survey reiterated the importance of the EOD community's role within mine warfare. The following comments reflect prominent viewpoints of the EOD community on this study's research questions.

The first research question concerned the support provided by the MCM-1 Class ships for an EOD detachment. A senior petty officer from EOD Group Two (Detachment Crane, ID) stated that "EOD and the mine warfare ships need each other to effectively operate in mine countermeasure [environments]." This claim is representative of the survey results which revealed that 82% of the responding EOD community believe mine warfare vessels should be designed to provide EOD support. (Appendix D)

The second research question sought to define the EOD community's role within mine warfare. A senior officer of EOD Technical Evaluation Unit One believes that, "the primary

role of Navy EOD should be mine countermeasures, and that EOD should be fully integrated in all facets of the mine warfare community". This claim is supported by the survey's overall statistical results which showed that EOD divers are the preferred MCM asset over an ROV for recovering and exploiting mines, reacting to global crises and having flexibility to meet mission demands. (Appendix D)

The third research question investigated the effective integration of EOD and MCM forces. A chief petty officer EOD technician emphasized that, "the key is EOD and mine warfare working together". This opinion is endorsed by 77% of those survey respondents aboard ship's who responded that mine warfare vessels need to be designed to provide EOD support. (Appendix D)

EOD Aboard Mine Warfare Vessels

Current naval tactical doctrine calls for EOD deployment from minesweepers and the MCM-1 Class ships. This study's survey addressed this doctrine by asking respondents: "Do you believe mine warfare ships (MSO/MCM/MCH) should be designed to provide support for EOD detachments?" The responses were a solid "yes";

82% of the EOD community surveyed answered yes,

77% of ship and shore command personnel surveyed answered yes, and

72% of minesweeper crews surveyed answered yes. (Appendix D)

The MCM officer of the USS INFLICT (MSO-456) stated that "EOD needs to be on board", and the Commanding Officer of USS ILLUSIVE (MSO-448) describes EOD as a "valuable asset". These statistics and specific comments reflect a general acceptance fleetwide of the doctrine published in NWP 27-2A.

The support for current tactical doctrine is not unanimous, however. Several respondents and interview subjects expressed reservations about tactics which deploy EOD detachments aboard current mine warfare vessels. Two primary arguments have been offered against such tactics: (1) shipboard facilities are inadequate to support the personnel and material of an EOD detachment, especially regarding berthing, storage and work space, and (2) combining an EOD detachment and the MCM ship curtails the flexibility of each unit, allowing only one to be employed at a time. This is an inefficient use of both assets, and will be further explored later in this chapter (McFadden, Personal communication, June 1988).

The survey also addressed the adequacy of support currently provided aboard MCM vessels. Note that the survey did not ask what support should be provided, but rather simply asked for an evaluation of current conditions. The results were consistent for both EOD and shipboard personnel responding to the survey. Messing, communications and

navigational support were deemed adequate. Berthing, storage room and work space were deemed inadequate. (Appendix D)

So far this investigation has found that the mine warfare community generally supports the current tactics of deploying EOD detachments aboard mine warfare ships. It has also identified areas of support which are adequate and those which are not. The next step is to define the role of EOD while aboard mine warfare vessels and, consequently, the support that these vessels must provide the EOD detachment.

EOD versus ROV

Remotely operated vehicles are relative newcomers to mine warfare. Some individuals view them as EOD's successor, while others see them only as fragile, ineffective toys. It is important to compare ROV and EOD divers in order to judge which viewpoint is correct, if either, and further define the role of EOD in mine countermeasures.

EOD divers and ROV's have similar capabilities. They both can locally search for mine-like objects using their own sonars, both can visually identify mines and also destroy those mines. Each asset, though, has specific advantages over the other. EOD divers can recover and exploit mines for intelligence, a task which the ROV cannot perform. The ROV, on the other hand, can dive deeper and for longer times than EOD, and without any risk to personnel. Some ROV's have fly-

away capabilities, but the MCM-1 Class ROV is a permanent member of the MCM-1 Class ship's arsenal. Thus, this vehicle's response time to a world scene depends upon the ship's response time. EOD, however, has complete fly-away capabilities from two specialized MCM mobile units. The EOD community boasts that they can deploy anywhere anytime. In fact, EOD divers began MCM operations in the Persian Gulf before ROV's arrived, and 58% of all survey respondents believe EOD reacts faster than a ROV to a world crisis. (Appendix D) Thus EOD forces are generally more mobile and can react to a world crisis faster than ROV's.

The survey also asked respondents to compare the effectiveness of EOD divers against an ROV for specific mine countermeasures tasks. The results are summarized as follows.

