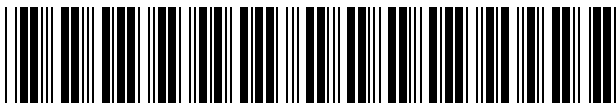


**U.S. NAVY
U.S. MARINE CORPS**

**NWP 3-15
MCWP 3-3.1.2**

MINE WARFARE

**DEPARTMENT OF THE NAVY
OFFICE OF THE CHIEF OF NAVAL OPERATIONS AND
HEADQUARTERS U.S. MARINE CORPS**



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DEPARTMENT OF THE NAVY
NAVAL DOCTRINE COMMAND
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August 1996

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Mine Warfare

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List of Acronyms/Abbreviations

A

AAW. Antiair warfare

ACMPM. Analytic Countered Minefield Planning Model

ADCON. Administrative control

AFV. Armored fighting vehicle

AG. Armament groups

AHP. Allied navigation publication

AIMD. Aircraft intermediate maintenance department

AMC. Air Mobility Command

AMCM. Airborne mine countermeasures

AMW. Amphibious Warfare

AOA. Amphibious operations area

ARG. Amphibious ready group

ASD. Area Search Detachment

ASUW. Antisurface warfare

ASW. Antisubmarine warfare

ASWC. Antisubmarine warfare commander

ATF. Amphibious task force

ATP. Allied tactical publication

B

BF. Battle force

BFTT. Battle force tactical training

BT. Bathythermograph

C

CAPTOR. EnCAPsulated TORpedo

CATF. Commander amphibious task force

CCM. Counter countermeasure

CD-ROM. Compact disc-read only memory

CIC. Combat information center

CINC. Commander in chief

CINCLANT FLT. Commander in chief, U.S. Atlantic fleet

CINCPACFLT. Commander in chief U.S. Pacific fleet.

CINCUSNAVEUR. Commander in chief U.S. Naval forces, Europe

CLF. Commander landing force

CMPM. Countered minefield planning model

COASTSYSTA. coastal systems stations

COMINEWARCOM. Commander, Mine Warfare Command

COMOMAG. Commander Mobile Mine Assembly Group

COMSUBDEVRON. Commander, Submarine Development Squadron

COMUSMARDEZLANT. Commander, U.S. Maritime Defense Zone, Atlantic

COMUSMARDEZPAC. Commander, U.S. Maritime Defense Zone, Pacific

CONUS. Continental United States

COOP. Craft of opportunity

CRRC. Combat rubber raiding craft

CTDA. Commander's Tactical Decision Aid

CUDIX. Common user digital information exchange

CV. Aircraft carrier

CVBG. Aircraft carrier battle group

CWC. Composite warfare commander

C2W. Command and control warfare

C4I. Command, control, communications, computers,
and intelligence

D

DAMA. Demand assigned multiple access

DEA. Defense exchange agreement

DELTA. Delivery tactic

DEU. Diver evaluation unit

DIA. Defense Intelligence Agency

DMS. Deep moored sweep

DST. Destructor

E

EMI. Electromagnetic interference

ENWGS. Enhanced naval wargaming system

EOD. Explosive ordnance disposal

EODMCM. Explosive ordnance disposal mine
countermeasures

EODMU. Explosive ordnance disposal mobile unit

ET. Exercise and training

F

FADL. Fly away diving locker

FAMP. Forward area minefield planner

FARC. Fly away recompression chamber

FASCAM. Family of scatterable mines

FLTCINC. Fleet commander in chief

FMWC. Fleet Mine Warfare Center

FPB. Fast patrol boat

FSMTP. Fleet service mine test program

FSU. Fleet support unit

G

GPS. Global positioning system

GRP. Glass reinforced plastic

H

HF. High frequency

I

ICDP. Intercount dormant period

IDMS. Improved deep moored sweep

IEG. Information exchange groups

ILDP. Interlook dormant period

IOC. Initial operational capability

ISIC. Immediate senior in command

IWDM. Intermediate water depth mine

J

JMCIS. Joint Maritime Command Information
System

L

LCAC. Landing craft air cushion

LOS. Line of sight

LP. Live period

LSM. Littoral sea mine

LSS. Life support skid

M

MARDEZ. Maritime defense zone

MCAC. Multipurpose craft air cushion

MCD. Mobile communications detachment

MCCDC. Marine Corps Combat Development Command

MCM. Mine countermeasures

MCMTA. MCM tasking authority

MCMV. Mine countermeasures vehicle

MCS. Mine countermeasures command and support ship

MDA. Mine danger area

MEDAL. Mine Warfare Environmental Decision Aids Library

MEDEVAC. Medical evacuation

MFPF. Minefield planning folder

MHC. Mine hunter coastal

MICFAC. Mobile integrated command facility

MIO/LEO. Maritime interdiction operations/law enforcement operations

MILC. Minelike contact

MILVAN. Military owned demountable container

MIUW. Mobile inshore underwater warfare

MIW. Mine warfare

MIWC. Mine warfare coordinator

MMF. Mobile maintenance facility

MMS. Marine mammal system

MNS. Mine neutralization system

MNV. Mine neutralization vehicle

MOE. Measure of effectiveness

MOGAS. Motor gasoline

MOMAG. Mobile mine assembly group

MOP. Magnetic orange pipe

MPA. Maritime patrol aircraft

MPO. Minefield performance objective

MPSRON. Maritime Pre-positioning Squadron

MRCI. Mine warfare readiness certification inspection

MRN. Mine reference number

MSB. Minesweeper boat

MSC. Minesweeper coastal

MSF. Magnetic silencing facility

MSI. Min sweeper inshore

MSO. Minesweeper ocean

MSS. Mine search squadron

MSU. Mine search unit

MWES. Mine warfare environmental survey

MWWP. Mine warfare working party

N

NATO. North Atlantic Treaty Organization

NAVIPO. Navy International Programs Office

NAVOCEANO. Naval Oceanographic Office

NAVSPECWAR. Navy Special Warfare Command

NCA. National Command Authorities

NDC. Naval Doctrine Command

NMIC. National Maritime Intelligence Center

NOD. Night observation device

NOMBO. Nonminelike bottom object

NRF. Naval Reserve Force

NSAP. Navy Science Assistance Program

NSW. Navy special warfare

NTIC. Navy Tactical Information Compendium

NUWC. Naval Underwater Warfare Center

O

OCD. Ordnance clearance detachment
ONR. Office of Naval Research
OOD. Officer of the deck
OPAREA. Operations area
OPCON. Operational control
OPDEC. Operational deception
OPLAN. Operation plan
OPSEC. Operations security
OPTASK. Operational tasking message
OPTEVFOR. Operational Test and Evaluation Force
OTC. Officer in tactical command
OTCIXS. Officer in tactical command information exchange system

P

PAC. Probability actuation circuit
PEO MINEWAR. Program Executive Officer, Mine Warfare
PERSTEMPO. Personnel tempo of operations
PG. Project group
PINS. Precise Integrated Navigation System
PMO. Program management office
PMS. Planned maintenance system
PMT. Performance Monitoring Team

R

RDT&E. Research, development, test and evaluation
RECO. Remote control
RHIB. Rigid hull inflatable boat
ROE. Rules of engagement

ORIGINAL

RO/RO. Roll on/roll off
ROV. Remotely operated vehicle
RSP. Render safe procedure

S

SACLANT. Supreme Allied Commander Atlantic
SAM. Self-propelled acoustic magnetic vehicle
SAR. Search and rescue
SATCOM. Satellite communications
SEAL. Sea air land (Navy Special Warfare force nickname)
SIMA. Shore Intermediate Maintenance Activity
SLMM. Submarine launched mobile mine
SLOC. Sea line of communication
SMCM. Surface mine countermeasures
SMCMV. Surface mine countermeasures vehicle
SOA. Speed of advance
STW. Strike warfare
STWC. Strike warfare commander
SUW. Surface warfare
SW. Shallow water
SWDG. Surface warfare development group
SWMCM. Shallow-water mine countermeasures
SZ. Surf zone

T

TACMEMO. Tactical memorandum
TARLOC. Target localization
TAMPS. Tactical aircraft mission planning system
TARPS. Tactical air reconnaissance pod system
TDD. Target detecting device

TGO. Tactical group ORESTES

TLAM. Tomahawk land attack missile

TPFDD. Time Phased Force Deployment Data

TPFDL. Time Phased Force Deployment List

U

UBA. Underwater breathing apparatus

UEP. Underwater electric potential

UHF. Ultra high frequency

UMCM. Underwater mine countermeasures

UMPM. Uncountered minefield planning model

V

VDS. Variable depth sonar

VEMS. Versatile exercise mine system

VHF. Very high frequency

VLCC. Very large crude carrier

VMFI. Visual mine firing indicator

VSW. Very shallow water

PREFACE

NWP 3-15/MCWP 3-3.1.2 Mine Warfare, has been brought into existence to give a broad command overview of Mine Warfare and to provide a link to other documents critical to the understanding and planning processes.

Throughout this publication, references to other publications imply the effective edition.

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CHAPTER 1

General Concepts

1.1 INTRODUCTION

This publication has been brought into existence to give a broad command overview of Mine Warfare and to provide a link to other documents critical to the understanding and planning processes. Its ultimate purpose, therefore, is to play a supporting role in keeping the Mine Warfare lessons learned truly *learned*. It may thereby aid in the avoidance of such unfortunate tactical situations as befell USS PRINCETON (CG 59), USS TRIPOLI (LPH 10), and USS SAMUEL B. ROBERTS (FFG 58). In future naval engagements with an enemy, especially in joint littoral warfare, mines are certain to play an important role. It is imperative to minimize the potential loss of human life and warships and to enhance the smooth integration, coordination, and effectiveness of the mine warfighting element to support overall military force and political objectives.

Since the invention of the Bushnell Keg in 1776, mine warfare has been an important element of naval warfare. The use of mines and countermeasures to mines has figured significantly in every major armed conflict and nearly every regional conflict in which the United States has been involved since the Revolutionary War. Mine warfare has been increasingly important and effective since World War I. Mines presently on the world arms markets are relatively inexpensive, easy to procure, reliable and effective, and difficult for intelligence agencies to track. The mine, as a weapon system, has an extremely favorable investment return (cost of mine to cost of damage ratio) for the miner.

Despite the logic and effectiveness of maintaining the mine element of war at sea on an even footing with the other naval warfighting specialties, throughout its history, the U.S. Navy has devoted proportionally fewer resources to mine warfare. As a result, despite the emergence of the U.S. Navy as the world's premier maritime power whose individual warfighting capabilities generally are superior to those of other navies, its mine countermeasure capabilities have lagged behind.

The old adage that those who will not learn the lessons of history are doomed to repeat them has persistently applied to the mine warfare aspect of the U.S. Navy. North Arabian Gulf operations of the U.S. Navy in Desert Storm contain some bitter experiences, including the mission-aborting mine strikes to two major warships, as well as the controversy over the decision not to land U.S. Marines in Kuwait. Despite the unfortunate nature of the initial Desert Storm experience and the need to recapture expertise in MCM, the U.S. Navy and Allied navies did have substantial success in countering the nearly 1,300 naval mines deployed by the Iraqis and emerged victorious in the MCM element of Desert Storm warfighting as in the other aspects of that war.

This positive conclusion to the mine clearance campaign in the North Arabian Gulf was because of the unparalleled material and logistics support from the Department of the Navy's shore establishment and the cooperation of many allied nations in the coalition effort. In addition to national support and multinational cooperation, the enabling elements of this success were the ability of the American Bluejacket to learn and adapt quickly, combined with good tactical command in the fields. Of special note is that as the course of the mine clearance campaign progressed, the Naval Component Command leadership came to understand, appreciate, and support the complex warfighting nature of mine clearance operations.

1.2 KEY DEFINITIONS

Mine warfare uses many terms that, although they may appear in other warfare areas, carry different or more specific definitions when applied to mine warfare. Additionally, there are terms used by Allied mine warfare forces that seem similar to U.S. terms but that differ to some extent. Allied or coalition force operations can be far more difficult when the forces and commanders are not able to communicate freely because of the misunderstandings caused by different terminology. Therefore, it is important for the commander to become familiar with the various terms that may be employed when discussing and planning mine warfare operations.

Appendix A contains terminology used in mine warfare that is not defined in Joint Pub 1-02 or NWP 1-02.

1.2.1 Mine Warfare. MIW is defined as the strategic and tactical use of sea mines and their countermeasures. It includes all available offensive, defensive, and protective measures for both laying and countering sea mines. As such, it encompasses the fields of designing, producing, and laying mines, as well as the parallel efforts of designing, producing, and operating all forms of MCM equipment to combat the enemy's mining campaign.

1.2.2 Mining. Mining is one of the two distinct subdivisions of mine warfare. Mining operations are used to support the broad task of establishing and maintaining control of essential sea areas, and they embrace all methods whereby naval mines are used to inflict damage on enemy shipping and/or hinder, disrupt, and deny enemy sea operations. Mines may be employed either offensively or defensively to restrict the movement of surface ships, submarines, and underwater systems and personnel. Mines can be used alone to deny free access to and from ports, harbors, and rivers, as well as movement through SLOCs, and they can be used as a force multiplier to augment other military assets to reduce the enemy surface and submarine threat. A mining campaign is intended to inflict damage on enemy ships that challenge the minefield, thereby having an adverse effect on their defense, offensive operations, and logistics support efforts, but it can also force the enemy into conducting a heavy MCM effort that may exceed the magnitude of the mining operation itself. Enemy ships kept at their base or deterred in transit by mining may be rendered as ineffective for the immediate war efforts as if they were otherwise sunk or destroyed. Further, delays in shipping may be as costly to the enemy as actual losses. The threat posed by a minefield may be real or it may only be perceived, but mining does have a significant psychological impact on the enemy by forcing him to combat an unseen force.

1.2.3 Mine Countermeasures. MCM is the other distinct subdivision of mine warfare, and it includes all offensive and defensive measures for countering a mine threat, including the prevention of enemy minelaying. MCM is considered to be any action that is taken to counter the effectiveness of and/or reduce the probability of damage to surface ships or submarines from underwater mines.

1.3 MINE WARFARE FORCE ORGANIZATION

This section describes the operating forces for mining and MCM in the U.S. Navy. However, as the Service is downsized, this organization will undergo a process of consolidation and change that may result in variation

from the organization as described. Complementary to the following description of operating forces, Appendix B provides a discussion of the program management organization responsible for establishment of requirements, budget, and program plans associated with staffing, training, and maintenance for MIW ships, aircraft, and systems. Appendix B also describes the training and technical support organization, which performs a critical role in enabling MIW forces to operate successfully.

CINCLANTFLT is the administrative and operational commander for the MIW forces. When MCM support is required by other fleet commanders, CINCLANTFLT directs COMINEWARCOM to provide forces as necessary.

CINCLANTFLT, CINCPACFLT, and CINCUSNAVEUR each have operational control over mobile mine assembly group units or detachments and the mine stocks located in their areas of responsibility.

COMINEWARCOM is responsible to CINCLANTFLT for the training, tactics, interoperability, and readiness of MIW forces. These forces are required to be prepared to deploy on short notice with sufficient force levels and capabilities to support two major regional contingency operations in any combatant commander's area of responsibility.

COMINEWARCOM is also assigned as technical adviser to CINCLANTFLT, CINCPACFLT, CINCUSNAVEUR, and SACLANT and provides technical advice to NATO and Allied countries when directed.

1.3.1 Mining. The COMINEWARCOM Staff conducts minefield planning and prepares MFPP as requested by naval component commanders. MFPP may contain numerous possible minefields that a commander may select according to the intended purpose of the minelaying operation.

COMINEWARCOM also advises naval component commanders on the requirements for prepositioned mine stocks to execute approved MFPP and recommends redistribution of mine stocks as necessary when new plans are developed or variations in the stockpile occur.

Tactical minefield planners are those personnel on numbered fleet staffs, battle group staffs, and air wing staffs who may tailor plans from a MFPP to fit the specific mission needs of a commander or may generate new minefield plans where no appropriate plan is available in a MFPP. These personnel are not dedicated planners, but they have been trained by attending necessary

courses at the Fleet Mine Warfare Training Center and they perform planning as a collateral duty.

COMOMAG is under the operational and administrative control of COMINWARCOM but also reports for additional duty to CINCLANTFLT, CINCPACFLT, and CINCUSNAVEUR. COMOMAG is responsible for maintaining the highest standards of mine material readiness and, when directed by the appropriate war plan execution authority, assembling and completing final preparation of service mines.

In performance of this mission, COMOMAG maintains permanently staffed Mobile Mine Assembly group units and detachments at mine storage sites around the world (see Figure 1-1) who monitor readiness of mine stocks, prepare mines for shipment, and conduct assembly and final preparation of mines. Mobile teams from these sites are capable of rapid deployment to afloat units or other mine sites when necessary to support mining operations. CINCLANTFLT, CINCPACFLT, and CINCUSNAVEUR have operational control of the MOMAG units and detachments in their area of operations, whereas administrative control belongs to COMOMAG.

There are no dedicated mining assets in the U.S. Navy. (A limited capability for surface laying of mines is described in Chapter 2.) A minelaying mission is assigned to several types of Navy aircraft and some submarines. Some Air Force B-52s are also capable of

mine laying. For a breakdown of aircraft and submarine types and capabilities, refer to Chapter 2.

A limited mine recovery capability exists in Charleston, SC, under the command of EOD Mobile Unit Six. This capability is specifically intended to support recovery of exercise and training mines at the Charleston OPAREA Mine Range. This range is one of only two locations on the east coast where minelaying training and certification can be performed. The other location is in the Puerto Rico OPAREA, where recovery is supported by assets from the Naval Station, Roosevelt Roads, Puerto Rico, augmented by EOD detachments from EODGRU TWO. In the Pacific Fleet, ET mine location, scoring, and recovery services are provided at the Pacific Missile Test Center Range by detachments assigned to EODMU THREE. Detachment Point Mugu has primary responsibility and is augmented by a Mk 5 MMS detachment. In addition to the location and tethering for recovery of ET mines configured for MMS, the Mk 5 MMS detachment has the capability to conduct similar missions to a depth of 500 feet at remote sites throughout the Pacific. Configuration for the Mk 5 MMS involves designated attachment points and installed 9-kHz and 37-kHz pingers. Surface craft support and actual mine shape recovery are conducted by contracted services.

1.3.2 MCM. The COMINWARCOM Staff conducts MCM force deployment planning, MCM operations planning and analysis, and exercise planning and

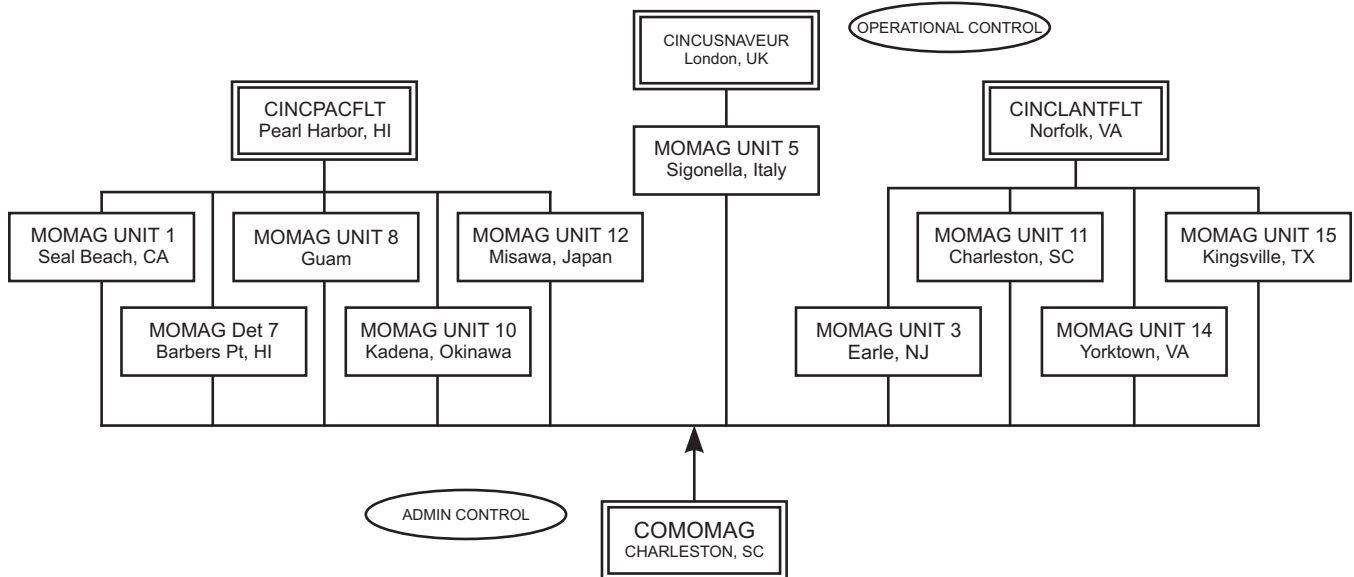


Figure 1-1. Mine Storage and Preparation

analysis. Staff intelligence personnel monitor the collection and analysis of intelligence on MEW capabilities throughout the world. Staff requirements personnel conduct liaison with type and operational commanders and with supporting organizations to determine unfilled operational needs and prepare mission need statements for unfilled requirements.

Operations personnel, in addition to planning operations and exercises, review tactics and doctrine seeking to maximize integration of MIW forces into fleet operations and maximize the effectiveness of MCM forces.

As shown in Figure 1-2, Commander, Regional Support Group Ingleside (additional duty of COMINELWARCOM) is assigned administrative control over surface MCM forces, including SIMA Ingleside. COMNAVSURFLANT is the type commander for surface MCM units, performing all type commander duties except for scheduling. The COMINELWARCOM Staff Operations Officer maintains scheduling authority of MCM forces.