An ROV is slightly favored for searching for and detecting mines. Forty-two percent of shipboard personnel surveyed favor a ROV over EOD, while seventeen percent favor EOD and forty-one percent see no advantage either way. Thirty-four percent of EOD personnel surveyed view each asset as equally capable, while twenty-four see EOD as superior, and thirty-three see ROV as superior. (Appendix D)

An ROV is unquestionably recognized as having deeper and longer operating limits than EOD divers. Seventy percent of shipboard personnel and eighty-four percent of EOD personnel surveyed responded that the ROV has superior

operating limits. (Appendix D)

EOD was rated slightly superior for mine identification. Thirty-five percent of shipboard personnel rated EOD superior over ROV, while thirty-six percent rated them equal. Sixty percent of EOD personnel rated EOD as superior, while twenty-five percent viewed them as equal. (Appendix D)

EOD is definitely more capable when neutralizing mines, recovering mines, exploiting mines, reacting to a global crisis, and being flexible, durable and dependable. Both EOD and shipboard survey respondents favored EOD in the above categories. (Appendix D) Numerous comments were received on surveys concerning the ineffectiveness of the ROV during mine countermeasures operations in the Persian Gulf in 1989. These comments were received from minesweep sailors and EOD divers alike. It should be noted, however, that the ROV deployed to the Persian Gulf is less capable than the ROV aboard the MCM-1 Class.

MCM tactics concerning the employment of ROV's and their coordination with EOD divers are rapidly evolving. Lieutenant Commander Leinster of the Navy's Mine Warfare Command explains that the emerging role for ROV's is the repetitive classifying and neutralizing of mines. This takes advantage of the vehicle's indefinite operating duration and depth. Meanwhile, EOD retains its intelligence gathering and exploitation role (Leinster, personal communication, May 6,

1988).

EOD Support Platforms

In order to judge the acceptability of the MCM-1 Class ships as EOD support platforms, the researcher sought to define the ideal characteristics of an EOD support platform through various interviews and survey questions. The survey results were as diverse as the population surveyed, with the predominate answer being that the respondents did not know which was the "best" EOD support platform. This result is attributed to a lack of experience of most survey respondents in integrated mine warfare tactics. Many EOD respondents are not familiar with ship capabilities, and many shipboard respondents are not familiar with EOD support requirements. Interviews with members of EOD Mobile Unit Six in Charleston, South Carolina, shortly after their return from Persian Gulf mine warfare operations, clearly defined an ideal EOD support platform.

EOD Mobile Unit Six team members demanded that the ideal EOD support platform would be dedicated solely for EOD use. It would have sufficient deck space to support the detachment's fly-away dive lockers and recompression chamber, provide sufficient stowage space, a crane or other means for rapidly and easily deploying the EOD zodiac boats, and a relatively low freeboard to reduce the dangers to personnel

when launching or recovering boats. It should also provide ample messing and berthing. Several team members, and also some minesweep sailors deployed to the Persian Gulf, identified the rented Kuwaiti tug used in the Persian Gulf as an excellent platform. It was dedicated to EOD, operated independent of minehunting MSO's, and had ample room for the Fly Away Dive Lockers, chamber, and EOD personnel (McFadden, Personal Communication, June 1988).

MCM-1 Class EOD Support

The AVENGER Class is required to be capable of supporting a temporarily assigned EOD detachment for MCM operations. The ship can provide an EOD detachment with adequate messing, but berthing can be provided only by displacing regular crew members. The MCM ships do not have sufficient deck space for either the EOD Fly Away Dive Locker or chamber, and storage space beyond the EOD locker is very limited.

MCM-1 Class EOD Locker

Table 1 listed the minimum shipboard space requirements for an embarked EOD detachment, and also indicated which requirements were satisfied aboard the MCM-1 Class ships. Note that there are serious space deficiencies aboard the

MCM-1 Class ships. Only one EOD locker is provided rather than the two spaces required, and considerable stowage and work space is lacking. Moreover, the MCM-1 Class ships have no deck space for a recompression chamber, which is not listed in Table 1 but is strongly recommended by Naval Warfare Publication 15-3. Finally, additional criticism has been levied on the MCM-1 Class because its gas piping system lacks certification.

FADL and Chamber

A dive to 120 feet has a no decompression time of thirteen minutes. This means that a diver has thirteen minutes between the moment he leaves the surface until he must begin ascending if he wants to avoid stopping for decompression on his way back to the surface. According to Chief Warrant Officer Wilson of EOD Mobile Unit Six, it takes an EOD diver using the MK 16 underwater breathing apparatus approximately seven minutes to reach a depth of 120 feet. Thus the diver has only six remaining minutes to perform his assigned task, and this frequently will be insufficient to perform an underwater MCM task. This means that as a general rule, EOD dives to or beyond 120 feet require decompression (Wilson, personal communication, May 1, 1989).

Decompression may take place in the water or in a chamber on the surface. Surface decompression is preferred,

especially when diving with a self contained underwater breathing apparatus (SCUBA) such as the MK 16, because this allows qualified people to attend the diver should any problems arise. Thus, there is a definite need for a chamber to support EOD dives.

The EOD community expects to allow dives beyond 190 feet in the near future, and these dives will absolutely require a chamber on station. The MCM ships do not provide sufficient deck space for the EOD fly away chamber, and therefore dives from the MCM-1 Class must be of limited depth and duration.

Gas System Certification

The EOD locker has installed piping which transfers breathing gases from storage flasks into the locker. The shipbuilder is required to clean and test this installed gas piping system; however, he is not required to certify it. Mr. Rup Warren of the Naval Sea Systems Command (Code OOC) stated that simple gas transfer systems, such as the one aboard the MCM-1 Class ships, do not require certification (Personal communication, March 11, 1989).

This lack of certification, however, is one of the EOD community's major arguments against the locker's acceptability. Lieutenant Neely of the USS AVENGER also complained about the lack of system certification, including

a lack of a Preventive Maintenance System (PMS), operating procedures, emergency procedures and reentry controls. Kathy McCaully, of the Supervisor of Shipbuilding, confirmed that none of these procedures exists (Personal communication, February 13, 1989). According to Lieutenant Commander Fraser of EOD Mobile Unit Six, the non-certified piping system is "not good" and should be investigated by the Naval Safety Center. It is interesting to note that the piping is not even necessary because EOD detachments have the equipment to hook up temporary gas lines to the gas storage flasks as needed. Finally, in the words of Lieutenant Commander Rodal of Mine Squadron One, the system is designed very poorly. It has gauges and valves exposed to the weather which makes them prone to failure and contamination.

Personnel Strategies

The U.S. Navy's personnel strategy regarding the deployment of EOD mine countermeasures forces is quite different from the approach taken by foreign mine countermeasures forces. The U.S. Navy keeps EOD as a labor pool assigned on an as-needed basis. The theory behind this strategy is that the EOD community possesses highly specialized skills which demand persistent concentration. Any non-EOD duties and responsibilities would negatively impact their preparedness, and therefore any duties which

distract from EOD training and proficiency must be kept to a minimum. Many foreign navies, on the other hand, have EOD divers assigned as full time members of MCM ships. This requires foreign EOD divers to perform many shipboard responsibilities in addition to their EOD responsibilities. These foreign MCM ships are designed to support all phases of EOD diving. Sufficient stowage space is afforded for a dive locker and recompression chamber, as well as personnel berthing and work spaces.

Several survey respondents called for the U.S. Navy to integrate the EOD community more fully into the mine warfare community as is done in many foreign navies. This request is at least partially satisfied by the U.S. Navy's young Special Operations Community which not only allows officers to specialize in diving, but specifically in both EOD and MCM. Theoretically, a Special Operations officer could spend his entire career switching between EOD and MCM billets. The enlisted EOD community, however, retains its specialization. The researcher regards the complete integration of this community into mine warfare ships, similar to the approach used in many foreign navies, as a major restructuring of the EOD community and beyond the scope of this study.

Tactics

Persian Gulf

Recent events in the Persian Gulf have redefined mine countermeasures tactics. What was written in naval warfare publications and based upon theory was tested under fire and adapted in order to get the job done. Two ad hoc work groups consisting of MCM forces returning from the Persian Gulf convened in Seattle on 17 January and 11 April 1989, and were tasked to record lessons learned from Persian Gulf operations and agree upon workable mine countermeasures tactics. The result of this work group will be published as tactical notes (TACNOTES) and as an updated naval warfare publication, neither of which have been printed as of this study's completion date.

Integrated Tactics

The literature review discussed several naval warfare publications which identified EOD detachments as an MCM asset, and MCM vessels as EOD support platforms. From a

strategic planner's viewpoint, the tactic of deploying EOD forces from a MCM vessel appears to be a logical, synergistic relationship. The MCM vessel locates mines using its sonar, then EOD divers neutralize the mine. Many operating forces, however, do not favorably view integrated tactics which deploy EOD divers from MCM vessels. Lieutenant Neely of the USS AVENGER stated that the MCM vessels are poor diver support crafts, and embarking an EOD detachment wastes the vessel's mine hunting capabilities. Once divers are deployed, the MCM will be forced to back off into a safe stand-off distance where she cannot interfere with the divers or cause bodily harm through sonar transmissions. This is an inefficient use of the U.S. Navy's most capable mine hunter (Neely, personal communication, December 8, 1988). Senior Chief McFadden, an EOD technician with EOD Mobile Unit Six, agrees with Lieutenant Neely. When EOD detachments are deployed aboard mine warfare vessels, each asset must operate in turn. While divers are investigating mine-like objects, the mine warfare vessel must stand off. While the mine warfare vessel searches for mines with its sonar, the EOD divers must either be out of the water or at a safe distance as specified by Naval Warfare Publication 15-3.