COMCMRON ONE is responsible for planning and executing MCM exercises and operations as directed by COMINELWARCOM. COMCMRON ONE focuses on MCM planning for the Pacific theater, although operational assignment may be to any theater. COMCMRON ONE is assigned operational control of MCM 1 Class and MHC 51 Class ships as necessary for intermediate or advanced training and for participation in exercises or real world operations. COMCMRON ONE also has operational control over Helicopter MCM Squadron Fifteen (HM-15) and west coast EODMCM detachments (see Figure 1-2). Administrative control of HM-15 is assigned to COMNAVAIRPAC. Administrative control of west coast EODMCM detachments is assigned to the parent EOD Mobile Unit under COMEODGRU ONE.

COMCMRON TWO has the same responsibilities as COMCMRON ONE with a focus on the Atlantic and Mediterranean theaters and is assigned operational control of HM-14, east coast EODMCM detachments, and MCM or MHC ships as necessary. Administrative control of HM-14 is assigned to COMNAVAILANT, and administrative control of EODMCM detachments remains with their parent EOD Mobile Unit under COMEODGRU TWO.

COMINELWARCOM, under COMNAVSURFLANT, has administrative control over all MHC and MCM class ships and operational control over all MCM and MHC class ships that have not been assigned to one of the other squadrons.

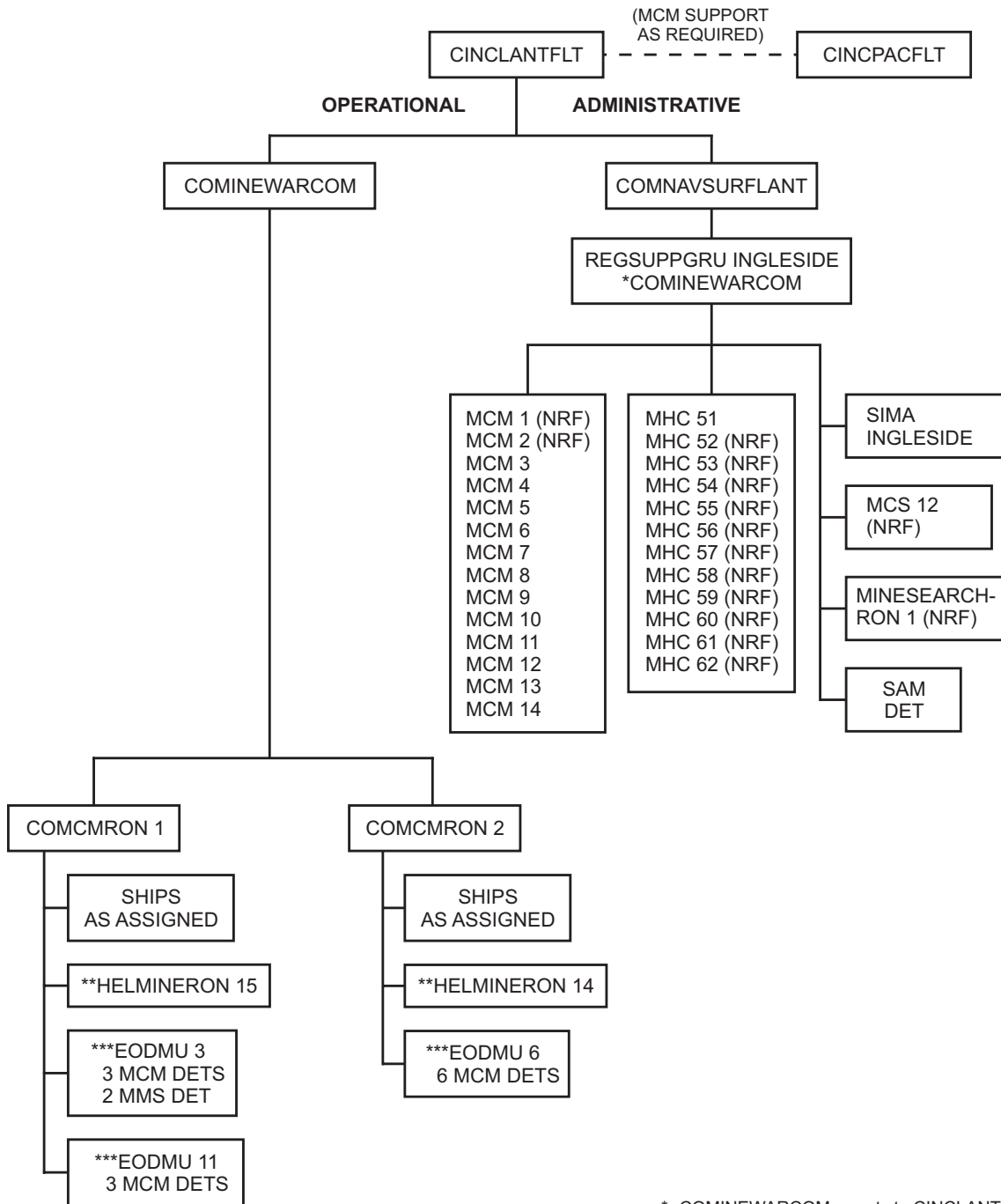
MCM assets that have completed all basic phase training requirements may be assigned to COMSECONDFLT or COMTHIRDFLT for participation in fleet level exercises or support of the numbered fleet commander's operational requirements. This assignment will usually be made as an integrated task unit including an MCM squadron commander.

EOD is a critical aspect of modern MCM forces. EODMCM detachments are specially trained and equipped with nonmagnetic, low-acoustic signature equipment that permits them to approach influence mines safely and perform identification, destruction, or render-safe and recovery operations.

In the Atlantic Fleet, six EOD detachments are assigned to EODMU SIX, and two MCM detachments are assigned to EODMU EIGHT. Additionally, there is one EOD MMS detachment with a mine recovery mission (Mk 5) assigned to EODMU SIX. Administrative/operational control of the EODMCM detachments at EODMU EIGHT remain with EODMU EIGHT, under COMEODGRU TWO (ADCON) and CINUSNAVEUR (OPCON). Other Atlantic Fleet EODMCM and EOD MMS detachments ADCON remain with their parent mobile units, and OPCON is assigned to COMINELWARCOM. In the Pacific Fleet, two EODMCM detachments each are assigned to EODMU ELEVEN and EODMU FIVE, and three EODMCM detachments are assigned to EODMU THREE. Additionally, there are two EOD MMS detachments (Mk 4 and Mk 7) with MCM missions assigned to EODMU THREE. Administrative/operational control of the EODMCM detachments at EODMU FIVE remain with EODMU FIVE, under COMEODGRU ONE (ADCON) and CTF-76 (OPCON). Other Pacific Fleet EODMCM and EOD MMS detachments ADCON remain with their parent mobile units and OPCON is assigned to COMINELWARCOM.

NSW forces are responsible for conducting MCM in the VSW/SZ regions in support of amphibious operations. NSW forces are not routinely included within the MCM force chain of command. When an ATF is assembled, the NSW forces assigned to the CATF will include SEAL teams capable of conducting the VSW/SZ MCM mission. SEAL teams maintain one platoon trained in conducting VSW/SZ MCM and capable of integrating with other team members to execute the MCM mission.

The Commanders, MARDEZ Atlantic and Pacific are responsible for MIW planning within the MARDEZ. MARDEZ sector and subsector commanders participate in preparation of MIW plans and monitor MCM operations but do not have permanently assigned MIW assets. In wartime, COMSECONDFLT or COMTHIRDFLT



- * COMINWARCOM reports to CINCLANTFLT but also serves as COMREGSUPPGRU Ingleside. SMCM scheduling authority is COMINWARCOM N3.
- ** ADCON for HM-14 and HM-15 is COMNAVAIRLANT/PAC
- *** ADCON for EOD Dets is COMEODGRU 1 or 2 via parent EODMU

Figure 1-2. MCM Operational Forces

will delegate control of mining or MCM forces as necessary (and if available) to support the MARDEZ commanders.

1.3.3 Naval Reserve Forces. NRFs have played an important role in MIW for many years. From the early 1970s until the end of the 1980s, the majority of the SMCM force was assigned to the NRF. Due largely to the role of mines in the Iran-Iraq War and Operation Earnest Will, as the MCM 1 Class ships replaced MSOs, they have remained in the active force. The MHC 51 Class was designated to be commissioned in the active force and transfer after 1 year to NRF status to maintain an active-reserve mix. As of October 1994, the planned active-reserve mix of ships is 10 active to 4 NRF MCM 1 Class ships and 1 active to 11 NRF MHC 51 Class ships. Additionally, the MCS 12 will be assigned to NRF status when conversion is complete.

The Naval Reserve also plays a role in the AMCM and EODMCM force. HM-14 and HM-15 each have a reserve component of pilots and maintenance personnel. Of the 12 aircraft assigned to each squadron, 6 belong to the active squadron and 6 belong to the NRF organization. NRF EOD forces are composed of four reserve units: EODMU TEN and EODMU TWELVE under COMEODGRU TWO, and EODMU SEVEN and EODMU SEVENTEEN under COMEODGRU ONE. Each reserve unit trains and provides administrative support for three different types of detachment: OCDs are fully qualified in diving and demolition procedures and are trained to locate, identify, and dispose of sea mines. ASDs use side-scan sonar systems to locate minelike objects underwater. MCDs provide fully mobile communications capability in support of fleet operations and exercises.

Another Naval Reserve program that supports MIW is the MSS and MSU. The MSS is an administrative staff consisting of reservists on active duty (TARs) who manage the staffing and training of MSUs. Along with other missions, an MSU trains in the operation of side-scan sonar systems for mine hunting along Q-routes or in harbor approaches where small craft can operate. The craft used by these units may be Navy assets or commercial assets contracted for the purpose. This program replaced the COOP in 1994.

Naval Reserve units are also used to augment the command and control structure for MIW. COMINEWARCOM has a reserve staff detachment available for augmentation when needed, and NRF Mine Division Staffs have supported Mine Squadron Staffs. As the armed forces are reduced in size, the NRF staff structure is also expected to be reduced.

1.4 NATO/ALLIED COALITION AND COOPERATION

In almost any foreseeable MIW operation of significance, U.S. Navy MIW forces can expect to be operating side by side with NATO and/or other Allied forces. Such coalition type operations could even include MCM forces of the former Soviet Union or Warsaw Pact.

1.4.1 Operations. Each of the NATO/Allied MIW services brings its own strengths into combined operations. Whenever multinational forces operate together, many different types of MIW vessels with varying systems and degrees of readiness will be encountered. These may include sweepers, surface drones, hunters, divers, AMCM helicopters, remote underwater vehicles, hull-mounted and variable depth sonars, side-scan sonars, underwater vehicles with ahead-looking sonars, and utility helicopters. (For a brief description of NATO/Allied MCM assets, see paragraph 3.7.1.) If the operation is being conducted as a NATO operation, NATO doctrine, procedures, command structure, and communications techniques will be used. In situations such as the 1987-88 Operation Earnest Will in the Persian Gulf, several nations' MCM forces (all of whom were members of NATO) were operating in the same area with a common mission, but not under a combined command structure. The forces used NATO procedures and doctrine and resolved potential conflicts by close communications between all nations concerned. Future multinational MCM operations may include Partnership for Peace navies or Allies from the Pacific theater who are not members of NATO. MCM doctrine is currently being developed in NATO that takes into account operations with almost any free world navy. As more exercises and real world operations that include multinational forces occur, fewer interoperability problems can be expected.

1.4.2 Non-NATO Operations. COMINEWARCOM has made recommendations to the Navy International Programs Office (IPO-10) on how to sanitize the NWP 3-15 (formerly NWP 27) series of MIW publications for release to foreign nations. The sanitization instructions are written at three different levels: NATO plus Japan and Australia, Allied nations, and Third World nations. NAVIPO does not automatically provide these sanitized publications to foreign navies. A foreign government must ask for the publications and must pay for them. Therefore, a battle group commander who wishes to utilize these sanitized NWP 3-15 series publications to conduct Mine Warfare operations with a foreign navy must ensure that the foreign navy requests the publications from NAVIPO (IPO 10) or that the Battle Group Commander makes the request. In many cases, the actual sanitization has not been done by NAVIPO. In that

case, the battle group commander may receive instruction from NAVIPO on how to sanitize the specific publications.

1.4.3 Doctrine. NATO MIW doctrine is delineated in ATP 6 and ATP 24. This is the doctrine that all NATO navies, including the U.S. Navy, will follow during NATO operations or exercises. Almost every NATO nation has a national annex to ATP 24 that may contain variations in the standard doctrine or specifics on national systems not released to all nations. U.S. national doctrine is very similar in many ways to the NATO doctrine. The only variations in doctrine may stem from differences in force capabilities (e.g., availability of AMCM forces) or different geographically driven missions. The NWP 3-15 series is the primary doctrine for U.S. Navy MCM and mining forces. The U.S. MCM Commander must be prepared to operate exclusively within NATO doctrine and procedures and to explain to NATO counterparts when U.S. Navy forces will deviate or operate apart from the NATO doctrine because of national concerns. This same procedure is currently followed by other NATO navies when national concerns become paramount.

1.4.4 Support Organizations. Within the NATO organization there are working groups, planning groups, IEGs, PGs, and AGs. Written agreements which foster cooperative development of MIW techniques, tactics, and systems focus the combined knowledge of the participants on the shortcomings of existing Mine Warfare systems and capabilities.

The bilateral (Belgium/The Netherlands) Mine Warfare School (Eguermin) at Oostende, Belgium, functions as a center for NATO MIW training. Eguermin is used by U.S. forces as well and is closely linked with U.S. MIW training facilities.

The MWWP was established to initiate, develop, and process proposals for military standardization, including tactics, tactical instructions, and procedures in the field of MIW. The MWWP brings Mine Warfare participants together annually to discuss issues of common concern in mining, MCM, training, equipment, support, command, control, and communications. This has been a key component of the successes achieved by NATO MIW forces, although each may have been working under specific national directives. Currently, the MWWP is organized with three panels: operational/tactical, technical, and exercise evaluation.

DEAs generally are bilateral diplomatic tools whereby agreement is made to exchange certain data for mutual military purposes. Unlike general agreements, the DEAs are negotiated between countries or groups of

countries for specific types of information. There are few general DEAs in existence. Frequently, newly obtained data and information can be exchanged rapidly when a DEA is in place.

1.5 INTERNATIONAL LAW ASPECTS OF MINE WARFARE

1.5.1 Hague Convention. The Hague Convention (VIII) of 1907 probably had more of a legal impact on MIW than any other forum. The attendees at this convention placed international restrictions on the use of drifting mines, established various guidelines that affected automatic contact mines, and set forth requirements for the incorporation of sterilization and/or self-destruct features in mines. The following specific provisions were laid down by this Hague Convention:

1. Armed, unanchored mines must have a maximum life of 1 hour.
2. Armed, anchored mines must become unarmed if they break free from their moorings.
3. Mines must be designed to become harmless should they miss their target.
4. It is illegal to mine solely against commercial shipping.
5. Neutral nations are not to be interfered with, and the safe transit of neutral shipping must be ensured.
6. Mines must be removed by the planting force at the conclusion of hostilities.

The specific international laws set forth during the Hague Convention remain in effect today; however, they have not been always been adhered to by all nations, and world events have seen major deviations from these principles. Although the United States did not ratify the Hague Convention, we have always abided by its restrictions and principles.

1.5.2 Other Legal Aspects. Both offensive and defensive mining operations are considered to be acts of war. The intent of these mining operations is to inflict damage to or restrict the transit of enemy shipping. Protective mining conducted within a nation's own waters is not considered an act of war as long as the necessary notifications to shipping are made through the appropriate channels.

The Seabed Arms Control Treaty of 1972 prohibited the use of mass destruction weapons that are attached to

the ocean floor beyond a 12-mile coastal zone. This treaty applies to the use of nuclear warheads in either bottom or moored mines since they are designed to remain in place after they are armed. U.S. policy on the employment of naval mines is addressed in chapter 9 of NWP 1-14 (formerly NWP 9), and in chapter 1 of NWP 3-15.5 (formerly NWP 27-4).

1.6 MINE WARFARE/POLITICAL INTERFACE (INTELLIGENCE AND WARNINGS)

History is well endowed with peacetime, wartime, and low-intensity conflict MIW incidents ranging from threat alone to large-scale mining campaigns. Appendix C provides a synopsis of MIW history to illustrate the place of MIW in overall military-political perspective.

The intelligence data available plays a crucial role in determining the effectiveness of mining and MCM planning and operations. Without knowledge of potential mining events or the MCM capability of a potential enemy, mining and MCM planners are likely to prepare ineffective plans that may place delivery assets, MCM assets, or transiting commercial and naval ships at risk. Mining and MCM planning are based on a significant number of assumptions even in the best of situations; therefore every effort should be made to reduce these assumptions and protect the expenditure of critical resources. All information and data requested by a planning staff should be made available to the maximum extent possible and as quickly as possible.

1.6.1 Threat. To the miner, knowledge of the threat means knowing what the minelayer must face in performing his mission and knowing what MCM forces may be used to counter the minefield. To the MCM planner, knowledge of the threat means knowing what types of mines were available to or used by the layer, as well as the available operating selections of those mines. U.S. MCM forces have no defensive ability against other threats.

The MCM commander must be able to brief military and political authorities on the MIW threat so that they can balance the final risks and goals against the realization of that threat. No threat can be discounted as insignificant to the MCM force or the transiting assets. Even primitive weapons can bring havoc and mission-abort situations to modern forces. The threat is always the explosive capability of the weapon without regard for the packaging.

1.6.2 Movement of Forces. An essential element of intelligence information in MIW is movement of forces. Consider the miner: movement of certain of his forces may indicate pending or imminent deployment of

mines. If mines and the laying forces are not collocated, the miner must plan the logistic support and timing to get the mines to the minelayer, and this time can be exploited by the opposition if movement is detected.

MCM forces are typically slow transitters who require significant support to remain at sea. They are not commonly found with a battle group unless an MCM action is planned. Therefore, the movement of MCM forces may be an indicator of a planned amphibious landing or SLOC choke point penetration.

Political will must be exercised on either side in these cases. Forward deployment of MCM forces may be sufficient to determine or complicate and thwart a mining plan. Early movement by miners may be sufficient to permit national authorities to justify offensive MCM against vessels at sea or shore facilities.

1.6.3 Delay Arming. Delay arming features allow the miner to conduct operations and leave the area prior to the arming of weapons. This can permit actions to be conducted prior to the acknowledged beginning of hostilities or operations. The threat may exist long before it is recognized by conventional forces because the miner determines when the threat becomes valid. Additionally, arming delays can and will complicate operations for the MCM forces because environmental factors and operational factors can then require a recommitment of critical assets to an area otherwise believed to be safe. Delay arming cannot be discounted in any operational scenario until proof exists that no such features were used by the opposing force.

Recent history has emphasized that the threat may be outside of international law or convention, hence the saying “a mine in the water has no loyalty.”

1.7 MINE WARFARE INTERFACE WITH OTHER WARFARE SPECIALTIES

1.7.1 Mine Warfare Coordinator. To improve the interface between MIW and other warfare specialties, a MIWC was added to the CWC’s organization. Following are the roles of the MIWC:

1. To act as the single point of contact for MIW
2. To provide recommendations to the CWC and other warfare commanders and coordinators
3. To provide guidance on how MIW operations fit into theater operations of the fleet commander.

The MIWC shall also perform the following tasks:

1. Make recommendations to assist in establishing force disposition in the presence of a mine threat
2. Coordinate requests for all nonorganic mining and MCM support
3. Evaluate the implications of enemy mine warfare operations and recommend appropriate MCM operations
4. Coordinate with the ASWC on all defensive minefield planning matters
5. Coordinate the employment of tactical air assets in mining with the STWC
6. Ensure that mining operations are conducted in accordance with international law
7. Designate MDAs
8. Maintain the status of all force MIW capabilities
9. Coordinate obtaining oceanographic support for mining operations.

The MIWC maintains an OPTASK MIW Supplement to communicate general procedures and instructions to other forces inside and outside the CWC organization as necessary.

1.7.2 Strike Warfare. STW capable aircraft are a key element in many mining plans. The MIWC provides recommendations to the CWC for employment of strike assets to conduct mining that will support CWC objectives. If approved, the minelaying planning and execution are then carried out by the STWC and Strike Operations Department on board the CV.

STW assets are also employed in conducting offensive MCM. Reconnaissance conducted by tactical aircraft may identify movement of mine assets or minelayers, indicating mining is imminent. The MIWC monitors intelligence data and provides offensive MCM targeting recommendations to the STW and CWC early in the conflict.

1.7.3 Special Operations. Special operations forces are involved in both offensive and defensive MCM. In certain situations, special operations forces may be chosen to conduct raids to cripple or destroy opposition force mine storage sites and mine stocks. Their ability to conduct small-scale raids with accuracy and limited collateral damage may be preferred in some cases over tactical air strikes or TLAM strikes. In the defensive MCM role, NSW forces conduct beach recon-

naissance in advance of an amphibious landing to determine whether a mine threat is present. When mines are encountered, the NSW force is responsible for mine clearance in the very shallow water and surf zones. NSW forces work together with EODMCM, AMCM, and SMCM forces to develop coordinated tactics for conducting MCM in support of amphibious operations.

1.7.4 Surface Warfare. MCM forces interface with ASUW forces in several ways. In situations where no large deck MCM command ship is available, a surface combatant may serve as the flagship for the MCM commander and provide support to surface MCMVs. Larger ships (e.g. CGs) are well equipped as command platforms and can accommodate the MCM Commander's staff. ASUW forces can provide protection from various threats to MCM forces, as well as some logistic support. They also may be tasked to provide ASUW helicopters to transport EOD forces and conduct spotting for mines cut by mechanical sweep operations or drifting mines. MCM forces conduct reconnaissance of ASUW ship operating areas when mining is suspected and, if necessary, clear operating areas for ASUW ships to conduct patrol operations or fire support operations.