Divers could remain clear of the sonar transmissions by using their inflatable zodiac boat to approach previously marked mine areas. However, these boats are not intended for extended operations. Divers kept aboard these boats all day

would be severely fatigued and have reduced diving abilities. Ideally, the divers would frequently return to a larger support ship with their zodiac boat. This would allow the divers to rest aboard a more stable platform between dives and also receive better personnel support: food, berthing, supervision, etc,. This large support ship would also support a recompression chamber. Returning the zodiac and divers to MCM-1 Class ships is not desired because of the relative difficulty and danger of deploying and recovering boats, in addition to the previously addressed shortages in personnel support. Lieutenant Commander Rodal, an EOD officer stationed at Mine Squadron Two, advocates the use of a dive support platform independent of the minehunting ship because this would allow each asset to concentrate on its specialty. The MCM-1 Class ship would hunt for mines while EOD would destroy previously located and marked mines (Rodal, personal communication, May 5, 1988).

Costs

The costs of constructing the EOD locker has been estimated by the Marinette Marine Corporation at $16,658.65. This total cost is itemized in Table 2.

EOD LOCKER COSTS

Material

Piping	12,464.00
Cylinders	506.65
Work table and shelving	1,000.00
Safe	863.00
Oxygen monitoring system	1,265.00
Oxygen detector system	310.00
Low pressure air connection	250.00
TOTAL	$16,658.65

TABLE 2

CHAPTER V

DISCUSSION

This study has investigated integrated mine warfare tactics involving EOD mine countermeasures divers and mine warfare vessels, specifically the MCM-1 Class ships. This final chapter presents the researcher's conclusions and recommendations.

EOD Role in MCM

The EOD community has a significant and undeniable role in mine countermeasures operations. Unfortunately, there is a lack of understanding between the EOD community and mine warfare ships concerning each other's capabilities and limitations, and this prevents a smooth integration of MCM assets. This communication gap could be partially bridged by allowing Special Operations officers to specialize in MCM and EOD. It could be further alleviated by requiring regular training exercises with an EOD detachment embarked aboard an MCM vessel at least semi-annually.

Strategy

Support

Persian Gulf operations demonstrated that the ideal support platform for an EOD detachment employed in large MCM operations is an independent craft dedicated for EOD use. This allowed the maximum utilization of both minehunting vessels and EOD divers. This doctrine favors the continued specialization of EOD apart from the mine warfare community, but does not invalidate the requirements for mine warfare ships to support an EOD detachment. Smaller MCM operations may best be performed by embarking an EOD detachment aboard the MCM-1 Class ships due to the synergistic relationship between EOD and mine warfare ships. Tactical planners should continue to recognize mine warfare vessels as potential EOD support platforms, and emphasize that this will be a primary mission assignment for the ship. Additionally, future mine warfare ship designs should recognize this relationship and include complete EOD support capabilities.

Personnel Strategy

The researcher recognizes the highly skilled profession of EOD and does not question the concentration necessary to maintain competence. Nevertheless, this researcher did discover that this specialization of the EOD community has created a communication and coordination gap between EOD and other mine warfare personnel. This gap must be reduced in order to maximize effectiveness in mine warfare operations. A career path allowing officers in the U.S. Navy's Special Operations community to rotate between EOD and MCM billets could help alleviate this communication gap. Therefore, it is not recommended that enlisted EOD divers become permanent members of mine warfare ships, but rather that they maintain their explosive ordnance specialization.

Tactics

Tactical Doctrine

The U.S. Navy cannot afford to ignore the lessons learned about mine countermeasures operations in the Persian Gulf. The education gained from this hands-on experience is currently being documented and needs to be distributed to all mine warfare participants. This new doctrine should become a

foundation upon which EOD and other mine warfare assets can establish cooperative and coordinated operational procedures. The goal should be the integration of multiple MCM assets into one mutually recognized tactical doctrine.

ROV and EOD

Developing tactical doctrine must recognize the specific strengths and weaknesses of ROV's and EOD divers. A logical division of tasks would utilize the ROV for repetitive search, detect and destroy missions, while EOD divers perform exploitations, recovery and any unusual destructions.

MCM-1 Class

Achieving the Assigned Tactical Mission

The MCM-1 Class ships' EOD support facilities are sufficient to support an EOD detachment as required by the Required Operational Capabilities and naval warfare publications. This support, however, is minimal. The MCM-1 Class ships cannot support an EOD detachment's fly away material, including a recompression chamber. Therefore, the

EOD detachment must tailor its equipment inventory to match the specific mission and MCM-1 Class ship. The following support can be provided aboard each AVENGER Class ship:

(1) personnel messing and berthing,

(2) confidential storage for publication and instructions, limited to one small safe, but EOD will also have access to the ship's instruction inventory,

(3) no stowage for EOD zodiacs, so EOD would use MCM-1 Class ship's semi-rigid hull boats,

(4) minimal stowage for EOD explosives,

(5) dedicated work space in the EOD locker, and,

(6) helium and oxygen supply.

Operational Doctrine

The AVENGER Class ships need a specific operational doctrine which explains the ship's capabilities and limitations for supporting an embarked EOD detachment. Ideally, one MCM officer from one MCM-1 Class ship should interface with the MCM specialists at EOD Mobile Unit Six in Charleston, South Carolina to develop a standardized doctrine for all MCM-1 Class ships. This doctrine should address specific procedures for supporting personnel and conducting operations. It should provide specific dimensions of available work and storage space, address what material has been previously staged, and provide detailed operating

procedures for the Gas Transfer System aboard MCM-1 Class ships. These operating procedures should address valve alignment, safety checks, gauge parameters, start-up, shut-down, maintenance, system reentry, and emergency procedures. The MCM officer aboard each MCM-1 Class ship should be responsible for ensuring this doctrine is appropriately tailored to coordinate with local EOD mobile units.

Limitations

As a result of previously discussed shortcomings with the MCM-1 Class EOD locker, operations embarking an EOD detachment on board should be limited to 72 hours. Dives from the MCM-1 Class should be limited to a safe working depth which should not involve decompression because a recompression chamber is unavailable for either emergency medical treatment or surface decompression.

Alterations to the MCM-1 Class Ships

Current EOD facilities aboard the MCM-1 Class ships provide adequate support for temporary assignments and for limited depths. Long term or deep diving operations must be performed from a separate support craft. The researcher recommends the following actions to create a tactically effective EOD locker:

(1) update the Weapon Systems File and Consolidated Shipboard Allowance List to provide spare part support for the Bacharach model oxygen analyzer (researcher has submitted allowance change request),

(2) add preventative maintenance for the oxygen analyzer (requested by researcher),

(3) remove helium and oxygen hard piping between gas storage flasks and EOD locker. This eliminates any discussion concerning system certification, while supply flasks are still usable with temporary charging whips. Otherwise, require that the Navy Safety Center review the EOD locker Gas Transfer System for certification requirements. If deemed necessary, each shipyard should be required to complete system certification requirements prior to ship delivery. Additionally, ships would have to be added to the Navy's gas testing program. The MCM officer and engineer officer of each MCM-1 Class ship would ensure that each ship has adequate shipboard instructions addressing reentry control procedures and maintenance of the certified gas system.

(4) add a ship's telephone to space as required by NWP 15-3 (Researcher submitted work request), and

(5) add carbon dioxide fire extinguisher to space.

Costs

The costs invested in the MCM-1 Class EOD locker will be justified if regular embarkation training occurs.

Summary of Recommendations

1. Supporting an embarked EOD detachment is a valid mission for all mine countermeasures ships.
2. Require EOD embarkation training aboard MCM-1 Class ships at least semi-annually.
3. Enlisted EOD personnel should maintain their specialization, but Special Operations community officers should be encouraged to pursue MCM/EOD career paths.
4. Developing tactical doctrine should recognize the synergistic relationship between EOD divers and mine countermeasures ships, and a division of tasks between EOD and ROV.
5. An EOD detachment embarked to a MCM-1 Class ship must tailor its equipment inventory to match the specific mission and ship.
6. A standardized EOD detachment support doctrine should be developed for the MCM-1 Class ships.
7. EOD operations from a MCM-1 Class ship should be limited to 72 hours and no decompression dives.
8. Spare parts support and preventative maintenance is required for the EOD locker's oxygen analyzer.

9. EOD locker gas transfer piping should be removed from MCM-1 Class ships.

10. Add a fire extinguisher and telephone to the MCM-1 Class ships' EOD locker.

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APPENDIX A

GLOSSARY

ATP — Allied Tactical Publication.

Billet — A job or appointment.

CNO — Chief of Naval Operations. Highest ranking U.S. Naval officer.

Detailer — Individual responsible for assigning members to open billets.

DSS — Deep Submergence System. Includes diver life support systems.

ECN — Engineering Change Notice. A modification to the shipbuilding contract.

EOD — Explosive Ordnance Disposal. Any process of disposing or handling explosive ordnance.

EOD DET — EOD detachment. Four to six man team assigned to specific operations.

EOD GRU — EOD Group. Major EOD command which oversees several EOD mobile units.

EOD MU — EOD Mobile Unit. Minor EOD command composed of several EOD detachments.

Exploitation — Disarming and dismantling recovered underwater mines to gather military intelligence.

FADL — Fly Away Dive Locker.

Integrated tactics — Multiple assets or forces allied against a common enemy.

MCM — Minecountermeasures. Any method of removing or reducing the danger from mines.

Mine — The conventional naval or sea mine is defined as an explosive device designed to be planted in the water and actuated when a target enters its damage area.

Minesweeping Mechanical: The mine clearance procedure by which mines are cut or dragged from their moorings. In the process, the mines may be detonated or damaged through physical contact between the sweep gear and the mine or its attachments.

Influence: The mine clearance procedure which provides the appropriate influence field (acoustic or magnetic) to cause the detonation of influence mines through the actuation of their firing mechanisms.