1.7.5 Antisubmarine Warfare. ASW forces may employ protective minefields (laid by air assets) as barriers to assist in controlling the submarine threat. The CAPTOR mine can be used alone or in conjunction with other mines in this role. ASW forces will support the MCM force by maintaining reconnaissance in their area of operations for minelaying assets or the existence of minefields. Some ASW sonars can also be employed for mine detection and avoidance. They permit the ASW ship to operate with an increased degree of safety in waters where the mine threat has not been determined, allowing the ship to detect moored mines and avoid transiting through a mined area. The ASW ship's helicopter can support MCM forces by providing transportation to EODMCM forces and conducting aerial surveillance.

1.7.6 Antiair Warfare. The interface between MIW forces and AAW forces is limited to the protection role AAW ships and aircraft perform. MCM forces, both surface and air, are not equipped for self-defense. If any hostile air threat exists, it is necessary for AAW forces to be assigned to counter that threat and permit MCM forces to operate. Considering the small size of the MCM force, even the loss of one ship or helicopter can be critical to completion of the MCM mission.

1.7.7 Amphibious Warfare. MCM forces have historically operated in close support of amphibious operations when conducting an opposed landing. The mine is one of the cheapest weapons that can be employed

against an invading sea force, and the presence of mines without a sufficient capability to counter them can result in significant losses to the AMW force or cancellation of landing operations.

Early, detailed requirements should be provided by the supported commander for amphibious operations (e.g., CATF) to the MCM Commander to facilitate planning. MCM considerations include the size of the AOA in comparison to the available MCM assets, slow MCM ship transit times to the AOA, the rate of MCM operations required to meet established deadlines, and requirements to protect MCM operations against hostile threats (including the use of OPSEC and OPDEC). Enemy observation of friendly MCM operations may compromise tactical surprise. In addition to conventional MCM forces, NSW forces are employed in amphibious operations to locate, destroy, and/or neutralize enemy barriers, obstacles, or minefields placed in or on the shallow water approaches to the landing beaches.

Large-deck, aviation-capable amphibious ships are frequently assigned to embark and support MCM forces of all types. Although Marine forces are displaced, the LPH and LPD have both been used extensively as MCM support ships, with the MCM commander, AMCM helicopters, and EODMCM detachments embarked and providing logistic support to surface MCM vessels.

During MCM operations in support of amphibious operations the CLF will also supply assets to be used in the shallow water/surf zone MCM effort, such as combat engineers, tank plows, bulldozers, etc.

1.7.8 Maritime Interdiction Operations/Law Enforcement Operations. MIO/LEO forces are likely targets for mining and should remain alert for indications of mine laying. The use of passive MCM explained in Chapter 4 should be reviewed and employed where appropriate. When inspecting transiting merchants, it is important to note any cargo and handling or packing equipment that might have been used in transporting or laying mines. If mining has occurred or is expected, MIO/LEO forces should be supported by MCM forces to establish safe operating areas, anchorages, and transit lanes.

1.7.9 Salvage Forces. Salvage forces not engaged in salvage operations may be called on to support MCM forces by providing an operating platform for EODMCM divers. Any salvage vessels that have an installed recompression chamber will be considered for support to EOD divers who may require emergency recompression. If an MCS is present and has an installed recompression chamber, it may also be used to support salvage forces. MCM forces are frequently called on to

assist in initial location of aircraft, boats, or other assets that have been lost so that salvage forces can conduct recovery operations. The minehunting sonars on MCM 1 and MHC 51 Class ships and the side-scan sonar used by AMCM are excellent for locating bottom objects, and the AN/SLQ-48 MNS can be used to make positive identification on objects much deeper than divers can operate.

1.7.10 Command and Control Warfare. C2W is essentially an employer of MIW forces. The threat of mining or the ready availability of MCM forces can be used to influence an enemy's command and control. Placing a CV into position has significant impact on the enemy's decision-making because of the STW capability resident within the CV, including mining. In the same manner, deployment of MCM forces or repositioning of MCM forces in a theater reduces the potential impact of opposition mining and may result in a decision not to commit a hostile mining action. Additionally, C2W may play a part in the defense of minelaying forces by providing both early warning against opposition forces and cover by jamming air defenses. For the MCM mission, the primary interface is via the information flow from C2W sensors, which might indicate mining in progress. This information is normally channeled through the intelligence community for analysis and then passed to the theater or battle group commander as an indicator of the need for MCM effort.

1.7.11 Fleet Exercises. MCM forces are integrated with battle group training exercises whenever possible. For inport training exercises, participation may be limited to MCM squadron staff members, either on-scene or from a remote location. During fleet exercises, MCM forces may participate in the scenario by transiting to the exercise operation area or by establishing a scripted geographic area near the MCMV homeport of Ingleside, TX. The MCM staff can conduct exercises in this area and transmit information with coordinates converted to match the geography of the fleet exercise area. Since MCM operations frequently occur out of sight of the battle group, this type of participation saves fuel and transit time without sacrificing significant aspects of the interface between the MCM and the battle group.

1.8 MINE WARFARE/JOINT INTERFACE

1.8.1 Army-Navy. The Army is responsible for conducting most mine development, minefield planning, and MCM on land, although the Marines share some responsibility. The Navy responsibility ends at the landward limit of the craft landing zone along sea shores, but extends inland where waters are navigable from the sea. Where navigation is no longer possible by seagoing vessels, Navy responsibility ends. However, when a

mining situation exists, the Joint Force Commander will be primarily concerned with capability, not responsibility. If Navy assets are capable of conducting MCM in a waterway where Army craft need to navigate, it is likely they will be directed to clear the mines. The riverine MIW operations in Vietnam are a prime example.

The Army has a tremendous amount of material that has to be moved to support overseas operations such as Operation Desert Storm. The majority of this material must be moved by sealift ships belonging or under contract to MSC. To support the rapid buildup of forces normally desired in an overseas conflict, the loading, transit, and unloading of these ships must follow a tight schedule. A mining threat either in CONUS, at chokepoints along the SLOCs, or at the offload port can delay or completely halt the movement of material. U.S. Navy MCM forces (and MCM forces from NATO or Allied nations if involved) will be tasked by the Joint Force Commander to clear channels and anchorages and to maintain them to permit the free flow of traffic. EODMCM forces may also be tasked to clear and assist in maintaining safe harbors for off-loading of shipping.

1.8.2 Air Force-Navy. The Air Force plays two important roles in supporting MIW forces (in addition to potentially supporting offensive MCM). The first role played by Air Force assets is the laying of mines by B-52 aircraft. The B-52 can carry the largest mine load of any U.S. aircraft and can deliver mines at long distances from CONUS or other bases. B-52s may play a critical role in accomplishing mining plans directed for execution by joint commands.

The second is the Air Mobility Command's support of deployment of AMCM and EODMCM forces and the continuing delivery of critical repair parts via AMC aircraft. Even in a situation where all MCM forces deploy by surface lift, rapid delivery of critical repair parts is crucial to maintain MCM force readiness for operations.

1.8.3 Marine Corps-Navy. The interface of Marine Corps assets and MCM forces is to some extent the same as that described for its interface with the Army. Rapid deployment of USMC forces other than those already embarked on amphibious shipping is accomplished by airlift of the personnel to a location where they can be united with equipment stored on MPSRON ships. In the same manner as MSC shipping carrying Army material, the MPSRON ships must be provided clear channels, safe anchorages, and harbors in which to unload their material. In some situations the MPSRON ships will join the amphibious ships and be supported by MCM forces to establish a landing beach and move assets ashore.

1.8.4 Coast Guard-Navy. During peacetime, the Coast Guard is part of the Department of Transportation and yet maintains a significant degree of interface with the Navy through the MARDEZ organization. The Commanders, MARDEZ Atlantic and Pacific are Coast Guard Admirals, and there are Coast Guard officers on many Navy staffs to maintain the MARDEZ structure and interface with the Navy. These officers usually are graduates of MIW training courses. As the MARDEZ mission expands into deployable port control and coastal shipping management and control, the interface with Navy MCM commands will increase.

Coast Guard assets are frequently involved in exercises where mining and MCM are included. Liaison with the local Coast Guard captain of the port is necessary for loading or unloading exercise mines at Coast Guard bases or commercial docks. Establishment of exercise minefields in areas that are not regular Navy OPAREAs requires coordination with the local Coast Guard command.

In the past, when the mission to conduct route surveys in all U.S. ports was active, a Coast Guard officer was assigned to the COMINWARCOM staff to facilitate cooperation between Coast Guard assets and Navy survey teams. Coast Guard buoy tenders have been and may be used to conduct survey operations in a number of scenarios using portable side-scan sonar equipment. They could also be used again if the route survey mission were to be reactivated.

In wartime, when the Coast Guard operates under the Department of the Navy, route survey and support of MCM forces conducting operations in CONUS will likely be supported to a major degree by Coast Guard assets.

1.9 RULES OF ENGAGEMENT

ROE are directive guidance that authorize and delineate the circumstances and limitations on the use of force. ROE are generally mission-oriented and action specific. ROE promulgated by the Theater Commander are based on guidance provided by the NCA through the Chairman of the Joint Chiefs of Staff. This guidance reflects political, legal, operational, and diplomatic factors that may restrict combat operations. ROE are required throughout the operational continuum to ensure compliance with the laws of war and NCA guidance. Combatant commander pre- and post-hostility ROE and OPLAN ROE should address authority to place obstacles and mines, including the FASCAM. Following NCA release of these elements for operations, ROE should address their employment by U.S. forces and the

prevention, denial, or countering of their employment by the enemy.

1.9.1 Reconnaissance. Reconnaissance operations to identify potential mine storage sites, minelayer movements, and restriction of traffic within national waters present circumstances that require special ROE. For units conducting reconnaissance in international waters, ROE will define the permissible conduct of the unit upon encountering forces of a hostile or neutral nation. The execution of MCM reconnaissance operations may require the MCM force to operate in proximity to or inside an adversary's territorial waters. ROE will be used to specify the permissible conduct of both the MCM force and protective forces.

1.9.2 NATO/Allied Rules of Engagement Interface. When control of a U.S. mining or MCM force or asset is assigned to a NATO commander, it must conform to ROE established by the NATO command structure. However, there may be occasions when U.S. forces will operate with or in support of NATO or Allied country forces, but control will not be passed to the NATO command. In this situation, the U.S. forces must conform to U.S. ROE until otherwise directed by the U.S. command authority. Ideally, in a combined or coalition

force operation or exercise, all forces will operate under the same ROE. When this is not the case, lines of communication must be established to permit the speedy resolution of issues that arise concerning conflict between intended operations and ROE. The most important aspect of coalition operations is that the allies understand U.S. ROE and that the U.S. commander knows the ROE of other nations to employ all available assets effectively.

1.9.3 Rules of Engagement Interface with Warfare Specialties Supporting Forces. As forces from different branches of a command structure are assigned to work in supporting roles without a change in controlling authority, conflicts in ROE may arise. Mining or MCM forces may not be issued a relaxation of ROE that is approved for protecting C2W, special operations, or STW forces. Considerable confusion can result when two units operating together have different ROE and are not aware of the situational differences. For this reason, it is important to keep supporting and supported units advised of any changes in ROE. It may be necessary to review and compare ROE when new forces are assigned and when missions are changed.

CHAPTER 2

Mining

2.1 ADVANTAGES AND DISADVANTAGES OF MINING OPERATIONS

2.1.1 Advantages. Mining operations are distinguished from other naval operations in that minefields can inflict major, long-term damage on enemy shipping while allowing little or no chance for retaliatory action against the minelaying forces. Mines lie in wait for their target. Mining permits enemy shipping to be attacked without the necessity for a direct confrontation between the delivery vehicle and the target ship. Since the delivery vehicle does not have to directly engage or even locate the target ship, the smallest minelayer may indirectly destroy the most powerful capital ships, merchantmen, or enemy submarines. Minefields are also unique in that they provide the laying forces with the possibility of setting up a preemptive defense in which the aggressor must take full responsibility for any casualties that it suffers.

The mine may also offer the advantage of covertness and surprise, with the first indication of its presence being a detonation. Even if it is not covert, mining will offer the advantage of concealment because a properly planted mine provides no visible warning of danger and its exact location is undetermined. Moreover, an armed mine operates 24 hours a day. From the time the mine is armed until it is countered or its useful life expires and it becomes sterilized, a mine will continuously threaten enemy ships with no need to retire for logistics support or any other purpose.

Mines, when used in conjunction with other forces, can serve as a force multiplier. A well-laid minefield can be used to perform a variety of functions that would otherwise occupy patrol or other combat forces, thus freeing those forces for use in other warfare operations. For example, mines can be used to reduce the number of vessels that are required to execute an effective naval blockade.

Early offensive mining may disrupt an enemy's war plans more effectively than any other naval weapon. Mining also offers numerous complementary actions,

such as the overloading and disruption of the enemy's transport and logistics systems caused by the minefield's interruption of normal port activity. The funneling of supplies, or the storing of large concentrations of supplies in a few ports, will cause those supplies to be more susceptible to attack by other warfare forces.

One of the most widely recognized advantages of mining, but perhaps the one most difficult to quantify, is the psychological effect that a minefield has. The enemy's perception of the danger that is posed by a minefield has a large psychological impact on the forces that must transit through it. While this is a real factor and a definite advantage that is unique to a mine, it must be recognized that the psychological threat is the threat perceived by the enemy, not by the minelayer, and that this perception may vary from nation to nation and culture to culture.

The mine may also be the only weapon of naval warfare that offers an apparent ability to alter geography. An area that has been mined or one that has been declared to have been mined must be avoided by transiting forces as if it were land.

Implicit in all these advantages is the fact that the mine may be very effective if its use is only simulated or threatened. That is, its actual detonation may not be a significant factor in its effectiveness.

2.1.2 Disadvantages. The primary weakness of a mine is that it is a passive weapon that must wait for a target instead of seeking it out and attacking it, and once laid, a mine recognizes no friends. Unless proper precautions are maintained, a mine can threaten friendly as well as enemy ships. Also, a mine is stationary once it has been planted, which provides the enemy with an opportunity to detect the minefield and then either avoid it or counter it with MCM operations. Additionally, exposure to sea water for long periods of time can cause the mine to become materially degraded through either biological fouling and/or corrosion, and the temperature of the water can adversely affect the life of the mine's batteries. Another environmentally related disadvantage

of mining is that there are water depth restrictions on where mines can be laid.

2.2 MINE CLASSIFICATION

Naval Mines are typically classified in three ways:

1. By their final position in the water
2. By their method of delivery
3. By their method of actuation.

2.2.1 Final Position in the Water. When classified according to the position they assume in the water after they have been laid, mines fall into three primary categories.

1. Bottom/ground mines
2. Moored mines
3. Drifting mines.

2.2.1.1 Bottom/Ground Mines. Bottom mines are nonbuoyant weapons. When planted, the mine case is in contact with the sea bed and it is held in place by its own weight. In areas with a soft bottom, these mines may be completely or partially embedded in the sea bed, in which case they would be referred to as buried mines. A mine case that is resting on the bottom and not buried is referred to as a proud mine. Bottom mines are also called ground mines.

The nonbuoyant case of a bottom mine allows for the use of a much larger explosive charge than that of a buoyant mine case. This larger explosive charge provides the mine with a larger damage distance and enables a single mine to cover a larger volume of water. However, bottom mines must be planted in water depths where the target ships will be damaged by the explosion. The depth at which a specific bottom mine can be effective against a specific surface target is dependent upon the shock resistance of the target, as well as the amount and type of explosive used in the mine. If they are intended for use against a surface ship, bottom mines are most effective in comparatively shallow waters (<200 feet). If planted in very deep waters, a surface vessel may pass over the mine without actuating its firing mechanisms, or if the firing mechanism is actuated, the surface ship may pass by without suffering the desired level of damage.

There are two special categories of bottom mines that react differently from other bottom mines when they are

initially laid, but they become standard bottom mines once they have reached their final plant position:

1. A moving bottom mine is a mine that is designed to move itself along the bottom after it has been planted but before it arms.
2. A self-propelled mine is a mine that is fitted with propulsion equipment, such as a torpedo, that is used to propel the mine case to its intended final plant position. For example, a submarine could fire a self-propelled mine from a standoff point that is outside of the intended minefield location, and the mine would then propel itself to the desired plant location.

2.2.1.2 Moored Mines. Moored mines have a positive-buoyant mine case that is moored at a preset depth beneath the water's surface. The mine case is held in place above the sea bottom by means of a cable or chain that is attached to an anchor. Moored mines are frequently, but not always, fitted with a self-destruct device that will cause them to flood and sink if they are separated from their anchor. A moored mine that has been separated from its anchor and risen to the surface is called a floater. Floaters may continue to float until either they are struck and detonated or they deteriorate from their exposure to the seawater.

Moored mines are designed to be laid in deep water, and they are effective against both submarines and surface ships. The maximum water depth in which a moored mine can be laid is limited by the length of its mooring cable, the weight of the cable, and the mine case crush depth. The explosive charge and firing mechanism of a moored mine are housed in the positive-buoyant case. Because this mine case is buoyant, the amount of the explosive charge used in moored mines is less than that found in a typical bottom mine, and the damage radius is also smaller.

A major disadvantage of moored mines is that the mooring cable can be cut with mechanical sweep gear. When this occurs, the mine case floats to the surface and can be avoided or detonated without accomplishing its mission. Another disadvantage of moored mines is that they can be affected by current and tidal variations that could cause the mine case to dip below its intended depth and thereby reduce its effectiveness against a surface target.

Despite their susceptibility to mechanical sweeping, moored mines play an important role in mining operations. They can be moored so close to the surface that the smallest craft entering the minefield will be endangered. Additionally, mooring mines at different water

depths will add a vertical dimension to a minefield, rendering it hazardous to both surface ships and submerged submarines.

There are two special types of moored mines that contain propulsion systems that enable the mine case to quickly reach the intended target:

1. Homing/guided mines are propelled moored mines that use guidance equipment to home onto a target once the target has been detected.
2. A rising mine is a propelled or buoyant moored mine that releases from its mooring and rises to detonate on contact with, or in proximity to, a target. A rising mine does not incorporate a homing device to guide it to the target, but it does contain logic circuitry that enables it to calculate where it expects the target to be.

2.2.1.3 Drifting Mines. Drifting mines have a buoyant mine case, but they do not have an anchor or any other device to maintain them in a fixed position. They are free to move with the waves, currents, and wind. Drifting mines may float at the water's surface, or they may be kept at a set depth beneath the surface by a depth-controlling hydrostatic device. Drifting mines are classified differently from a moored mine that becomes a floater, because a floater was designed to be held in place by an anchor and a drifting mine was designed to float freely with the tides and currents.

A modified version of a drifting mine is a buoyant mine case that has a weight attached to it that is heavy enough to hold the mine case near the bottom, but not heavy enough to hold it in place. These mines are known as creeping mines, because they are free to creep along the bottom when affected by tidal currents.

The principal advantage of drifting mines is that their use is independent of the bottom depth. They can be set to oscillate at or near a preset depth, which permits the mining of water that is too deep for bottom or moored mines. The major drawback of drifting mines is that they scatter and imperil friendly and neutral shipping. Consequently, drifters are usually, but not always, fitted with devices designed to sink them after a relatively short life span. Because of their short life span, the most useful application of drifting mines has been in tactical situations in which they are laid in the path of an enemy force to cause a delay or diversion giving friendly forces a tactical advantage.

2.2.2 Method of Delivery. When mines are classified according to the method by which they are deliv-

ered, they again fall into three categories: aircraft-laid mines; submarine-laid mines; and surface-laid mines.

2.2.2.1 Aircraft Delivery. Aircraft are the most suitable vehicles for the majority of offensive minelaying operations because they can penetrate areas denied to surface ships and submarines. Air-delivered mines are dropped from aircraft in the same manner as a bomb, and in general, any aircraft that is equipped to carry bombs can carry a similar load of mines of the same weight class. These mines are specially configured for air delivery and they are designed so that they will not crush or be damaged upon water entry.

There are a number of advantages associated with aerial mining operations. When compared to the other mine delivery platforms, aircraft have a fast reaction time and they can respond quickly to a mining mission. They are also the only delivery platform that can replenish an existing minefield without being endangered from previously laid mines. Airplanes can also be used to mine enemy-held inland waterways, and they can lay mines in shallow bodies of water, including rivers and harbors, that cannot be transited by submarines or surface minelayers.

There are two major disadvantages associated with the use of aircraft as minelaying vehicles. First, the weapon loads are relatively small unless large, cargo-carrying aircraft are used for mine delivery. Second, the mine positioning accuracy is lower with aircraft than with surface ship deliveries.

2.2.2.2 Submarine Delivery. Submarine-delivered mines are normally used in covert offensive operations. These mines are specially configured so that they can be launched from the torpedo tubes or mine belts of submarines. Submarines are effective minelayers because they can penetrate areas that are too well protected by air and/or surface craft for other minelayers. The availability of mobile standoff mines enhances the submarine's minelaying capability.

Submarine mine delivery is a covert operation, and when secrecy is paramount, the submarine is the preferred minelaying vehicle.

When required by OPORD or specified by Combatant Commander, capable SSNs can be available and loaded with mines, but this requirement has to be anticipated in advance to be readily available. A disadvantage associated with submarine mine laying is that there are limited numbers of submarines available, and they are frequently already tasked for other missions when the need for a mining mission is identified. Submarines have a limited mine-carrying capacity and a relatively slow

reaction time. In order for a submarine to conduct a mining mission, it must first be recalled to a port where it can offload torpedoes and onload mines.

2.2.2.3 Surface Delivery. The Mk 60 CAPTOR mine is the only U.S. mine that can be surface laid. It requires a surface ship with a crane or boom that can drop the mine from a height of at least 30 feet above the water using a modified aircraft weapons rack. All other U.S. mines would require extensive engineering modifications to be surface laid. Surface mine delivery requires control of the sea area, and it is therefore considered to be a suitable delivery method for defensive minefields only.

Surface ships offer two major mine delivery advantages. First, they are able to carry a much larger mine payload per sortie than either aircraft or submarine minelayers, and, second, they have the ability to deliver mines with much greater accuracy than either aircraft or submarines.

Outweighing these advantages, however, is their vulnerability to attack by the enemy. A surface minelayer can only be effectively used if the sea area being mined and the surrounding air space are under friendly control. In addition to this, their reaction time is slower than aircraft because of their transit speed. Surface minelayers must transit to a location where they can onload the mines and then they have to transit to the desired minefield's location.

2.2.3 Method of Actuation. Naval mines are actuated by three primary methods: contact, influence, and command/control.

2.2.3.1 Contact Actuation Logic. Contact mines are the oldest and perhaps the most commonly known type of mine. Contact mines are mines that use a contact mechanism to initiate the firing sequence and actuate the mine's explosive charge. To fire a contact mine, the target ship must touch the mine case or a contact-responsive mechanism that has been attached to the mine case. Typical contact firing mechanisms include the following:

1. Inertial switch mechanisms consist of a freely suspended contact that is positioned between a number of stationary electrical contacts. When the mine case is tilted or jarred by contact with a target, the suspended contact will engage one of the stationary contacts and energize the firing circuit.
2. Chemical horn mechanisms contain a fragile vial which is used to separate an electrolyte from the battery electrodes. The vial ruptures when the

mine case is hit by a target ship, allowing the electrolyte to flow between the electrodes. This action energizes the battery and activates the firing circuit.

3. Switch horn mechanisms consist of a spike that is connected to one terminal of a firing circuit. When the target hits the mine case, the spike is driven into the other terminal, which closes the firing circuit and activates the mine.
4. Galvanic action mechanisms use seawater/sea water as the electrolyte. A copper antenna or copper horn is attached to the mine case and connected to a firing mechanism. When the horn/antenna comes into contact with the steel hull of a ship, a current is generated that actuates a relay and the firing circuit.

2.2.3.2 Influence Actuation Logic. The firing mechanism of an influence mine is actuated by a change in the mine's physical environment that is caused by a target's presence in the immediate vicinity. A surface ship or submarine generates a variety of influence signatures, such as magnetic, acoustic, and pressure, and an influence mine mechanism is designed to sense these signatures. An influence mine utilizes one or more detectors to sense one or more of the influence fields, and if the appropriate signal is detected, an electrical signal is sent to the firing mechanism. The firing mechanism will then analyze the signal to determine whether it was generated by a valid target (i.e., an enemy vessel of a given size) and, if it is determined that a valid target is present, the firing mechanism triggers a mine actuation. The level of intensity and the duration of time that an influence field must be applied to satisfy the firing circuits of a influence mine are options available to the minefield planner.

1. A magnetic influence mechanism is a device that is designed to sense a change in the earth's ambient magnetic field that is caused by a target ship. The two types of magnetic influence mechanisms are magnetic dip-needle and magnetic inductance.
 - a. A magnetic-dip needle mechanism contains a horizontally pivoted, delicately balanced magnetic needle that is designed to pivot far enough on its axis to close a firing circuit. The horizontally pivoted magnetic needle aligns itself with the surrounding earth's magnetic field and waits for this field to be disturbed by the presence of a target. The needle pivots in response to the change in the total vertical magnetic field at the mine that results from the presence of a ship.

- b. There are three types of magnetic inductance mechanisms: search coil, total field magnetometer, and thin film magnetometer. Although their methods of detection differ, each of these inductance mechanisms is capable of generating an electrical impulse sufficient to actuate a mine's firing circuit. This electrical impulse is generated in response to a designed rate of change in the magnetic field intensity surrounding the mechanism. This change in the magnetic field intensity is caused by the passing of a target ship.
2. Acoustic influence mechanisms consist basically of passive microphones and associated circuitry for detecting underwater noises and active transponders that transmit signals and receive echoes from a previously acquired target. The passive mechanisms consist of hydrophones that are responsive to the characteristic frequency, intensity, and duration of detected noises generated by a ship's propeller, engine, machinery, or hull noises.
 3. The seismic influence used in some mechanisms is closely related to the acoustic influence. That portion of the acoustic signature that is transmitted through the ocean bottom rather than through the water is used to actuate a seismic mechanism. These mines use a geophone to sense the shaking or vibration through the mine case that is caused by the sound.
 4. Electric potential influence mechanisms make use of the electric current flow that occurs when the dissimilar metals are used in the construction of a ship are immersed in seawater. For example, an electric current is formed because the hull of a ship and its propeller are made out of different metals. This electric current flows through the water around the hull of the ship, and it can be measured and sensed by properly designed mine mechanisms.
 5. Pressure influence mechanisms detect the low pressure zone created beneath a moving ship's hull. This system may be affected by surface wave action, and, as a result, it is used primarily in sheltered waters only in combination with another influence mechanism. The advantage of a pressure influence system is that it is impossible to simulate the pressure signature of a target ship without actually towing a vessel. Therefore, this type of mine is very difficult to sweep.
 6. Combination influence mines consist of acoustic, magnetic, and pressure-firing mechanisms assem-

bled together, each of which is responsive to its own type of influence. Each sensing mechanism must receive the appropriate signal in a specified period of time for the mine to detonate. Systems involving a combination of influences are available in most mine firing devices. Combination influence mechanisms are designed to use the advantages of one system to compensate for the disadvantages of another. The most common combinations are: magnetic/acoustic; magnetic/seismic; magnetic/acoustic/pressure; and magnetic/seismic/pressure. Mines with combination influence sensors are much more difficult to sweep than mines with a single influence.

2.2.3.3 Command/Control Detonated. The firing mechanisms of command/control mines are generally directed by a control station on shore; however, it possible to locate this control station in an afloat unit. The mines receive their firing signals through hardwired control cables that run from the land-based control centers to the individual mines. Command/control mines are generally fired by personnel located in the control station who track the targets until they reach a position within the damage radius of the mines. However, detection and localization of potential targets may also be achieved by a monitoring device that is located in a mine case. Command/control mines are traditionally used as defensive weapons to protect harbor approaches, but they can also be used offensively. In some designs, the actuation control for the mine may be switched to an automatic mode, in which case each weapon becomes an influence mine. Examples of command/control mines are as follows:

1. Cable actuation
2. Remote control actuation
3. Independent actuation.

2.3 COUNTER-COUNTERMEASURE FEATURES

To complicate the MCM problem, the minefield planner has a wide variety of CCM features available on modern mines that are used to give a planted mine resistance to a wide variety of MCM techniques. These devices range from simple antisweep devices that are designed to foul or cut minesweeping equipment to highly sophisticated target discrimination circuitry and mine case construction and coatings designed to inhibit detection by sonar. The use of CCM devices, especially on influence mines, can force an enemy to make repeated hazardous, costly, and time-consuming passes over the same area to clear the minefield.

The various types of CCM devices available include the following:

1. Those that force the MCM equipment to simulate a ship exactly
2. Those that attack the sweeper or hunter
3. Those that make MCM physically more difficult (e.g., obstructers, passthrough devices, and ship counts)
4. Those that render the mine insensitive at predetermined times.

Some of the more important CCM accessories are identified in the following paragraphs.

2.3.1 Ship Counter. A ship counter can be used on mines with influence firing mechanisms to delay a mine's detonation until the firing mechanism has been satisfied a predetermined number of times. A ship counter is nothing more than a counting mechanism that is included in the mine's circuitry. When the mine receives a signal that is of the correct type(s) and of sufficient strength and duration to satisfy the influence mechanism(s), the counter is actuated and it clicks off a ship count. When the counter has been actuated a preset number of times that is, when the current ship count setting is one the firing circuit is closed and the mine becomes poised. A poised mine will fire on the next valid target that it detects.

2.3.2 Probability Actuator. A PAC can be used instead of a ship counter. A PAC allows the mine to be active for only a specific number of seconds out of any given time period. When the mine is not active, valid ship and/or sweep signatures will not be registered and the mine will not actuate.

2.3.3 Delay Arm. This accessory is a clock-delay timing mechanism that keeps the mine circuits open for a preset period of time after planting. While the mine circuits are open, the mine is inactive and it will not arm. The mine cannot be fired or swept until it has been armed. The use of delay arming features will provide for the apparent replenishment of a bottom influence minefield by having the mine's arm at varying time periods after planting. Thus, as enemy influence sweeping operations are conducted against active mines, the delayed arming of other mines will periodically replenish the field. The available delay arming time periods vary from one mine type to another, but they commonly range from several minutes to as long as a year.

2.3.4 Delay Rise. A delayed rising feature can be incorporated into moored mines that keeps the mine case attached to the anchor until a preset amount of time has passed. This feature can be used to reduce the effectiveness of mechanical mine sweeping. Delayed rising devices are used in moored mines for the same purpose as delayed arming in bottom influence mines. Through the use of the delayed rising feature, the minefield can be replenished on a continuing basis or the activation of a minefield can be delayed until some preset time.

2.3.5 Interlook Dormant Period. The ILDP is a specified period of time between influence looks during which time the weapon becomes inactive or dormant. Many influence mines require that the sensor take more than one look to determine whether a valid target is present, and each look may require the same or different level of influence intensity.

2.3.6 Intercount Dormant Period. The ICDP is a specified period of time between ship counts in which an influence mine becomes inactive or dormant. This feature is incorporated into an influence mine so that a single pass of a minesweeper is unable to satisfy more than one ship count.

2.3.7 Live Period. The LP is a time interval during which a specified event, usually a second look, must occur to satisfy the firing logic of the influence mine.

2.3.8 Dummy Mines. These are minelike objects or sonar decoys that are placed in a minefield to complicate the minehunting operation. Any object that produces a minelike image on a sonar console could be classified as a dummy mine. Each of these objects must be classified, or marked and avoided, when they are identified during minehunting operations.

2.3.9 Obstructers. These are mechanical or explosive devices that are designed to interfere with or hinder mechanical minesweeping operations by severing the sweep wires. A sprocket obstruder is a device that is designed to allow a sweep wire to pass through the mooring wire without severing the cable.

2.3.10 Anechoic Coating/Camouflage. This would include anything that is done to a mine case to make it more difficult to locate and identify through minehunting operations. Anechoic coating can be applied to the exterior of a metallic mine case to reduce its acoustic reflectivity. Nonmetallic mine cases that do not generate an acoustic return when prosecuted by minehunting sonar can also be used. Another form of camouflage would be the use of irregularly shaped mine cases, which do not reflect the type of sonar image that is considered to be minelike.

2.3.11 Nonsympathetic Detonation. Sensitivity settings can be incorporated into influence mines to ensure that they are not affected by sympathetic detonation. That is, when one mine is actuated by a target ship or a sweep, the minefield planner must ensure that other mines in the minefield are not actuated. The minefield planner should also specify what the minimum spacing must be between any two mines in a specific minefield to reduce the possibility of sympathetic detonation.

2.3.12 Antisweeper. Mines can be planted in a minefield in such a way as to target surface minesweeping vessels. These may be moored contact mines set just below the surface, or they may be bottom influence mines that have extremely sensitive actuating mechanisms incorporated into them.

2.3.13 Antirecovery, Self-Destruct, and Antistripping Features. Mines may be equipped with various features to prevent recovery by enemy forces or to resist exploitation. These may include hydrostatic switches that detonate the mine or erase the memory of a programmable mine when raised above a certain depth or internal switches that are tripped by any attempt to disassemble the mine components. These features represent a significant threat to EODMCM personnel conducting render-safe or recovery operations.

2.4 MINE DAMAGE TO SHIPS

There are three types of ship damage that can be inflicted by a mine's detonation. These types of damage are as follows:

1. Hull rupture, which is caused by the pressure wave created by the detonation.
2. Internal damage to equipment, which is caused by vibration and flooding.
3. Structural damage, which is caused by the whipping motion of the bubble pulse that is created by the detonation.

The type and amount of damage actually inflicted depends upon two factors:

1. The magnitude of the explosive force
2. The shock resistance of a particular target.

The magnitude of the explosive force that the target is exposed to is dependent upon the weight and composition of the explosive charge, as well as the geometry of encounter (e.g., the athwartship distance and the mine/target orientation).

The resistance of a particular target to an underwater explosion is dependent upon the ship type and construction, the age and history of the vessel, and the machinery's state of maintenance.

The amount of ship damage resulting from a mine's detonation also depends upon whether the mine was in contact with the target ship when it detonated. Contact mine detonations will result in an inefficient concentration of the shock wave energy, whereas noncontact mine detonations will usually result in a full shock wave and bubble pulse cycle.

2.4.1 Contact Mine Damage. When the mine explodes in contact with the ship's hull, the primary shock wave that hits the ship is moving much faster than the speed of sound, and its overpressure is not greatly diminished from that of the detonating shock wave. In any normal hull, the hull plating and structure yield for several feet around the point of contact, resulting in a large hole and severely bent or broken strength members. In the process, the ship will absorb quite a jolt that may cause further damage.

If the hole opens into an air-filled space within the ship, most of the gas will vent into the ship and expand along the paths of least resistance until it is contained by the ship structure or until it vents into the atmosphere. This may cause the rupturing of decks, hatches, bulkheads, or doors. In a submerged submarine, the internal pressure will increase as explosive gasses enter through the rupture. Seawater flooding through the hole immediately follows.

2.4.2 Noncontact Mine Damage. The damage caused by a mine that is not in contact with the ship's hull is a result of the shock wave and the gas bubble created by the explosion.

2.4.2.1 Initial Shock Wave. The most dangerous element in underwater explosions is a high-pressure pulse called the initial shock wave. Although other phenomena compound ship damage, the initial shock wave produces the most violent results because 50 to 55 percent of a mine's explosive energy is expended through the shock wave.

The initial shock wave travels radially outward from the explosion at supersonic (500 ft/s) speed. The spherical wave front will move through a ship, causing compression and acceleration of materials in every part of the ship. The pressure pulse has a very short duration (less than a millisecond) but contains enormous energy. The most devastating results will be broken welds and weakened structures. Some personnel injuries may be

caused by the initial shock wave, but most will result from other effects of the explosion.

The broken welds and weakened structures will increase the ship's vulnerability to these other effects of the explosion, such as hull whipping.

2.4.2.2 Hull Whipping. After the initial shock wave, the next destructive effect of an influence mine is gas bubble expansion and consequent water displacement. This is what is called hull whipping. The speed at which the gas bubble expands, pushing water before it, can cause the keel to bend and the hull to buckle. Masts, shafts, and other very long components of a ship will be stressed and probably damaged. Hull plating may not rupture, but the ship will likely suffer a mission kill due to engineering and combat systems equipment damage.

2.4.2.3 Gas Bubble Behavior. The very hot gases generated by an explosion expand rapidly, regardless of hydrostatic pressure (hydrostatic pressure is about 45 psi at 100-foot depth). Water is pushed outward, forming a bubble that continues to expand until internal pressure falls well below hydrostatic pressure.

If expansion were controlled and slow, the bubble would grow only until internal pressure equaled hydrostatic pressure or until it reached the surface. But because of the violent nature of the explosion, the bubble expansion is so rapid that it goes beyond the point of equilibrium. The radially displaced water continues to move outward until hydrostatic pressure is reached. The farthest extent of expansion is called the first maximum.

Upon reaching maximum radius, the bubble collapses until internal pressure rises to about 10 times hydrostatic pressure. At this point, the gas bubble has reached the first minimum and contraction abruptly ceases, causing another shock wave. The elapsed time for this depends on the depth and weight of the explosive, but for mine warfare considerations it is less than a second. The internal pressure built during the collapse causes another expansion to the second maximum. The process continues up to 10 oscillations if the explosion occurs in sufficient water depth.

Because the bubble is always lighter than the surrounding water, the size and depth of the explosion determines the time required for the bubble to reach the surface. For example, 1,000 pounds of TNT in 40 feet of water will cause an explosion that has only one expansion. The bubble gases will vent to the atmosphere upon reaching the first maximum, with water rushing in to fill the void. In another example, 300 pounds of TNT in 300 feet of water will cause a gas bubble that expands

and collapses four or five times before venting to the surface.

2.4.2.4 Energy Transmission. The initial shock wave contains 50 to 55 percent of the energy from an explosion. The gas bubble generated contains the remaining energy: the first expansion expends 5 to 10 percent (depending on depth), while the second shock wave carries off about 20 percent. Successive contractions send off smaller shock waves, but by the end of the second contraction, about 85 percent of the energy has been expended. Depending on depth, the bubble will expand and collapse until all explosive energy is expended.

The energy from an explosion in deep water will primarily be converted to heat, raising the temperature of the surrounding water. In shallower water and in the vicinity of boundaries like the bottom or a ship hull, a more dramatic energy conversion takes place: the bubble expansion violently displaces water, which pushes moveable objects before it; a reversal of water flow when the bubble collapses then carries the movable objects back toward the center.

2.4.2.5 Secondary Shock Wave. Gas bubble pressure at the first minimum is about 1,000 psi, depending on water depth and explosive weight. The reversal of water flow, when this high-pressure region stops collapsing, creates another shock wave. The peak pressure of the secondary shock wave is only about one-twentieth of the initial shock wave, but the duration of overpressure may last 10 times as long. Consequently, the impulse (pressure times duration) of the secondary shock wave is of the same magnitude as the initial shock wave even though the energy contained in the wave is about one-tenth that of the initial wave. A ship can receive additional damage from the secondary shock wave if a mine detonation is close enough for the initial shock wave to cause damage.

2.4.2.6 Bubble Migration. Because a gas bubble is less dense than the surrounding water, it is moved upward by buoyant forces. A bubble travels to the surface with increasing speed until it reaches terminal velocity or the surface. If a rising bubble oscillates at a frequency equal to or a harmonic of the natural frequency of a ship's hull (about 2 Hz), the bubble will emit shock waves that can amplify damaging effects to the hull, keel, and equipment.

If mine detonation occurs near a boundary (sea bottom or ship hull), the bubble created tends to stick to the boundary. Since bubble oscillations cause water to flow outward from the point of the explosion, no flow will occur on the boundary side. However, water on the side

away from the boundary will return to the vicinity of the boundary on successive collapses, giving ship hull plating an additional pounding.

2.4.2.7 Plume. A gas bubble generated in shallow water will breach the surface and vent gases. A cylindrical sheet of water will be thrown high into the air with enough velocity (hundreds of feet per second) that ships or landing craft could sustain severe damage if in the vicinity of the plume.

2.5 U.S. NAVY/ALLIED MINES

2.5.1 U.S. Navy Service Mines and Mine Characteristics. The U.S. mine inventory currently consists of air-and-submarine delivered, influence-actuated mines. The smallest mine is in the 500-pound weight category and the largest is 2,000 pounds. There are no drifting mines in the inventory, nor are there any contact or controlled mines in the U.S. inventory at this time. Appendix D provides a chart of U.S. mine characteristics. The U.S. mining program is set up to support offensive mining operations. If the United States desired to attain a strong defensive minelaying capability, new mines would be required or extensive engineering modifications would be required on current mines.

2.5.1.1 Destructor Mk 36 and Mk 40 (IOC 1968). DST are aircraft-laid bottom mines which were developed to provide a rapid-response mining capability during the Vietnam Conflict. They were called DST because the term "mine" was politically objectionable at that time. The mine case and explosive charge for the DST Mk 36 and Mk 40 are provided by the Mk 82 (500-pound) and Mk 83 (1,000-pound) General Purpose Low-Drag Bombs, respectively. The explosive weight of the DST Mk 36 is 196 pounds of H-6, and the DST Mk 40 contains 453 pounds of H-6. Since these mines are modified bomb bodies, they contain less explosives by weight than they would if they had been developed initially as mines. (Bombs have thick cases designed for their shrapnel-producing capabilities and mine cases are thin-walled and consequently lighter in comparison.)

The general purpose bombs are converted into mines through the installation of a modification kit of modular components. This kit contains an arming device, an explosive booster, an influence firing mechanism, a battery, and all associated hardware. The Air Force can incorporate this kit into its 750-pound Mk 117 bomb, which then becomes the DST Mk 59. In addition to the modification kit, all DSTs are also equipped with a retardation device (fin or parachute) for delivery.

When converting a bomb into a DST, the arming device and explosive booster are installed in the bomb's

nose cavity, and the firing mechanism and battery are installed in the bomb's tail cavity. The DST's firing mechanism is capable of sensing and responding to two different influence combinations, depending upon how it is set. The DST can be used as solely a magnetic mine, or it can be used as a combination magnetic and seismic mine. There are also several sensitivity settings available for use on DSTs as well as several delayed arming settings. All DSTs are designed to self-destruct at a preselected time after planting or when the battery's charge falls to a specific point.

DSTs became the first sea mines that could be used on both land and in water. When dropped on land, they bury themselves in the ground on impact, ready to be actuated by military equipment, motor vehicles, and personnel. When dropped in rivers, canals, channels, and harbors, they lie on the bottom, ready to be actuated by a variety of vessels, including warships, freighters, coastal ships, and small craft. DSTs were originally designed for use against small junks, sampans, and other craft that have small magnetic signatures, but they are also very effective against larger target types when they are properly set and planted in the appropriate water depths.

2.5.1.2 Mine Mk 56 (IOC 1966). The Mine Mk 56 currently has the distinction of being the oldest service mine in the U.S. inventory. The Mk 56 is a 2000-pound, aircraft-delivered moored influence mine that consists of an anchor, a buoyant mine case containing the explosive charge, which is 360 pounds of HBX-3, and flight gear. It was designed as an antisubmarine mine that was intended to be effective against high-speed, deep-operating submarines, but it can also be used effectively against some surface craft. The Mk 56 mine case can be moored at various depths to create a vertical wall against submarine intrusion.