Mine hunting The mine countermeasures procedure which locates an individual mine and concentrates on it.

MSO Ocean going Minesweeper.

NWP Naval Warfare Publication.

POE Potential Operating Environment.

PSOB Pre-Survey Outline Booklet. Detailed checklist which lists requirements for recordable evidence for certification.

Reentry controls — Restrictions on doing maintenance on a certified system.

RFP — Request For Proposal. Request to initiate a change to the shipbuilding contract.

ROC — Required Operational Capabilities.

ROV — Remotely Operated Vehicle.

SCA — System Certification Authority.

Scope — Regarding system certification. A list of those systems required to ensure and preserve the safety and well being of its operators.

Ship specifications — Shipbuilding contract.

Tactics — Art of directing and deploying one's forces against the enemy.

TLR — Top Level Requirements. Specific ship capabilities based upon the ROC & POE.

UBA Underwater Breathing Apparatus.

Zodiac A small rubber boat equipped with an outboard motor.

APPENDIX B

SURVEY

Introduction

This survey concerns your experience and opinions of EOD involvement in mine warfare operations. The survey's results will provide a database which will be used to define the use of EOD facilities aboard the MCM-1 Class ships. All responses will remain anonymous.

Individual background

Rank:_____ Command:_____

Current billet:_____

Yrs of mine warfare experience:_____

EOD trained? Y or N

EOD/Mine Warfare operations

1. How many times have you participated in operations deploying an EOD detachment aboard a mine warfare ship?
   a. 0 (Skip question #2)
   b. 1-10
   c. 11-25
   d. 26 or more

2. Concerning past operations with EOD detachments aboard mine warfare ships, was the EOD team provided sufficient support (as categorized below) to perform their mission?
   a. messing Y N
   b. berthing Y N
   c. storage space Y N
   d. work space Y N

e. communications Y N

f. navigation Y N

g. Comments or noted discrepancies:_____

_____

3. In your opinion, how do the following ships rate as an overall support platform for an EOD detachment?

(Circle your answer; Good, Adequate, Poor, or Unknown)

a.	MSO	G	A	P	U
b.	MCM	G	A	P	U
c.	TATF	G	A	P	U
d.	LCM/LCU	G	A	P	U
e.	COOP	G	A	P	U
f.	ATS	G	A	P	U
g.	ARS	G	A	P	U
h.	ASR	G	A	P	U
i.	FFG	G	A	P	U

4. What is the best EOD support platform? _____

5. In your opinion, what is the effectiveness for mine warfare operations of an EOD Mine Countermeasures Detachment compared to an remotely operated vehicle (ROV)?

Circle your answers as follows:

1 = EOD more effective than ROV
2 = EOD and ROV equally effective
3 = EOD less effective than ROV

a.	Search and detect	1	2	3
b.	Identify	1	2	3
c.	Neutralize mines	1	2	3
d.	Recover mines	1	2	3
e.	Exploit mines for intel	1	2	3
f.	Global reaction time	1	2	3
g.	Durability	1	2	3
h.	Dependability	1	2	3
i.	Operating limits (depth/time)	1	2	3
j.	Flexibility/adaptability	1	2	3

6. Do you believe mine warfare ships (MSO/MCM/MCH) should be designed to provide support for EOD Detachments?
Y or N

comments:

Thank you for your time and cooperation.

APPENDIX C

SURVEY DISTRIBUTION LIST

COMMAND	QUANTITY SENT	QUANTITY RECEIVED
1. USS ADROIT (MSO509)	7	R/2
2. USS AFFRAY (MSO 511)	7	
3. USS AVENGER (MCM-1)	7	R/2
4. USS BOLSTER (ARS 38)	7	R/5
5. USS BRUNSWICK (ATS 3)	7	
6. USS CONQUEST (MSO 488)	7	R/5
7. USS CONSERVER (ARS 39)	7	R/6
8. USS CONSTANT (MSO 427)	7	R/5
9. DEFENDER PRECOMMISSIONING	10	R/10
10. USS ENGAGE (MSO 433)	7	R/7
11. USS ENHANCE (MSO 437)	7	R/3
12. USS ESTEEM (MSO -438)	7	
13. USS EXCEL (MSO 439)	7	R/8
14. USS EXPLOIT (MSO 440)	7	R/4
15. USS EXULTANT (MSO 441)	7	R/5
16. USS FEARLESS (MSO 442)	7	R/6
17. USS FIDELITY (MSO 443)	7	DECOMMISSIONED
18. USS FLORIKAN (ASR 9)	7	R/1
19. USS FORTIFY (MSO 446)	7	R/5
20. USS GALLANT (MSO 489)	7	R/4
21. USS GRAPPLE (ARS 53)	7	
22. USS GRASP (ARS 51)	7	
23. USS HOIST (ARS 40)	7	R/1
24. USS ILLUSIVE (MSO 448)	7	R/7
25. USS IMPERVIOUS (MSO 449)	7	R/4
26. USS IMPLICIT (MSO 455)	7	R/4
27. USS INFLICT (MSO 456)	7	R/2
28. USS KITTIWAKE (ASR 13)	7	R/4
29. USS LEADER (MSO 490)	7	R/7
30. USS OPPORTUNE (ARS 41)	7	R/5
31. USS ORTOLAN (ASR 22)	7	R/1