The Mk 56 has a nonmagnetic, stainless steel case and a cast steel anchor. It is also equipped with flight gear since it is launched from an aircraft. The Mk 56 has a magnetic firing mechanism that uses a three-dimensional total-field magnetometer as its influence detector. This detector can be set to respond to various levels of magnetic influence intensities, and it also has various delay rise, case depth, and sterilization/self-destruct settings available for use, depending upon the intended purpose of the minefield.

When laid, the mine sinks to the bottom, where the case and anchor remain together as an integral unit until the preset delay rise time is reached. At that time the case and anchor separate and the mine case rises toward the surface. In the event that the mine becomes embedded in bottom sediment before case and anchor separation

takes place, a slow-burning propellant in the anchor ignites. As this propellant burns, it creates bubbles around the mine case, freeing it from any mud in which it may be buried. As the case rises, a hydrostatic sensor is used to ensure that the mine case is moored at the desired preselected depth. Should the mooring mechanism allow the mine case to rise to a depth that is too shallow, the case will scuttle itself, which reduces the possibility of compromise and eliminates it as a navigational hazard. This scuttling feature will also be used if the mine cable breaks or if the mine is set to sterilize rather than self-destruct when it reaches the end of its preset armed life.

2.5.1.3 Quickstrike Mines Mk 62 and Mk 63 (IOC 1985). Quickstrike Mines Mk 62 and Mk 63 are a new generation of aircraft-laid bottom mines that provide a fast response-to-readiness capability. Like the DST family of mines, the Quickstrike Mk 62 and Mk 63 are conversions of General Purpose Bomb Bodies Mk 82 (500-pound) and Mk 83 (1,000-pound), respectively. Also like the DST, the explosive weight of the Mk 62 is 196 pounds of H-6 and the Mk 63 contains 453 pounds of H-6.

The conversion of a general purpose bomb into a Quickstrike mine is very similar to that previously described for DST. In fact, the same arming device and explosive booster used in the DST are also installed in the nose cavity of the bombs to make these Quickstrike mines. However, the parts inserted in the bomb's tail cavity are different, and include an improved battery and a variable influence TDD Mk 57.

These mines were designed for use against both submarines and surface targets, and they are capable of having various arming delay, sterilization, self-destruct, and other operational settings placed into them. The TDD Mk 57 uses magnetic and seismic influences for target detection and validation, and like the DST's firing mechanism, it can be set to respond to various levels of magnetic-only influences or it can be set to require a combined magnetic and seismic influence of the proper magnitude.

2.5.1.4 Quickstrike Mk 65 (IOC 1985). The Quickstrike Mine Mk 65 is a 2,000-pound aircraft-laid bottom mine. Unlike the other Quickstrike mines, this mine is not a converted bomb. Instead, it is a weapon that was designed specifically to be a mine, and it consists of a distinctively different, new-concept, thin-walled mine case. The Mk 65 also has a newly designed arming device and nose fairing, and it has a tail section that is adaptable to a parachute option.

The Quickstrike Mine Mk 65 was designed for use against both submarines and surface targets, and like the other Quickstrike mines, it is also capable of having various arming delay, sterilization, self-destruct, and other operational settings placed into it. The Mk 65 can have either a TDD Mk 57 or TDD Mk 58 firing mechanism, both of which can be set to operate at a variety of sensitivity settings. The TDD Mk 57 uses magnetic and seismic influences for target detection and validation, and the TDD Mk 58 adds a pressure sensor capability to those provided by the TDD Mk 57.

2.5.1.5 Mine Mk 60 (CAPTOR). The Mine Mk-60 is a 2,000-pound, deep-water moored mine. It is normally laid by submarine or aircraft, but it may be laid by surface ships equipped with cranes or booms and a special release device. It is more commonly referred to as CAPTOR (an acronym for enCAPsulated TORpedo). The CAPTOR mine is a sophisticated antisubmarine weapon system that has an Mk 46 Mod 4 torpedo located inside of a mine case. This mine is designed so that it will detect and classify submarines and then release a modified Mk 46 Mod 4 Torpedo to acquire and attack its target.

The CAPTOR mine incorporates an acoustic influence target detection system. When employed, the weapon lies dormant until a target is detected, at which time the torpedo swims out of its capsule to attack and destroy its target. There are various arming and sterilization delay options that can be programmed into the Mine Mk 60, and the mine will also sterilize if the case moors too shallow or the battery voltage falls below a specific point.

2.5.1.6 Mine Mk 67 (SLM) (IOC 1987). The Mine Mk 67, which is more commonly referred to as the SLMM, is a 2,000-pound, submarine-laid bottom mine that is designed to target both surface ships and submarines. The SLMM is designed to be covertly propelled to a predetermined planting location and can be planted in areas that are not normally accessible for the planting of other mines.

The Mk 67 mine consists of a modified Mk 37 torpedo with a mine section attached to it. The Mk 37 torpedo serves as the propulsion vehicle to deliver the mine section to its intended location. The mine section of the Mk 67 contains the main explosive charge as well as the exploder, the arming device, the target detecting device, and the associated battery.

The Mk 67 uses the same firing mechanism as the DST. It can be set to respond to magnetic-only influences or to combination magnetic and seismic influences. There are multiple sensitivity settings available

for both the magnetic and the seismic sensors, and there are also numerous delay arming, sterilization and self-destruct settings available.

2.5.2 Exercise and Training Mines. ET mines are reusable mine configurations used primarily for training exercises. The ET mines use an inert loaded or empty mine case that, in most cases, makes them look like their service mine counterparts. Small explosive devices and/or pyrotechnics are contained in some ET mines to provide realism in mine delivery and firing simulation and to aid in recovery operations. Specific descriptions of some common exercise and training mines follow.

2.5.2.1 Actuation Mines. Actuation mines can be used to support total weapon employment training in exercises and in war games at sea. The target response characteristics of actuation mines are identical to those of the service mines of the same Mk and Mod. Actuation mines may be configured for either aircraft or surface delivery.

Actuation mines consist of an inert-loaded mine case that contains serviceable mine detection, firing, and safety devices. The bottom mine has an externally attached float that contains a pyrotechnic smoke signal and approximately 120 feet of nylon line used for recovery. When the mine actuates, it releases the smoke signal. At a preset time, the float is released, which enables recovery teams to locate and recover the mine. The moored mine also releases a smoke signal when actuated, and the case releases and rises to the surface for recovery at a preset time. Actuation mines use a sonar transmitter (pinger), which aids in location and recovery.

To distinguish actuation mines from service mines, and to enhance their visibility in expediting and facilitating recovery in the water, they are painted orange and white.

2.5.2.2 Versatile Exercise Mine System. VEMS is an exercise and training mine that is manufactured by British Aerospace. It can be used for a variety of purposes because it can be programmed to emulate any various foreign or domestic mines. VEMS can be used to assess the effectiveness of the magnetic/acoustic influence sweeps and tactics of the airborne, and surface, and EODMCM forces, provide indication of platform safety when sweeping against a particular mine, and provide training in minesweeping and minehunting operations. It can also be used to check the ship's magnetic signature.

2.5.2.3 Laying Mines. Laying mines are used by delivery vehicles during mine delivery practice. They con-

sist of inert-loaded mine cases that contain weights in place of internal mine components to provide a weight and center of gravity equivalent to its service mine components. Complete and operable mine flight gear is used on mines planted from aircraft. Other components that interface with arming wires are also provided (less explosives). A sonar transmitter is installed to aid in location for recovery. The mine case is painted orange with white stripes.

2.5.2.4 Diver Evaluation Unit. EOD Mobile Units are equipped with a DEU, which although not a mine, simulates the sensor package of a mine and provides the diver a method of measuring the reaction of the mine to his magnetic and acoustic signature. The EODMCM detachment uses the DEU for individual training and unit exercises, and it can also be employed in larger scale exercises to provide effective training feedback to the EOD force.

2.5.3 Future Mine Potentials. There are a number of mine improvement programs that are currently being worked. One of these is intended to provide a pressure influence capability for the SLMM, which will make it much more effective when used in countered minefields. There is also a program in place to develop an LSM to replace the aging Mk 56 moored mine, our only mine currently able to target surface ships in deep water. Other mine program improvements being looked at include a high-volume mining capability and a RECO capability for mines. Future mines could have computer chips in them for target detection devices, providing the planner with very selective target selection abilities, or mines which could cover a wider range of water depths and give a wider selection of target types.

2.5.4 Mine Storage, Preparation, and Transportation. The U.S. Navy maintains Service mines at pre-positioned locations in CONUS and overseas, as well as on some aircraft carriers and ammunition ships. Those mines located on afloat units can be made available for delivery within 24 hours, but their type and number are limited. Those located at land-based storage facilities must first be built up and then transported to the delivery platform. The time required to build these mines varies by mine type, but most of them can be prepared in less than 48 hours.

When land-based mines are needed for a mining mission, they must be transported to the delivery vehicle. This may be accomplished by using one or more of the following transport methods: truck, rail, cargo aircraft, or ammunition ship. The type of transport method selected will depend on the number of mines that must be transported, the availability of the transportation

methods, from what location they must be transported, and to what location they must be transported.

2.5.5 Minefield Planning Process and Procedures. A minefield is the actual or implied use of underwater explosive devices to impose strategic or tactical constraints on the operational use of an area by surface ships or submarines. The minefield is but one weapon that the military strategist can employ to accomplish specific objectives, and it must be considered as part of a total strategic network for a given campaign.

The United States maintains a set of preplanned strategic minefields that is contained in MFPPs. These folders are planned by the COMINWARCOM mine planning staff, as directed by the FLTCINCs, and are promulgated in accordance with a distribution list that is provided in MFPP 00. The plans contained in approved MFPPs are developed according to situations that may arise. MFPPs are reviewed and updated at regular intervals to ensure that they support the FLTCINCs' General War Plans. However, when a minefield is actually being considered for delivery, the preplanned fields may not be sufficient to support the desired objective, or there may not be a plan prepared for the area to be mined. In that case, the current plan may need to be updated, or a new plan may need to be developed. This process can be accomplished by the staff planners at COMINWARCOM, if time permits, or it can be accomplished by mine planners assigned to the battle group or air wing.

MFPP 00 serves as an index to all MFPPs, providing information about the Uniform Minefield Planning System, how to use each MFPP distributed, types of mines in the inventory, types of authorized delivery platforms, and the number of mines each can carry.

Individual MFPPs contain the following:

1. Recommended minefields identified by latitude and longitude
2. The recommended number and types of mines that will be used in the field
3. A list of priority targets that the minefield is to encounter
4. Recommended mine settings for the priority targets identified by the CINC
5. Options for different levels of threat
6. Recommended delivery platforms

7. An intelligence assessment of the country/area to be mined.

During the minefield planning process, there are a number of factors that must be determined and/or evaluated. For example, the number and type of mines that will be planned for delivery to a specific minefield is dependent upon a variety of variables, including the type of minefield that is to be constructed, its purpose, and whether it is expected to be countered. Target types and environmental considerations also play a major role in the minefield planning process. Some of the required planning factors must be provided to the minefield planner by the operational commander or other higher authority, while others are standard items which must be determined and/or evaluated by the planner.

2.5.5.1 Types of Mining Operations. The type of mining operation will have an effect on the types of mines that are used, as well as the settings that are employed on those mines. The location of the field and the type of delivery vehicle used are also affected by the type of the operation. Offensive mining operations are generally intended to destroy, or obtain mission abort damage, to enemy naval or merchant shipping, and they may be exposed to heavy enemy MCM efforts. Therefore, the field will generally be planned using sophisticated weapons with counter-countermeasures features. On the other hand, defensive and protective minefields are generally not subjected to MCM procedures, but since they must be planned to allow friendly passage, mine positioning within the minefield is very important and must be considered when selecting the delivery vehicle.

2.5.5.2 Types of Minefields. There are many different types of minefields, each having an impact on such things as field location, mine type(s) and settings, field sustainability, etc. The following are a few of the many types of fields:

1. A closure field is planned to prevent all enemy movement and should present a degree of threat severe enough to convince the enemy not to challenge the field. This type of minefield may be sustained or unsustained, countered or uncountered. In this type of field, the planner wants to achieve target damage whenever a mine actuates.
2. An attrition field would be planned to cause enough damage to hinder enemy movements through the field. These fields may be either sustained or unsustained fields.
3. A nuisance field would have an adverse effect on enemy movements until it was determined that the

actual threat posed by the field was relatively low. This type of minefield would be planned to force the enemy into taking countermeasures that would delay his efforts. In this type of field, the planner is more concerned with obtaining actuations than damage.

4. An antisubmarine field would be planned to specifically target submarines. It may be designed to target other types of ships, or to be effective only against submarines.
5. A dummy minefield contains no live mines and presents only a psychological threat. This type of field may be very effective against an enemy without an MCM capability, or it may sufficiently delay traffic while the enemy conducts MCM operations to determine that the field is a dummy.

2.5.5.3 Countermeasures. Expected countermeasures also have an effect on the planning process.

1. A countered field is a minefield in which the enemy is expected to employ MCM procedures, and the planner must determine what the expected level and type of MCM procedures would most likely be. A countered field will usually require the use of mixed mines of varying ship counts and delay arms, as well as other counter-countermeasure features to ensure the field's effectiveness.
2. An uncountered field would be one in which the enemy is not expected to employ any countermeasures techniques. These fields would generally require a smaller number of less sophisticated mines that have little or no counter-countermeasure features.

2.5.5.4 Intelligence. Available intelligence plays a major role in the minefield planning process. Intelligence information will be used to determine the primary and secondary target types that the field is planned against, and their expected transiting pattern. The number and types of targets will affect the types of mines used in the field, as well as the settings used on those mines. Available intelligence on enemy defenses will also have an impact on the planned type of delivery vehicle, which will also affect the types of mines that can be used, as well as where the field can be placed.

2.5.5.5 Measure of Effectiveness. A desired MOE must be designated for the minefield so that the planner has a quantifiable threat value to use in developing the minefield plan. The following five MOEs are available for use.

1. Simple initial threat is the most widely used effectiveness measure because it is easy to understand and easy to plan. Simple initial threat is the probability of hitting the very first target transitor that challenges the field; however, when this MOE is used, it does not provide any threat information for subsequent transitors. This MOE is very useful for fields where no MCM or infrequent ship transits are expected and is easy to calculate. Simple initial threat is the only effectiveness measure that can be calculated without the use of a computerized planning model.
2. A threat profile can be used to provide a threat measurement for each transitor of a given type in a sequence of transits. For example, if five transitors are expected, it can be used to determine what the threat would be for each transitor in the sequence. It represents an extension of simple initial threat.
3. Sustained threat is commonly used for countered minefields, and it provides an effectiveness measure to expected transitors over a period of time.
4. Expected casualties is an MOE that is useful to indicate the strength of a minefield. It is used to provide the average number of casualties that would be expected to occur for a given number of transits.
5. Casualty distribution is the most useful effectiveness measure for minefields being planned against multiple transitors. It specifies the probability of obtaining at least n casualties out of k transits at a specified level of confidence.

Once minefield planners have been provided with the above information, they commence the actual planning process in which they will determine the field's specific location, the delivery vehicles to be used, and the types and numbers of mines required, as well as the settings to be used on these mines. During this process, the minefield planner must also know what types and numbers of mines are available for use in the field being planned, as well as the availability of the required delivery vehicles.

When developing the actual plan, planners must first determine the actual geographic location of the minefield or minefield segments. This is accomplished by surveying possible locations to determine which one is best to achieve the objective within given constraints. The environmental conditions in the desired location will have an impact on mine quantities and types of

mines that can be used. The environmental considerations are extensive and are covered later in this chapter.

Using all available planning publications and/or computerized aids, planners determine the actual mine types and numbers required to achieve the desired result, as well as the specific sensitivity and operational settings that need be set into each mine. Some of the operational settings that the planner must determine are delay arming/rising, ship count, sterilization/self-destruct times, ILDP, and ICDP.

Once planners have developed the best plan for the desired objective, they must ensure that it is logistically feasible. That is, the required types and numbers of mines must be available within the time constraints required for delivering the field, and the required types and numbers of delivery vehicles must also be available. If these assets are not available in the required numbers, it may be necessary to lower the desired threat level or make other changes to the plan so that it is deliverable within the required constraints. The threat level is determined through discussions with the operational commander, who has the ultimate responsibility for the mine plan.

Delivery vehicle and weapon availabilities are important planning factors that may be uncertain until the operation actually commences. If Navy carrier-based aircraft are to be used, the field location might be chosen to minimize the number of mines (and the number of required sorties), within the limits of some acceptable risk to the delivery aircraft. The availability and storage location of the mines will also affect the minefield plan, and because of its availability, a less effective mine may be used in the field. Thus, during the initial minefield and mission planning, a best estimate of the situation is derived and included in the planning factors. During the final mission planning, last-minute alterations may have to be made to accommodate changes in the situation and/or availability of assets.

2.5.6 Computer Programs in Use. There are a number of computer programs available to the minefield planner. Some of these are available only to the staff planners at COMINEWARCOM and others are available to the mine planners on the battle group staff and in the air wings.

2.5.6.1 Uncountered Minefield Planning Model. The UMPM program is available to COMINEWARCOM staff planners. It allows the minefield planner to develop sophisticated minefield plans for an uncountered scenario. The model can be used either to determine how many mines are required for a specific scenario, or to evaluate a possible plan to determine

what a field's measure of effectiveness would be. The program accesses a database that contains damage and actuation data for a wide variety of mines and settings against various target types. The damage and actuation data for a specific mine versus target can be entered if it is not contained within the database.

2.5.6.1.1 Planning Mode. If the model is going to be used to determine how many mines are required for a specific minefield, the user must input a number of items. These include mine type (Mk and Mod), mine sensitivity setting, transitor type, number of transitors, transitor speed, transitor's navigational error, minefield width, water depth, desired damage level, and desired MOE. The planner usually desires to evaluate how different mines or different sensitivity settings will respond to a given situation. This can be done by successive iterations of the program, entering different variables for each iteration. The program is very simple to use and an experienced planner can make multiple runs very quickly. Each time the program is run, it calculates the number of mines of the given type and setting required to achieve the requested threat level. It also calculates the resultant effectiveness measure for all other types of effectiveness measures. For example, if you used the model to determine how many mines were required to achieve a 75-percent simple initial threat for a given scenario, it would also tell you what the resultant sustained threat, expected casualties, threat profile, and casualty distribution are for the scenario using the calculated number of mines.

2.5.6.1.2 Evaluation Mode. The planning mode of this model allows the planner to calculate only the number of mines required for one mine type at one sensitivity setting. However, in most cases, multiple mine types and/or multiple settings within a single minefield are used. The evaluation mode of the program can determine the effectiveness of a field with multiple mines and/or multiple settings. The inputs are basically the same as those required in the planning mode, except the number of mines must be input for each mine/setting combination to be evaluated, and the desired effectiveness is not entered. The resulting output will be the level of threat that the minefield would be expected to provide.

2.5.6.2 Analytical Countered Minefield Planning Model. The ACMPPM model provides a countered minefield planning capability to COMINEWARCOM planners. The program can be used in a planning or evaluation mode, similar to the UMPM, but requires additional, detailed information on anticipated MCM equipment and MCM techniques that the enemy would employ against the field. This program is very complex

and each iteration takes a great deal of time to set up and run.

2.5.6.3 Forward Area Minefield Planner. The FAMP computer model is available to the air wing planners. It is a floppy-disk computer program that operates on a WANG 2200 VP or MVP computer. FAMP provides fleet planners with the on-board planning capability to support their mining operations. It provides an uncountered planning capability similar to that available on UMPM, except that it has a smaller database. However, it is an excellent planning tool for the tactical planner who must develop a plan very quickly using on-board mine assets. FAMP also has a limited CMPM, but the planner must input all of the operational characteristics for the expected MCM assets, information that is usually unavailable. FAMP will also generate a formatted minefield plan message, prompting the user for the essential elements of information. The final module of the FAMP model helps develop the minefield DELTAC for TACAIR mine delivery. This segment of the program computes minelines and drop points for a uniform, random distribution minefield.

2.5.6.4 Tactical Aircraft Mission Planning System. TAMPS is a computerized method for planning and optimizing mission routes against hostile targets. It consists of core application software and aircraft and weapon-specific mission planning modules.

2.6 U.S./ALLIED MINELAYING ASSETS

Mines reach their maximum effectiveness only when they are accurately positioned in their selected areas in time to be armed and ready for the transit of the first target ship. This requirement for timely laying places the burden on operational forces to employ delivery vehicles with acceptable capabilities. Mines may be delivered to the minefield by aircraft, submarine, or surface craft. The selection of the vehicle to be used for carrying out a mining mission depends on the various environmental and operational factors associated with each situation. Factors to be considered when selecting a delivery platform are as follows:

1. Whether the minefield is defensive or offensive
2. Number and type of mines to be delivered
3. Number of sorties required
4. Defensive capabilities of the area, the attrition rate expected for delivery vehicles, and the need for standoff delivery systems

5. Environmental characteristics, such as water depth and bottom composition
6. The required accuracy of delivery
7. The logistics involved in coordinating stockpiled mines and delivery system.

Therefore, should a mining operation be ordered, the choice of vehicle depends on its availability and its compatibility for mine delivery.

2.6.1 Air Delivery. Aircraft are the most suitable delivery vehicles for most offensive mining operations. In general, any aircraft capable of carrying bombs can carry a similar load of mines of the same weight class. There are some constraints and limitations imposed by the mismatching of suspension lugs on some mines to certain bomb racks, the shape and dimensional changes of some mines brought about by the addition of flight gear or fins, and the high drag and buffeting characteristics of mines carried on external stations. Several incompatibilities are correctable with existing adapters and modification kits, but the performance limitations imposed on high-speed aircraft is also a factor. In planning a minelaying mission, such factors as range, weather conditions, auxiliary equipment, and armament must be considered because each can affect the maximum permissible load of the aircraft. The tactical manual of the individual aircraft is the final authority on mine carriage.

2.6.1.1 Advantages. There are a number of advantages associated with air delivery.

1. Aircraft can penetrate those areas that are denied to submarines by hydrographics or to surface ships because of enemy defenses. Aircraft can replenish existing minefields without endangering themselves from previously laid mines.
2. Aircraft have a faster reaction time than either surface ships or submarines. When properly alerted, aircraft can respond quickly and turn around faster than other assets when multiple strikes/sorties are required. Aircraft can also get to the minefield location quicker than other assets, especially if forward-deployed carrier-based aircraft are used.
3. Aircraft are generally more available than the other assets. They can usually complete their mining mission quickly and be made available for other missions.
4. Aircraft can carry a wide variety of mine types.

5. Aircraft have a virtually unlimited approach direction.

2.6.1.2 Disadvantages. There are a number of disadvantages associated with air delivery, but for offensive scenarios, many of these can be overcome through proper planning.

1. The carrying capacity per sortie for most aircraft is relatively small, except for large, cargo-carrying aircraft. However, this disadvantage can be overcome by their ability to rapidly make multiple sorties.
2. The minelaying accuracy of aircraft is lower than for a surface ship, but adequate for offensive mining scenarios.
3. Many aircraft types can be restricted by weather conditions.
4. The range of aircraft is more restricted than that available from either surface ships or submarines.

2.6.1.3 Helicopter Delivery. It is possible to deliver mines by helicopter, but the use of helicopters would be inefficient because of their limited range and carrying capacity. However, they may have a role in replenishing defensive and protective minefields or in placing small barrier fields in rapid response situations.

2.6.2 Submarine Delivery. Submarines are most effective in laying mines in areas that are too well protected for either surface or aircraft delivery. Normally, they will be used in offensive minelaying, but may be used to lay defensive fields as well. Submarine minelaying operations can take place day or night, on the surface or submerged. The availability of the submarine launched mobile mine enhances the submarine's minelaying capability.

2.6.2.1 Advantages

1. The greatest advantage of submarine delivery is that it is covert. The secrecy with which a submarine can deliver mines to an enemy port or operating area at great distances from friendly bases provides an overwhelming tactical advantage. When secrecy is paramount, the submarine is the preferred minelaying vehicle.
2. The mission radius of a submarine is also a major advantage.

2.6.2.2 Disadvantages.

1. Submarines cannot replenish a previously laid minefield.
2. Submarines have a limited mine capacity, so they are not conducive to carrying large payloads. To carry mines, a submarine must offload one torpedo for every two mines.
3. Submarines have a slow reaction time. If not preloaded with mines for a contingency operation, they must return to a port where torpedoes can be offloaded and mines unloaded when tasked with a mining mission. Their transit speed is also slow when compared to aircraft delivery.
4. There are limited submarines available, and they have other missions that would compete with minelaying.
5. The variety of mine types available for submarine delivery is limited. Mines must be specially configured to fit into a torpedo tube to be deliverable by submarine.

2.6.3 Surface Delivery. Surface delivery is the preferred method for protective and defensive minefields where the transit distances are small and the area to be mined is under friendly control. Any surface ship can be rigged to lay mines by hoisting or rolling the mines over the side or by using temporarily installed mine rails or tracks. Although minelaying ships of various types appeared on the Navy list for about 60 years, there are no active surface minelayers today. However, should an operational requirement develop, a surface minelaying capability could be provided through jury-rigged appendages to whatever ships were available or, if time permitted, by suitable conversion of ships with large cargo capabilities. The allies do have a surface minelaying capability.

2.6.3.1 Advantages

1. Surface ships are able to carry a larger number of mines than either aircraft or submarine minelayers.
2. Surface assets have the ability to position mines more accurately than the other delivery assets.

2.6.3.2 Disadvantages

1. Surface ships have a slow reaction time and are not suitable for minelaying when time is critical.

2. Surface ship minelaying is not very covert.
3. Surface ships are vulnerable to attack by the enemy, so they are not effective offensive minelayers.
4. Surface ships are unable to replenish existing minefields.

2.7 IMPACT OF ENVIRONMENT ON MINING

The environment plays a significant role in mining. The first consideration in planning a minefield is the possible geographic location. Locations (e.g., chokepoints, harbors, and ports) where ship traffic is physically constrained may appear more suitable than others. Although such points may seem to be the best choice from a geographic standpoint, other critical environmental factors may override their use. These additional environmental factors are water depth, prevailing sea state, sea ice, tides, currents, seawater temperature, bottom conditions, magnetic environment, acoustic environment, and pressure environment. Figure 2-1 provides a matrix of environmental considerations for mining.

2.7.1 Water Depth. The primary concern is to choose waters where the mines selected will be effective against their intended target. Water depth is a critical factor: a mine's detection ability and damage effectiveness, as well as its physical integrity, are affected by depth. If a minefield is planned against a surface target and the water is too deep for the mine type used, surface units may pass without actuating the mine, or if the mine is actuated, pass without suffering the desired level of damage. Additionally, if a mine is laid in water too shallow for the type used, much of the mine's damaging ability may be lost through surface venting.

2.7.2 Winds. Winds can have a direct impact on the sea state and swells, and they can also affect the delivery accuracy of air-laid mines.

2.7.3 Seas and Swells. Dependent on wave height and water depth, a pressure sensor can be affected by the pressure signature of a wave along the bottom. Under the right sea state conditions, an otherwise unsweepable pressure mine may become sweepable because the prevailing pressure environment satisfies the pressure sensor. Therefore, the planner should, when possible, lay pressure mines in sheltered areas where sea state will not affect the sensor.

Seas and swells can also cause mine burial and mine movement, and heavy swells can cause a sensitive magnetic sensor to actuate.

2.7.4 Sea Ice. A knowledge of the ice conditions can allow the planner to evaluate a particular mine type to determine its suitability for use. For example, ice coverage is better for pressure mines: ice may increase ambient background noise decreasing the effectiveness of acoustic mines.

Large chunks of ice may activate certain mines in the field, but it can also complicate the MCM effort. The presence of ice is currently a major deterrent in placing a minefield because of the uncertainties in the behavior of mines under an ice cover and the difficulty of penetrating the ice cover.

2.7.5 Tides. Relatively shallow water areas where moored mines might be used may be subject to very large tidal variations. These variations can significantly alter the depth at which a mine moors. Accordingly, the selection of the mooring depth can be critical, depending upon the water depth, the range between high and low tide, the lively tidal flow, other currents, and the expected hour that the mines will moor. If all of these factors are not carefully considered, that a large fraction of the mines may scuttle or, for certain periods, mines may be too deep to be effective.

2.7.6 Currents. Relatively high surface currents may also affect the response of certain influence mines by changing the magnitude of the acoustic and pressure influence fields generated by passing ships. Currents may also affect ground mines, especially on hard bottoms, by causing a rolling motion, resulting in spurious actuations. Where bottom currents and hard bottom conditions are known to exist, minefield activation delays of up to 3 days may be needed to allow the mines to settle. Currents can also cause problems for moored mines, causing the mine case to dip below its planned depth. The amount of dip is determined by the current speed and the amount of cable between the case and the anchor.

2.7.7 Seawater Temperature. High seawater temperature can reduce the life of a mine's battery. However, this is a concern only if the mine requires its maximum possible life prior to sterilization.

2.7.8 Water Transparency. Water transparency varies between operational areas and is dependent upon the amount of light, absorption of light, and scattering of light by particles suspended in the water. In very clear water, the mines will become more visible to spot, and can then be more easily countered or avoided.

2.7.9 Marine Life. Marine life fouling can degrade the performance of acoustic sensors and marine life can produce an increase in the ambient background noise.

ENVIRONMENT		EFFECTS ON MINEFIELD			
FACTORS	DEPEND ON	GROUND MINE MECHANISMS			MOORED CONTACT OR INFLUENCE
		ACOUSTIC	MAGNETIC	PRESSURE	
BACKGROUND NOISE	Marine life, swell, waves, tide, rain	Field effectiveness reduced. Adjust sensitivity settings	Little/none	Little/none	Same as for ground mine
MAGNETIC FIELD	Magnetic storms causing short period fluctuations	Little/none	Comparatively insignificant. DSTs may actuate	Little/none	Same as for ground mine
MINE BURIAL	Bottom material, current, mine mass, water depth, layer		Little effect	Signal attenuation; shallow: adjust sensitivity, deep: do not use	Burial > 1 meter may impede operation of delay rising mechanism
BOTTOM PRESSURE	Waves, swell	Little/none	Little/none	Stresses sensor, reduces sensitivity, aids MCM	Little/none
CURRENTS AND TIDES		Mine burial, mine rolling	Mine burial, mine rolling	Mine burial, mine rolling	Dip depth of mine below surface, mine walking
FOULING	Current, temperature	Signal attenuation	Little/none	Unlikely to be affected	Greater dip, mooring switches fouled, bioluminescence
TRANSPARENCY	Water movement, bottom sediment	Visual detection by diver, television, helicopter, and/or surface			Detection enhanced in shallow clear water

Figure 2-1. Environmental Conditions in Mining

Marine growth can also cause an increase in the amount that a moored mine case dips.

2.7.10 Bottom Conditions

2.7.10.1 Topography. Slopes may allow a bottom mine to roll out of position and may cause a moored mine anchor to walk to the bottom of the slope. A rough bottom or a cluttered bottom may increase sonar reverberation, decreasing the effectiveness of MCM mine-

hunting operations. A rough bottom can also reduce mine rolling.

2.7.10.2 Bottom Type. The nature of the bottom affects the degree to which a bottom mine will bury itself. In general, a soft bottom, conducive to burial, is desirable for several reasons. First, a fully or partially buried mine is more difficult to locate by mine hunting methods. Second, some degree of burial will lessen the likelihood of movement (and resultant spurious actuation)

of the mine in the presence of strong bottom currents. Burial has little or no effect on the sensitivity of a mine firing actuated by magnetic influence. However, acoustic and pressure influences may be attenuated by burial. Delayed rising moored mines may be adversely affected by soft bottoms, since separation of the case from the anchor at the end of the delay period may be inhibited. Knowledge of the bottom type allows the planner to determine whether burial will occur.

There are three types of burial: impact, scouring, and sand-ridge migration.

1. Impact burial occurs as the mine first strikes the bottom. The amount of burial is dependent upon impact angle, impact speed, bottom composition, and the weight of the weapon. The bottom grain size will contribute to the amount of burial. A decrease in the grain size of the bottom material will usually result in a higher degree of burial.

2. Scouring occurs as a result of bottom sediment being removed from around the bottom mine. This is normally found in areas with sandy bottoms, and is caused by surface wave action. Sediment is eroded from either end of the mine, creating a pit that continues to expand until the mine settles into the pit. The sediments then cover the mine.

3. Sand-ridge migration is another form of burial that is induced by strong currents. The bottom sand ridges migrate in the direction of the water currents at a speed dependent upon the speed of the current and the sand grain size.

2.7.11 Magnetic Environment. Magnetic influence mines are affected by changes in the earth's magnetic fields, which may be caused by environmental effects such as sunspots.

CHAPTER 3

Mine Countermeasures

3.1 GENERAL

MCM are classified as either offensive (proactive) or defensive (enabling). Offensive MCM are preventive in nature: because they are intended to prevent mines from being laid, they eliminate the requirement for defensive MCM. The effective execution of offensive countermeasures can eliminate or substantially reduce the degree of risk from mines that must be borne by operating forces, warships and submarines, and merchant shipping, as well as mine warfare ships, systems, and personnel.

Defensive MCM are classified as either passive or active. Passive MCM are dynamic measures that tend to prevent interaction between the mine and target. Active MCM are reactive in nature and involve interfacing directly with mines.

Figure 3-1 is illustrative of the relationships within this warfare specialty.

3.2 OFFENSIVE MINE COUNTERMEASURES

The concept of offensive MCM is to render ineffective one or more of the critical links in the minelaying process. This normally means destroying or disabling mines before they can be laid, or destroying the enemy's capability to lay mines and thereby preventing the establishment of an operational minefield. Mining can also be used as an offensive MCM tactic to trap surface minelayers in port. Offensive MCM should be an integral part of any OPLAN and, to prevent mining, must be considered by the battle group commander very early in the planning stages.

3.2.1 Offensive Mine Countermeasures by Strike Assets. Offensive operations against enemy mine storing, handling, and laying capabilities need to be included in the campaign plan. In addition, during a period of impending hostilities, the MIWC should recommend that ROE allowing surveillance and interdiction of enemy mine laying be considered. Offensive MCM is usually executed by strike or special operations

forces who have the capability to deliver an attack on mine storage facilities, loading or transportation facilities, or minelaying assets. While MCM assets have several techniques for countering mines once they are laid, no MCM asset has sufficient offensive weapons capability to conduct offensive MCM.

Intelligence is critical to successful offensive MCM. Strike planners need to know location, types of mines, fortification of the storage facility, and defense systems. Among the peacetime requirements for intelligence collection is the number, types, and location of mine stocks throughout the world. Whenever there are indications of potential hostility with a belligerent country, monitoring of known mine storage facilities should be high on the intelligence priority list. Early indications of mine movement can be detected and delivery countered if appropriate priority and planning are given to the mine element of naval warfare. As part of his planning, the MIWC must identify intelligence gaps and prioritize collection requirements to increase his knowledge of the enemy's MIW plans. Overt surveillance of an enemy may act as a deterrent.

Once movement is detected, offensive MCM against the transfer or loading operation is frequently a short notice, time critical event. The determination that loading is in progress must be followed within a matter of hours by the complete sequence of strike planning, approval, and execution if the offensive MCM operation is to be successful. Delay may result in striking after the mine movement is complete. Complicating the problem is the likelihood that if hostile intent exists, the transfer of mines will be carried out surreptitiously in darkness or using deceptive methods (as was the case with the Iraqis in Operations Desert Shield and Desert Storm).

The same is true for detection of minelaying operations. If the strike capability is not on-scene when mine laying is detected, it is likely that mines will be deployed before any offensive countermeasures can be made. In international waters, the ROE may permit a response without communication with higher authority, but in the national/territorial waters of another nation, delay can

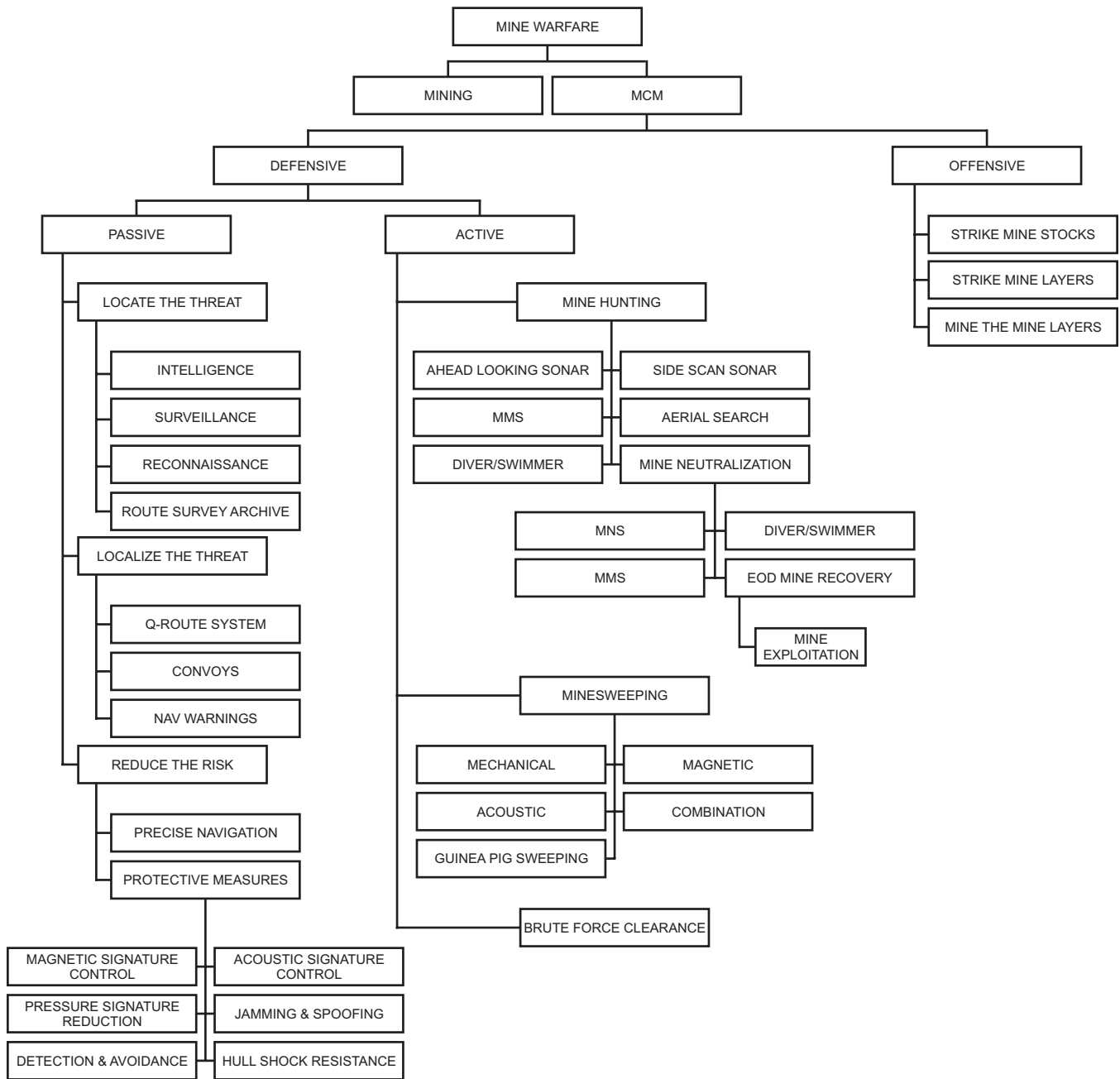


Figure 3-1. MCM Family Tree

be expected in obtaining permission to strike even if the capability is at hand.

To improve the chances of mounting a successful strike on transfer or laying operations, the commander might seek advance approval for strikes where mine storage has been identified but the ROE will not permit preemptive strike. With advance approval, the strike can be planned and executed in a more timely manner. At-

tack air strike assets may still require a few hours, but a TLAM attack can be executed very quickly.

3.2.2 Mining as an Offensive Mine Countermeasures Tactic. Where a direct assault on mine stockpiles or minelaying assets is not feasible, offensive mining may be used to prevent the effective employment of minelaying assets.

Depending on the types of mines available to the enemy, aircraft, surface vessels, or submarines may be used to lay mines. An offensive MCM effort against minelaying air assets is a more difficult task requiring the closing of all enemy airfields and support facilities that support mining aircraft or helicopters. Strike assets performing this mission face the same threat as if they were conducting direct strikes on the laying aircraft.

Offensive mining against surface or submarine laying assets is a simpler task. Mines laid in the loading ports or approaches can target craft of any size, and the sinking of one ship in the channel may be sufficient to stop all other traffic, including surface minelayers. Mining on the flanks of the operating area can help deny access to hostile surface and subsurface minelayers.

3.3 DEFENSIVE MINE COUNTERMEASURES

The objective of defensive MCM is to reduce the effectiveness of existing minefields. Defensive MCM is divided into two categories: passive and active. Passive defensive MCM includes all measures that reduce the effectiveness of mines without physically removing the mine. Active defensive MCM includes those measures that reduce the effectiveness of minefields by removing mines, destroying them in place, or neutralizing them.

3.4 PASSIVE MINE COUNTERMEASURES

This chapter will concentrate on passive MCM as practiced by MCM vessels or an organized MCM planning staff. Chapter 4 describes passive MCM measures for non-MCM vessels.

Passive MCM can be divided into three categories: locating the threat, localizing the threat, and reducing the risk.

3.4.1 Locating the Threat. Locating the mine threat requires some of the same actions as were necessary to support offensive MCM. First is a long-term intelligence collection effort to determine who has mines, where they have them, and where they intend to or are capable of laying them.

This must be followed by increased surveillance in times of heightened tensions to determine when mine laying is in progress and to chart as accurately as possible where the mines are being laid. Prior to the development of a long-range, stealthy minelaying capability using submarines or aircraft, visual mine watching was an effective surveillance method. A coast watcher spotting ships or aircraft dropping objects into the water would plot the splash positions, which would help to define the limits of an MDA. Although this technique is

still effective, modern technology has surpassed it. Today's surveillance methods involve satellite- and aircraft-based long range electronic systems that, if properly alerted, can track the minelayer from airfield or port departure to arrival at the minefield. Long range assets can then trigger tactical surveillance assets to pinpoint the minelaying operation. The MCM commander's involvement is to actively pursue intelligence collection, dissemination, and analysis that will provide timely support to his primary mission.

The third step in locating the threat is reconnaissance to determine whether mines are actually in place and, if so, the types of mines and the extent of the minefield. If the first two steps have been successful, reconnaissance may be performed by MCM assets. When the first steps fail, initial reconnaissance will most likely be performed by unprepared merchant or naval ships and the mining incident will be documented by damage reports.

The critical link in successful location of the threat is effective employment of intelligence assets. Where the likelihood of conflict is increasing, mine detection must have sufficient priority to keep mine stockpiles and minelayers under frequent inspection.

Route survey operations are also used to locate the threat. The primary goal of route survey is to compile an archive of minelike contacts and other significant sonar contacts before any mining has taken place. This permits the ship, upon returning to the area, to conduct rapid exploratory operations along the route and sort out new contacts that might be mines. Contacts that correlate by position as well as appearance to previously archived contacts can be bypassed. Critical to the success of route survey operations is the availability of a precise navigation system of a common type for all MCM assets. Without a common system, the minor variations in position between different navigation systems will result in a loss of ability to correlate sonar contacts to the data archive positions.