32. USS PAIUTE (ATF 159) 7
33. USS PAPAGO (ATF 160) 7 R/1
34. USS PETREL (ASR 14) 7 R/5
35. USS PIGEON (ASR 21) 7 R/1
36. USS PLEDGE (MSO 492) 7
37. USS PLUCK (MSO 464) 7 R/2
38. USS PRESERVER (ARS 8) 7 R/7
39. USS RECLAIMER (ARS 42) 7 R/1
40. USS RECOVERY (ARS 43) 7 R/7
41. USS SAFEGUARD (ARS 50) 7 R/5
42. USS SALVOR (ARS 52) 7 R/4
43. USS SUNBIRD (ASR 15) 7
44. CINCLANTFLT 1 R/1
45. COMNAVSURFLANT 1
46. COMINEWARCOM 10 R/5
47. MOBDIVSALU 5 R/3
48. CONSOLIDATED DIVER'S UNIT 5 R/3
49. MINE WARFARE INSP GRP 10 R/3
50. COMEODGRU2 7 R/1
51. EODMU2 5 R/5
52. EODMU4 5 R/6
53. EODMU6 10
54. EOD T/E UNIT TWO 5 R/4
55. EODGRUTWO DET BERMUDA 5
56. EODGRUTWO DET BRUNSWICK 5 R/1
57. EODGRUTWO DET CECIL FIELD 5
58. EODGRUTWO DET CRANE 5 R/4
59. EODGRUTWO DET DAHLGREN 5 R/2
60. EODGRUTWO DET EARLE 5 R/3
61. EODGRUTWO DET GUANTANAMO BY 5 R/3
62. EODGRUTWO DET KEFLAVIK 5
63. EODGRUTWO DET KEY WEST 5
64. EODGRUTWO DET KINGS BAY 5 R/3
65. EODGRUTWO DET MAYPORT 5
66. EODGRUTWO DET NEWPORT 5 R/5
67. EODGRUTWO DET NORFOLK 5 R/4
68. EODGRUTWO DET PANAMA CITY 5 R/2
69. EODGRUTWO ROOSEVELT ROADS 5
70. EODGRUTWO DET ROTA 5 R/1
71. EODGRUTWO DET SIGONELLA 5 R/4
72. EODGRUTWO DET ST MAWGAN 5
73. EODGRUTWO DET YORKTOWN 5 R/2
74. EODGRUONE 5 R/5
75. EODMUONE 5 R/7
76. EODMUTHREE 10 R/7
77. EODMUFIVE 5
78. EOD T/E UNIT ONE 5 R/5
79. EODGRUONE DET ADAK 5 R/2
80. EODGRU ONE DET ALAMEDA 5
81. EODMU NINE DET BANGOR 5 R/1
82. EODMU THREE DET CHINA LAKE 5 R/3

83. EODGRU ONE DET CONCORD 5
84. EODGRU ONE DET FALLON 5 R/1
85. EODMU FIVE DET GUAM 5
86. EODGRU ONE DET KEYPORT 5 R/3
87. EODMU THREE DET PT MUGU 5 R/1
88. EODMU FIVE DET YOKOSUKA 5
89. MINERONTWO 7 R/1
90. MINEGRUONE 7 R/1
91. COOPRON22 5 R/1
92. COOPRON 11 5
93. COMSUPPRON2 5

NOTE: ALL SURVEYS WERE ORIGINALLY MAILED ON 17 JUNE 1989

PERCENT RESPONSE = 73%

APPENDIX D

SURVEY STATISTICAL RESULTS

EOD

RANK
0-4 AND ABOVE = 10%
0-1 TO 0-3 = 30%
CWO1 TO 4 = 10%
E-7 TO E-9 = 34%
E-4 TO E-6 = 15%
E-4 AND BELOW = 00%

YEARS OF EXPERIENCE
0 = 12%
1-2 = 18%
3-4 = 19%
5-6 = 13%
7-8 = 10%
9-10 = 02%
11-12 = 03%
13-14 = 06%
15-16 = 05%
17-18 = 03%
19 PLUS = 07%

EOD TRAINED
YES = 100% NO = 0%

PARTICIPATION IN EOD OPS
0 = 22%
1 TO 10 = 52%
11 TO 25 = 12%
26 OR MORE= 13%

SUPPORT ADEQUATE ABOARD MCM PLATFORM
MESSING YES = 86% NO = 12% U= 02%
BERTHING YES = 34% NO = 63% U= 03%
STORAGE YES = 01% NO = 96% U= 03%
WORK SPACE YES = 17% NO = 81% U= 02%