As part of route survey operations, channel conditioning may be performed. Channel conditioning is the removal of objects that provide a minelike sonar target from the channel area. Once conditioning is completed, the channel should be clear of any objects causing minelike echoes. Channel conditioning is not normally practiced by U.S. Navy MCM forces.

3.4.2 Localizing the Threat. Localizing the mine threat means reducing the area in which shipping may be exposed to mines and thereby reducing the area that MCM forces must cover to protect shipping. Efforts to localize the threat do not depend on successful location of a specific threat, but can be carried out in advance of

hostilities as well as during a conflict before mining has been detected.

The most effective method of localizing the threat is to establish a Q-route system for shipping to use when transiting mineable waters. Q-routes are preplanned shipping channels that transit over bottom areas best suited for mine hunting. Each Q-route is 1,000 yards wide (where not restricted by water depth or obstructions) and connects with other routes that permit shipping to transit from port to port or from port to deep water and back.

The following is an example of the value of a Q-route system (Figure 3-2):

Assume that two ports are 10 miles apart (or that a port is 10 miles from deep water) and the navigable body of water is 10 miles wide. If ships are free to travel along any track, the area that requires MCM effort is 100 square

miles. By establishing a Q-route one-half of a mile wide, the area is reduced to 5 square miles. Assuming that the Q-route is sufficient to accommodate all the traffic and that the ships follow the route, mines laid outside the route are not an immediate threat and can be dealt with as time permits.

With or without a Q-route, if ships are directed to travel in convoys, MCM forces can be scheduled to prepare a channel and, if necessary, check it for reseeded or delayed moored mines just before the convoy's transit. Even when no MCM can be applied, the threat to traffic is reduced if all ships follow the same route because the traffic exposes itself to only a fraction of the mines present. This technique is called channelization.

For those ships not traveling in convoys and for Convoy Commanders, a navigation warning message system is used to provide information on suspected or confirmed minefields, cleared channels, or other important

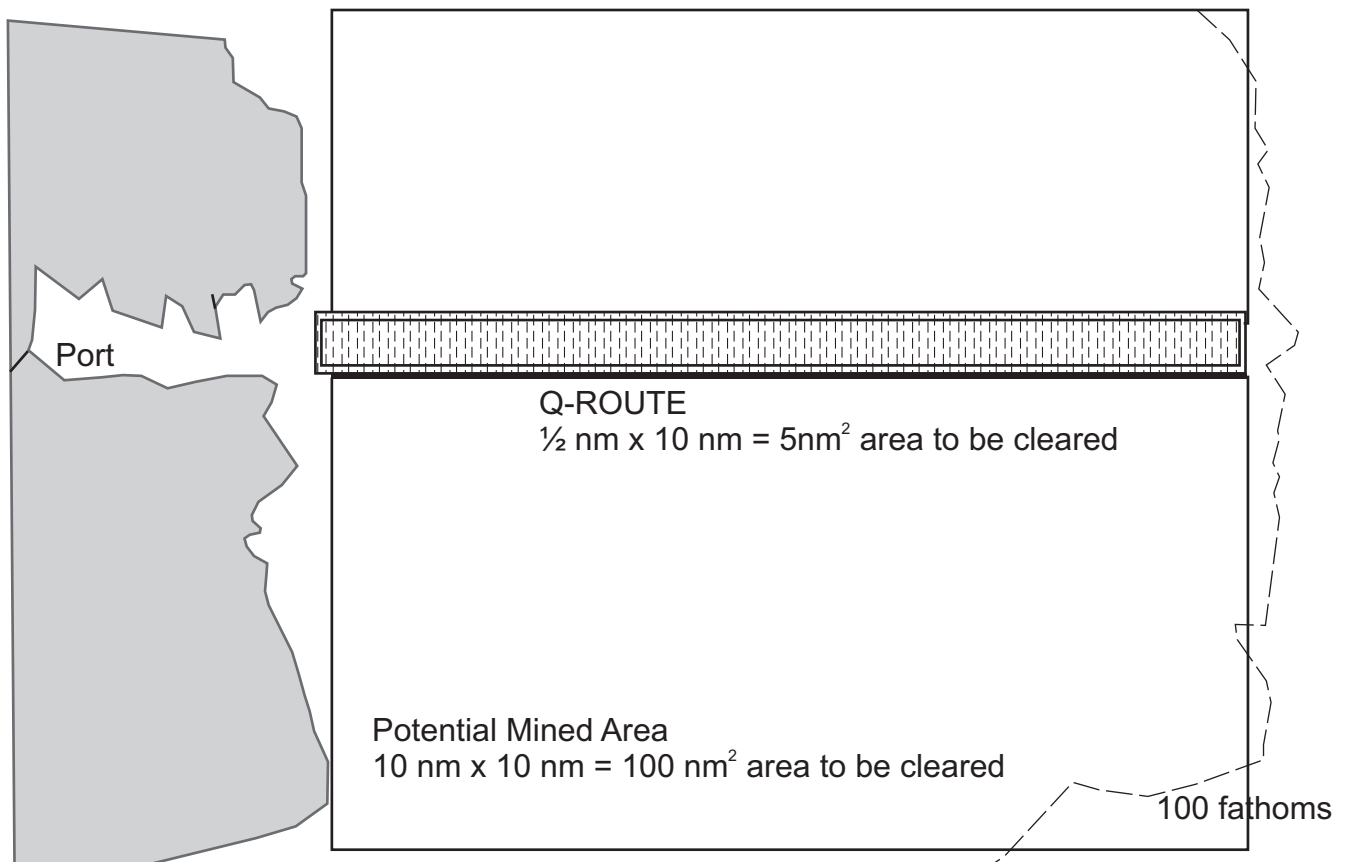


Figure 3-2. Localization of Threat by Q-Route

navigation information. The MCM commander assists the OTC or area commander by maintaining a mine sighting list, designating MDAs where necessary, and reporting the status of channels that MCM forces have been directed to clear.

3.4.3 Reducing the Risk. The primary passive methods of reducing the risk for MCM forces are precise navigation and practicing influence signature control. Before the widespread use of satellite navigation, risk reduction included altering navigation aids so that the minelayer would be fooled into putting mines in the wrong location. Since the minelayer may not depend on navigation lights or local radio beacons, this tactic is no longer as effective as before.

The availability of precise navigation for use by MCM forces, as well as traffic ships, has resulted in a significant reduction of risk for MCM forces. MCM units using GPS P-code are able to pass contact locations from unit to unit and successfully relocate those contacts without significant searching. The consistency of the GPS and the precise navigation and plotting systems now available to SMCM and AMCM units allow a unit to hunt or sweep a track and return to that same track later with confidence that the track the unit is on is the same area that was previously covered, not 50 or 100 yards to either side in uncleared waters. This risk reduction also extends to traffic ships using GPS. A GPS-equipped ship can transit without a leadthrough vessel when provided the coordinates of the cleared channel.

An MCM ship is expected to maneuver in proximity to all kinds of mines. Contact mines can be seen on sonar and avoided, but there are occasions when an MCM ship will maneuver within the sensing range of influence mines. Consequently, the MCM ship must have a magnetic and acoustic signature much smaller than the signature most mines will be intended to target. The greatest danger to an MCM ship is a shallow moored mine or a sensitive-set influence mine.

The magnetic silencing requirements for MCM ships are set by the ship Class Top Level Requirements Document and the OPNAV 8950.2 series instruction. A dedicated effort must be maintained to keep the ship's acoustic and magnetic signatures as low as possible and to complete all degaussing, ranging, and adjustment requirements. MCM vessels are scheduled for degaussing ranging to update their certification as close as possible to scheduled deployments, but there are only a few certified ranges where quarterly updates can be accomplished. U.S. Navy ranges capable of measuring MCM ships are located in Charleston, SC, and San Diego, CA. (The Charleston range may be relocated to Ingleside,

TX.) Other ranges that could be used are located in Japan, Italy, and the United Kingdom. A portable degaussing check range was used by British forces during Operation Desert Storm in the Persian Gulf. Several portable ranges are being procured by PEO MINE WAR.

Acoustic silencing of MCM ships is much less defined. The Class Top Level Requirements Document includes a requirement for the ship's acoustic signature, but there is no periodic measuring requirement. Each ship is expected to follow good maintenance practices and keep equipment vibration isolation mounts in good working order.

Ships may be equipped with systems intended to protect the ship from influence mines by jamming and spoofing mine sensors. If a mine sensor is designed to be resistant to influence sweeping by signal processing, the mine may be rendered temporarily ineffective by generating signals that cause the mine to shut down or make a false target determination rather than properly detect the ship. With the resulting protection from influence mine sensors, an MCM ship may be able to successfully maneuver in a minefield for hunting or sweeping, or a traffic ship may transit a channel with less risk.

Systems that are designed for detection of mines with the intention of avoiding the mine rather than prosecuting it are also classified as passive MCM. Detection and avoidance of mines are less risky (whenever avoidance is feasible) than active MCM. In the case of MCM forces, avoidance is usually a temporary measure, but for other combatants it is a valid tactic. Additional discussion of detection and avoidance is included in Chapter 4.

3.5 ACTIVE MINE COUNTERMEASURES

The two main subsets of active MCM are mine hunting and minesweeping.

3.5.1 Mine Hunting. Mine hunting is determining the location of individual mines so that countermeasures may be taken to avoid, remove, render harmless, or destroy each mine. It is a one-on-one operation, unlike sweeping, during which process all mines in the swept path are addressed at the same time.

Mine hunting performance is not affected by the type of mine firing mechanism in the mine, the sensitivity settings of the mechanism, ship count settings, or arming delays. Even delayed mooring mines can be detected by a bottom search.

Mine hunting operations are affected by the degree to which mines are buried, mine casing construction and

material, clutter on the sea bottom, and many other environmental factors.

3.5.1.1 Mine Hunting Process. The mine hunting process includes the following:

1. Detection — Potential minelike contacts are noted for further investigation.
2. Classification — The detected contact is further investigated, usually with a higher resolution sonar, and classified as a MILC or NOMBO. Equipment operators use all available features of the mine hunting system to examine a contact, possibly maneuvering to view a different aspect of the object. If the contact cannot be classified nonminelike with confidence, it will be called a MILC until identification proves otherwise.
3. Localization — The contact position is refined and plotted as precisely as possible (specifying navigation sensor, datum, and position in latitude/ longitude to a thousandth of a minute) so that further prosecution can be carried out either immediately or at a later time. MCM forces use the WGS-84 datum as measured by GPS P-code as the standard reference system.
4. Identification — The contact is investigated either by an EODMCM diver or ROV using video camera and sonar. Identification should be made using an optical system so that a positive ID of the mine can be made. This prevents expenditure of neutralization efforts and charges on nonthreatening objects. It also keeps the MCM forces from assuming a minefield exists where there is none.
5. Neutralization — The mine is either rendered inoperative or removed from the area. Paragraph 3.5.4 provides details of neutralization methods.

Though not a step in the mine hunting process, the prosecution of a contact should not be considered complete until details of the mine contact are reported to the MCM Commander using standard MCM reporting formats.

Since a neutralization charge does not provide positive evidence of success on the surface or on sonar, it is important to confirm, by diver or ROV inspection, that mines have indeed been neutralized. Verification may be performed immediately after neutralization if the operation is not on a critical time schedule. Otherwise, it should be done as an administrative cleanup action after the MCM objective has been attained.

3.5.1.2 Types of Mine Hunting. Acoustic mine hunting is the use of active sonars (including marine mammals) to find objects with minelike characteristics. SMCM and AMCM mine hunting sonars use a video display of the acoustic signal only and do not use audio, as is common in ASW sonars. Acoustic mine hunting is effective against mines with metallic cases or other cases that provide sufficient echo. Mines partially buried in mud or sand can be detected up to a point in marginal environmental conditions. The Mk 7 Mod 1 Marine Mammal System can be used to locate buried mines. Moored mines can be located by detection of the case, by detection of the anchor, or by the echo from the mine mooring cable.

Magnetic mine hunting is the use of magnetic detectors to find ferro-magnetic mines proud of the sea bed or buried. The detection range of magnetic systems is typically very short, making them unsuitable for mounting in ships. Devices that are towed close to the sea bottom have been tested. The difficulty with magnetic detectors is classifying contacts as minelike. With a simple magnetic detector, the only indication is the relative signature of the magnetic object. Currently no magnetic mine hunting systems are operational for shipboard or aircraft use. Developmental programs are in progress that link magnetic detectors with sonar and other sensors attempting to develop an effective combination. There are diver-carried magnetic locators, but these have limited use in MCM operations.

Optical mine hunting is the use of visual, optical, or electro-optical systems to find mines on the surface, in the volume, or on the sea bed. The primary limiting factor with optical systems is the poor light transmission quality of seawater. The air bubbles, marine life, and suspended matter in seawater scatter light rays very quickly so that light wave frequencies visible to the human eye do not perform well. Even so, the best operational optical system is a visual search. Conducted from a helicopter, a visual search can be effective against mines on or near the surface. Ships' lookouts are also effective against mines on the surface if properly trained, equipped, and stationed. Chapter 4 provides additional detail on visual search methods and equipment. Developmental programs are underway for dedicated mine detection systems that use laser optics and infrared frequencies, but none is fielded yet.

Detection of mines on the surface, particularly drifting mines, has also been attempted using aircraft radar systems. Results have not indicated radar to be a dependable method for detection, although some success has been observed.

3.5.1.3 U.S. Mine Hunting Systems. The AN/SQQ-30 Mine Hunting Sonar is a trainable variable depth sonar developed from the AN/SQQ-14 sonar used for many years on MSOs. It is deployed by cable through the ship's hull and can be operated at various depths to obtain the best contact detection configuration. It is a dual-frequency sonar using one frequency for detection and a higher frequency for classification. The AN/SQQ-30 search and classify transducers are mechanically trained and are not individually trainable. Consequently, when the classify operator has control of the sonar, the detection operator can only search in the sector where the contact is being classified. The AN/SQQ-30 sonar is installed on MCM Class ships 2-9 and will be replaced in the future by the AN/SQQ-32.

The AN/SQQ-32 Mine Hunting Sonar (Figure 3-3) is also a trainable VDS developed for deep-water mine-hunting. It also deploys by cable through the ship's hull, but has a longer cable and greater depth capability (for system characteristics, refer to NWP 3-15.11 (formerly NWP 27-2), NWP 3-15.61 (formerly NWP 65-10), or NWP 3-15.62 (formerly NWP 65-32)). In addition to separate detection and classification frequencies, the AN/SQQ-32 has a choice of three classification frequencies that permit better adjustment to the environment. The sonar's search transducer covers 360° with electronic scanning while the classify transducer is mechanically steered independently of the search transducer. The AN/SQQ-32 has computer-aided detection capabilities that assist the operator when in a high clutter environment. The AN/SQQ-32 is installed on MCM 1 and MCMs 10 to 14, as well as all MHC 51 Class ships.

The AN/AQS-14 Sonar Detecting Set (Figure 3-4) is a cable-towed side-scan sonar operated by the MH-53E AMCM helicopter at a tow speed of 7 to 20 knots. It has a video waterfall display for the on-board operator, and the sonar data is recorded on magnetic tape for postmission analysis.

The AN/PQS-2A Sonar is a hand-held model used by EOD divers for locating contacts. It provides an audio tone to the diver through earphones, which enables him to localize a contact within the sonar beam.

The primary magnetic locating device used for MCM is the Mk 25 Ordnance Locator. This is used by EODMCM forces to locate ferrous objects. It has a relatively short range and is therefore more of a localization device than a minehunting system.

3.5.1.4 Mine Hunting Procedure. General MCM procedure is to mine hunt when conditions permit and mine sweep when mine hunting is not feasible. This is based on the fact that mine hunting in a favorable environ-

ment is safer for the MCM assets than minesweeping. When mine hunting, the ship is detecting the mine prior to coming within range of the influence sensors. When minesweeping, the ship must pass over the mine (or nearby when using a diverted sweep) before the sweep takes effect. Consequently, when the environment permits reasonable detection ranges and mine burial is not significant, mine hunting is the optimal technique.

There are two approaches to the mine hunting process that can be followed. One is to have the unit that makes the detection carry out the neutralization prior to proceeding to the next detection. This is commonly referred to as the "blow as you go" procedure and is usually followed by the SMCM, since it has the option of employing the Mine Neutralization Vehicle or EODMCM divers, if embarked. The other approach is to have one unit conduct the detection-to-localization process and a different unit carry out the identification and neutralization. This procedure is known as "bumper pool." Since AMCM helicopters do not have a neutralization capability, they must follow this second procedure. SMCM ships may also use this procedure when separate vessels or helicopters are being used to support EODMCM teams. This procedure can speed up the detection process and permit the mine hunting assets to move on to other tasking or areas. Prior to the availability of GPS navigation, the relocation of contacts was sometimes a lengthy process and not always successful. However, since GPS is available to all MCM units, successful relocations have become routine.

3.5.2 Mechanical Minesweeping. Mechanical minesweeping is an MCM technique in which the sweep equipment physically contacts the mine or its appendages and removes the mine from the minefield. The simplest form of mechanical sweep gear is a drag chain with barbs, hooks, or other attachments that can snag the control cables of control mines. Another relatively simple sweep is a catenary sweep, that is the use of one or two ships towing a net or wire catenary to scoop up mines and drag them to a designated dump area. The net is effective against all moored mines, and in smooth bottom conditions it can be used to clear bottom and closely tethered moored mines.

An oropesa sweep consists of one depressor wire and two sweep wires towed astern at a preselected scope and diverted to the sides. The depth at the forward end of the wire is determined by the scope of depressor wire streamed. The ends of the sweep wire are spread by otters (also called kites or diverters), which pull outboard under hydrodynamic load. The depth of the end of the sweep wire (otter depth) is determined by the length of a pendant that connects the otter to a surface float. Various pendant lengths are carried or can be made

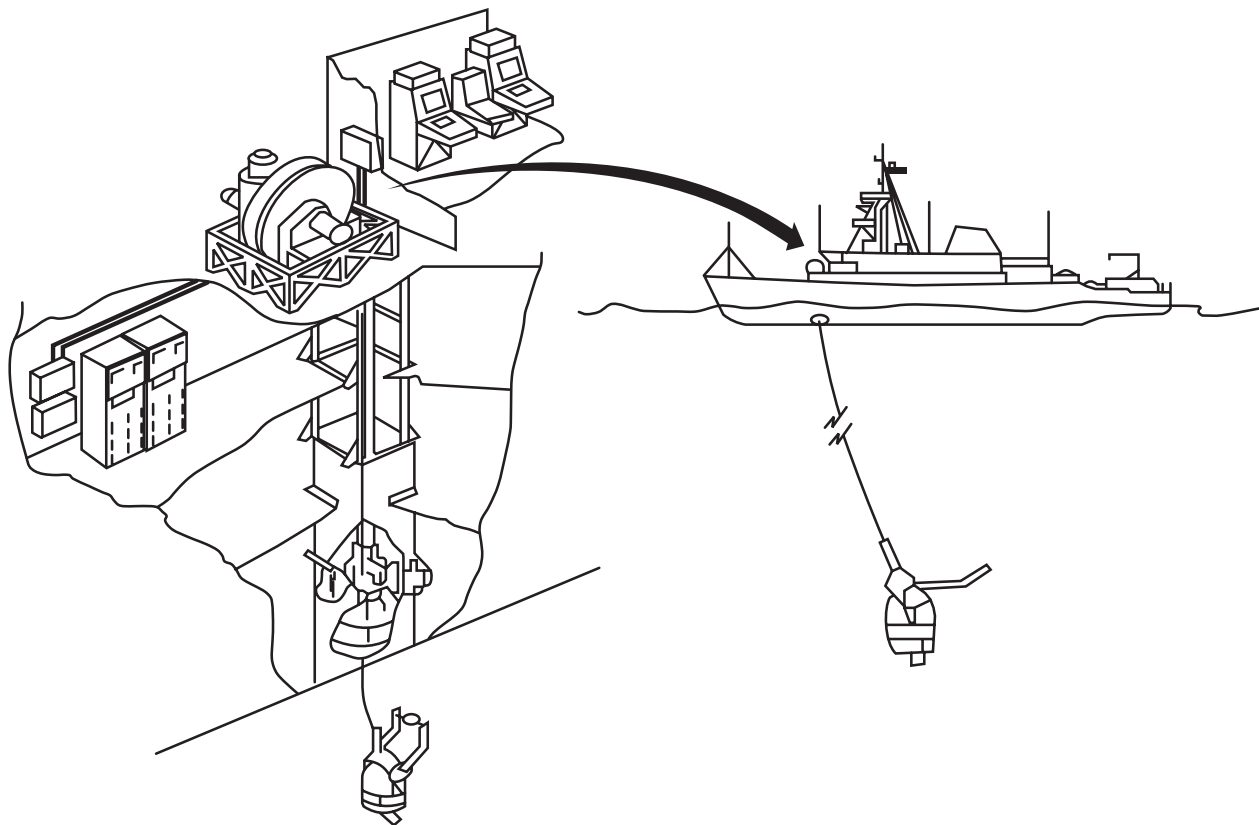


Figure 3-3. AN/SQQ-32 Minehunting Sonar

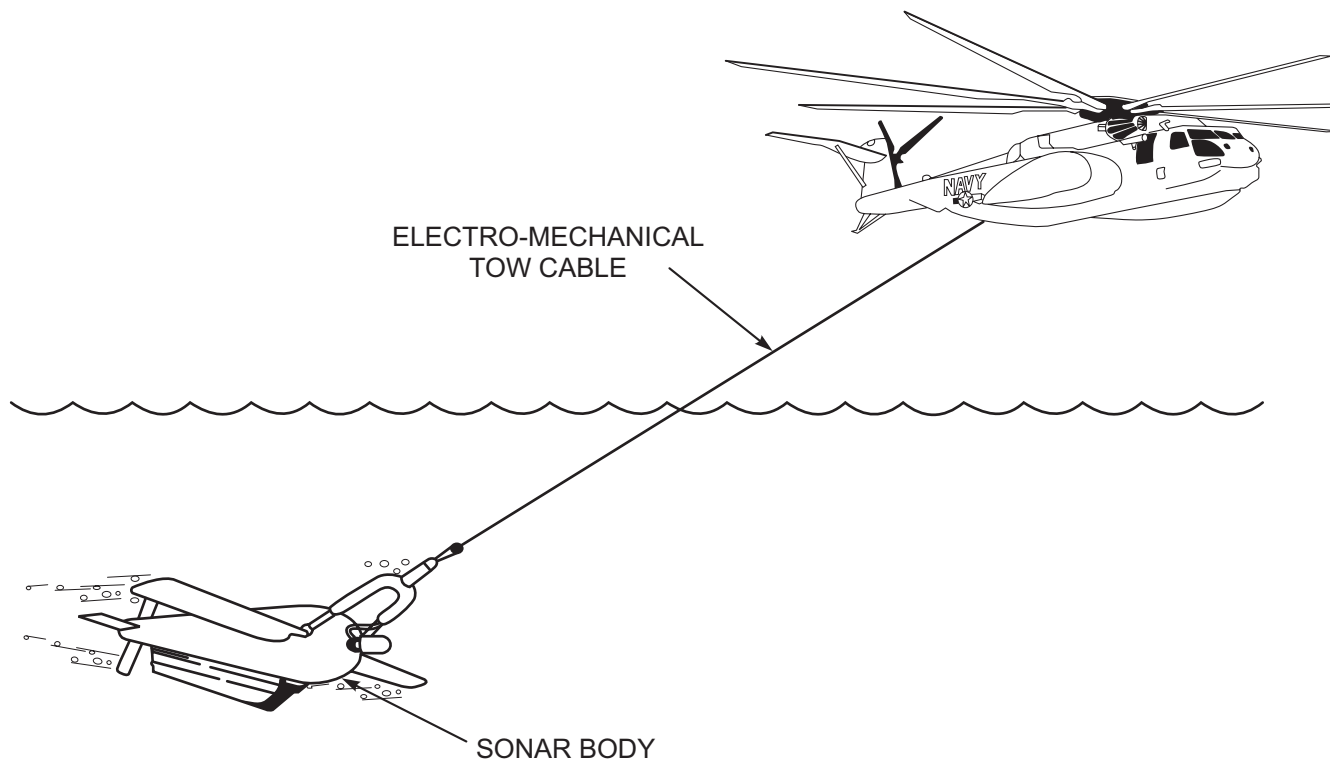


Figure 3-4. MH-53E with AN/AQS-14 Sonar

up on the ship. Mooring cables are cut either by abrasion by the sweep wire or mechanical or explosive cutters mounted on sweep wire, which can sever mooring cables from 1/4-inch cable to 1 1/2-inch chain.