COMMUNICATIONS	YES = 65%	NO = 33%	U= 02%
NAVIGATION	YES = 72%	NO = 23%	U= 05%

PLATFORM RATINGS

MSO	G = 10%	A = 28%	P = 48%	U = 14%
MCM	G = 09%	A = 18%	P = 09%	U = 65%
TATF	G = 12%	A = 21%	P = 11%	U = 56%
LCM/LCU	G = 18%	A = 32%	P = 27%	U = 22%
COOP	G = 14%	A = 18%	P = 11%	U = 58%
ATS	G = 14%	A = 21%	P = 13%	U = 52%
ARS	G = 16%	A = 33%	P = 15%	U = 35%
ASR	G = 10%	A = 30%	P = 13%	U = 47%
FFG	G = 07%	A = 09%	P = 30%	U = 55%

BEST EOD PLATFORM

MSO = 05%	UNKNOWN = 22%	MHC = 00%
MCM = 08%	ARS = 06%	AMPHIB = 03%
CV = 00%	LCU = 13%	FFG = 01%
TUG = 06%	TATF = 06%	SM BOAT = 02%
ASR = 00%	ATS = 05%	DEDICATED= 06%
COOP= 12%	DD/DDG = 02%	BUOY TND = 02%
MISSION DEPENDENT = 03%		

ROV VS EOD

SEARCH & DETECT	EOD= 24%	SAME= 34%	ROV= 33%	U= 09%
IDENTIFY	EOD= 60%	SAME= 25%	ROV= 09%	U= 06%
NEUTRALIZE	EOD= 41%	SAME= 38%	ROV= 13%	U= 09%
RECOVER	EOD= 68%	SAME= 20%	ROV= 03%	U= 09%
EXPLOIT	EOD= 85%	SAME= 03%	ROV= 04%	U= 08%
REACTION	EOD= 65%	SAME= 21%	ROV= 04%	U= 10%
DURABILITY	EOD= 61%	SAME= 15%	ROV= 14%	U= 10%
DEPENDABILITY	EOD= 74%	SAME= 14%	ROV= 04%	U= 08%
OP LIMITS	EOD= 02%	SAME= 02%	ROV= 84%	U= 12%
FLEXIBILITY	EOD= 75%	SAME= 12%	ROV= 02%	U= 10%

SHOULD MCM PLATFORMS PROVIDE SUPPORT?

YES = 82%	NO = 14%	UNKWN = 04%

WORK SPACE	YES = 46%	NO = 51%	U= 03%
COMMUNICATIONS	YES = 92%	NO = 04%	U= 04%
NAVIGATION	YES = 83%	NO = 06%	U= 11%

PLATFORM RATINGS

MSO	G = 16%	A = 24%	P = 43%	U = 17%
MCM	G = 23%	A = 17%	P = 11%	U = 50%
TATF	G = 20%	A = 17%	P = 05%	U = 59%
LCM/LCU	G = 09%	A = 20%	P = 20%	U = 51%
COOP	G = 03%	A = 13%	P = 15%	U = 69%
ATS	G = 26%	A = 20%	P = 07%	U = 47%
ARS	G = 30%	A = 26%	P = 07%	U = 37%
ASR	G = 27%	A = 21%	P = 08%	U = 43%
FFG	G = 07%	A = 19%	P = 18%	U = 55%

BEST EOD PLATFORM

MSO = 07%	UNKNOWN = 30%	MHC = 01%
MCM = 12%	ARS = 13%	AMPHIB = 04%
CV = 01%	LCU = 02%	FFG = 02%
TUG = 09%	TATF = 07%	AE = 01%
ASR = 04%	ATS = 05%	IND = 01%
MISSION DEPENDENT = 02%	DD/DDG = 01%	

ROV VERSUS EOD

SEARCH & DETECT	EOD= 17%	SAME= 24%	ROV= 42%	U= 17%
IDENTIFY	EOD= 35%	SAME= 36%	ROV= 13%	U= 17%
NEUTRALIZE	EOD= 60%	SAME= 20%	ROV= 05%	U= 17%
RECOVER	EOD= 71%	SAME= 07%	ROV= 06%	U= 15%
EXPLOIT	EOD= 69%	SAME= 14%	ROV= 02%	U= 16%
REACTION	EOD= 50%	SAME= 20%	ROV= 12%	U= 15%
DURABILITY	EOD= 49%	SAME= 11%	ROV= 22%	U= 18%
DEPENDABILITY	EOD= 57%	SAME= 17%	ROV= 10%	U= 17%
OP LIMITS	EOD= 09%	SAME= 14%	ROV= 70%	U= 16%
FLEXIBILITY	EOD= 53%	SAME= 18%	ROV= 13%	U= 17%

SHOULD MCM PLATFORMS PROVIDE SUPPORT?

YES = 77% NO = 17% UNKWN = 07%