Against moored mines, oropesa mechanical sweeps are designed to cut the mooring cable so that the mine comes to the surface. Unless the mine has some antisturb function or antirecover hydrostatic actuator, once the mooring is cut, the mine is converted to a drifting mine (usually still functional). These drifting mines must be disposed of, preferably by EODMCM divers operating from another ship or helicopter.

In mechanical sweeping by surface ships, the ship is obliged to transit the mined area before the sweep, actuating any moored mines less than the ship's draft. AMCM helicopters can mechanically sweep without being exposed to the mines. Consequently, modern tactics dictate a precursory sweep by AMCM assets for sweeper safety or require sweeping the first track in safe water with the sweep diverted into the mined area.

The AN/SLQ-38 Mechanical Minesweep System (in Figure 3-5) is an oropesa sweep installed on the MCM-1 Class. Sweep characteristics are provided in NWP 3-15.11 (formerly NWP 27-2).

The DMS is a variation of the AN/SLQ-38 sweep in which the wire is streamed on one side only and an extra depressor is used. The swept path is narrower, but the depth can be increased. This sweep has also been referred to as the Single Ship Deep Sweep. The IDMS variation of the AN/SLQ-38 sweep hooks the sweep wire from two ships together to be towed like a catenary sweep. Depths of 2,000 feet can be reached using this sweep, but it is difficult to be sure of the swept path. If a third ship is available, it may use sonar to track the sweep and vector it towards mine contacts.

The Mk-103 Mechanical Sweep is a modified oropesa-style sweep used by AMCM helicopters. The depth of this sweep is determined entirely by selecting pendants that attach the sweep wire to surface floats at several points. This sweep may also be towed by the MCAC.

A new sweep system developed to provide increased depth capability for AMCM use is the A/N37-U Controlled Depth Sweep shown in Figure 3-6. It is similar in design to oropesa gear, but depth is determined by control surfaces on the depressor and otters. One depressor and each otter has a water-driven turbine generator that powers control circuitry. Depth sensors are used to vary the control surfaces and maintain the indicated depth. Additional depressors, without adjustable sur-

faces, may be necessary as depth increases. No surface floats are required.

The AN/SLQ-53 Single Ship Deep Sweep is a surface version of the A/N-37U packaged as a modular mechanical sweep for the MHC 51 Class ships. A palletized winch mounts on the ship's fantail along with storage containers for the sweep gear. The towed gear is identical to the aircraft towed gear.

3.5.3 Influence Minesweeping. Influence mine sweeping is intended to satisfy the mine sensor and have it detonate at a safe distance from the sweeper. Influence mine sweeping includes magnetic influence, acoustic influence, and combination influence sweeping. There is no minesweeping system for pressure mine sensors. If pressure sensors are encountered, mine hunting is the technique that should be used. The alternative is a guinea pig ship that can satisfy the pressure sensor and detonate the mines. These ships are usually modified cargo ships with additional flotation material to prevent them from sinking and blocking a channel. The guinea pig is intended to absorb the damage from several mine detonations before being repaired or scrapped.

There are two tactical approaches to influence mine sweeping. One is to take advantage of the weaknesses in the target discrimination ability of mines by producing an influence signature that will sweep all mines in the field of a particular type or setting. This allows the use of high-energy sources that have large sweep widths even though the signatures are not exactly ship-like. To determine the required sweep characteristics, exploitation and analysis must have been conducted on the mines. U.S. Navy influence sweeps are designed for this tactic.

The other approach is to produce an influence signature that emulates the type of ship expected to transit and sweep all mines that are a threat to that ship. The emulation approach does not require knowledge of the mines present, but it does require knowledge of the specific signature of transiting ships and may require a more sophisticated sweep system.

3.5.3.1 Magnetic Minesweeping. In magnetic mine sweeping, whether single-influence or combination-influence minesweeping (which includes a magnetic component), the magnetic field of the surface minesweeper must be small enough to let it pass over the mine without satisfying the mine sensor. Also, the magnetic field generated by the sweep must be far enough astern of the sweeper so that a magnetic mine is not actuated until the ship is at a safe distance. When a mine has a shipcount setting, the magnetic field of some sweeps can be pulsed to simulate several ships passing.

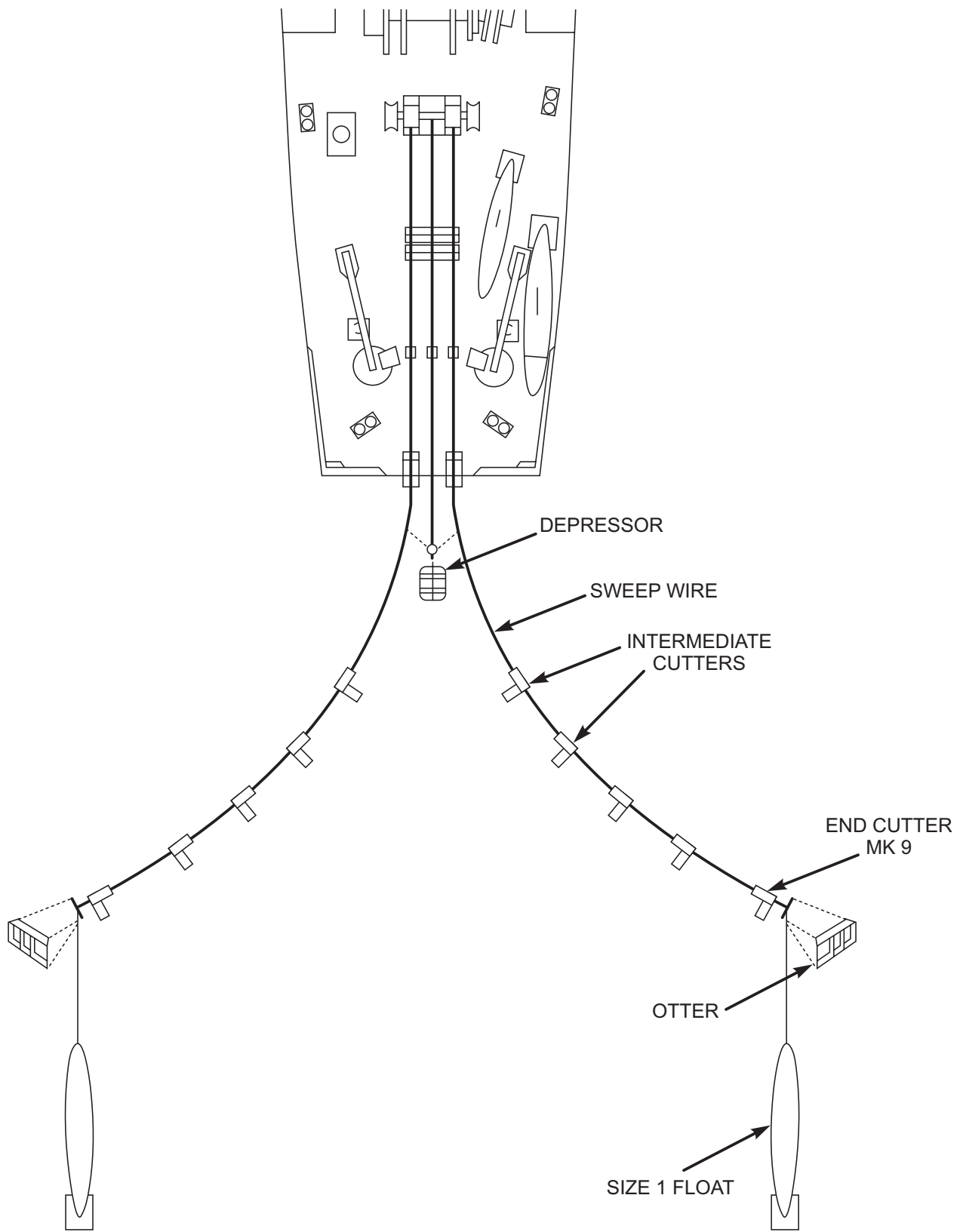


Figure 3-5. AN/SLQ-38 Mechanical Sweep

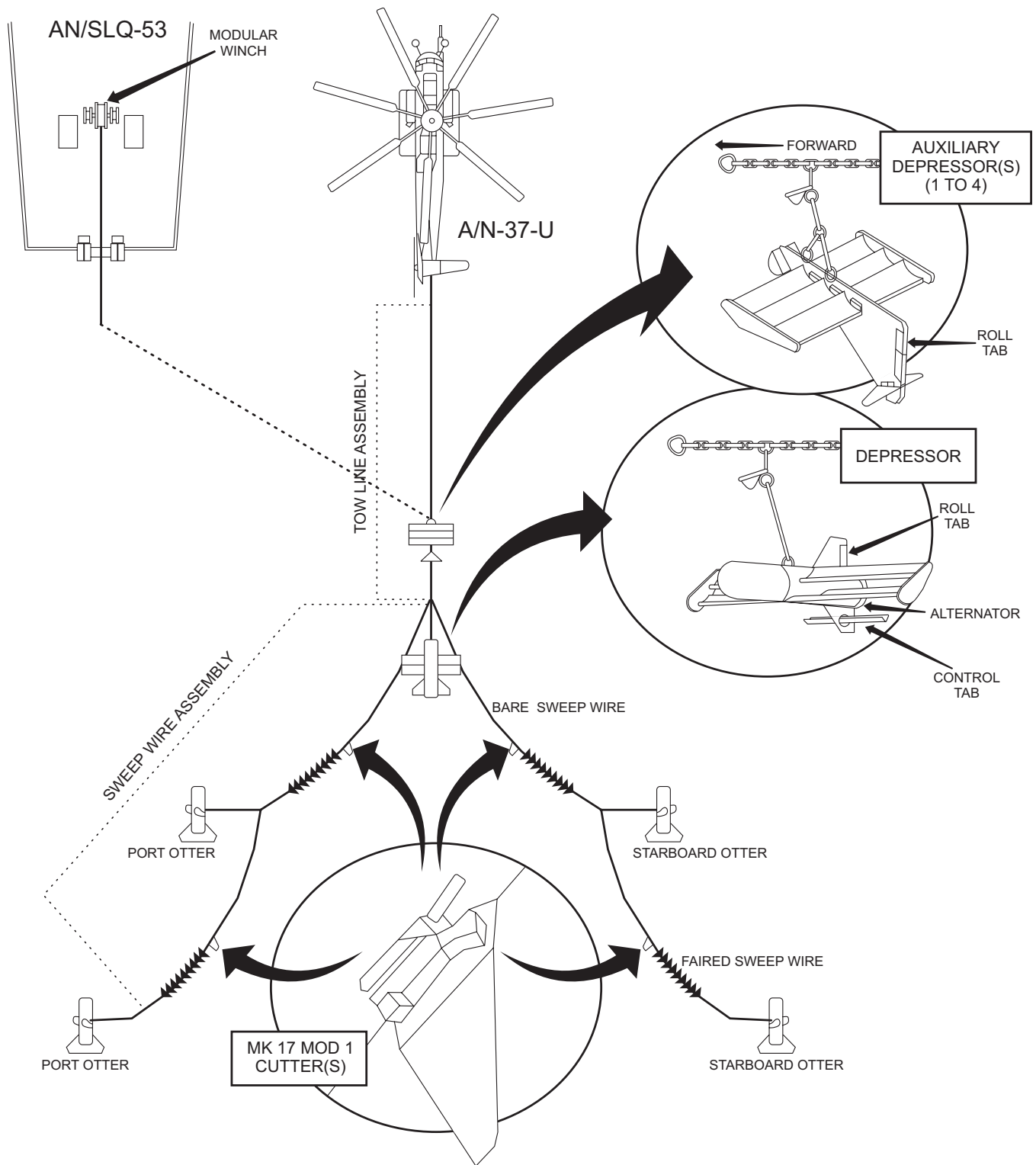


Figure 3-6. A/N37-U Controlled Depth Sweep / AN/SLQ-53 Single Ship Deep Sweep

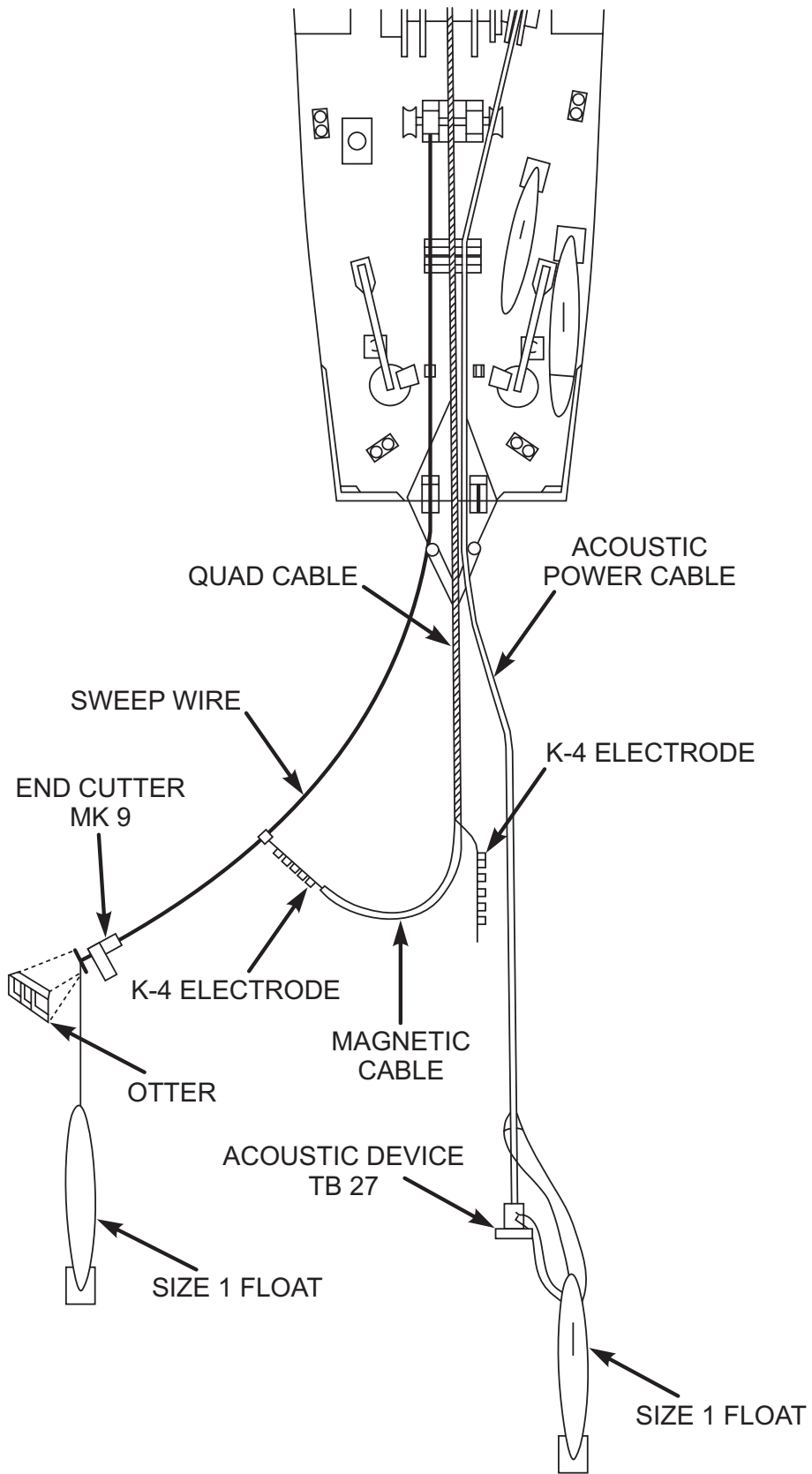


Figure 3-7. AN/SLQ-37 Combination Influence Sweep

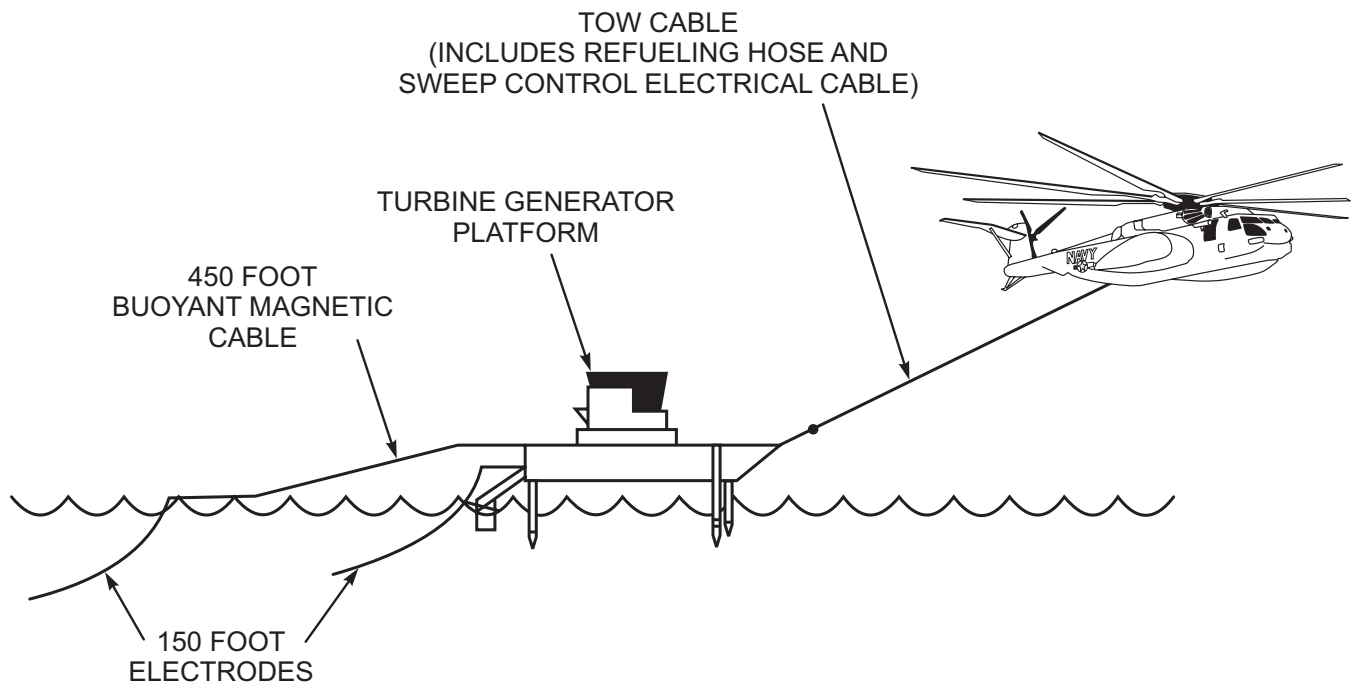


Figure 3-8. MH-53E with Mk-105 Magnetic Minesweeping System

Otherwise the minesweeper must make multiple runs on each track to account for all sweepable mines.

There are two types of magnetic sweeps used, those that are natural magnets and those that generate a magnetic field by passing an electrical current through some system of wire cables or coils.

The AN/SLQ-37(v)3 Influence Sweep System (Figure 3-7) is used on the MCM-1 Class and generates a magnetic field around a cable (tail) streamed astern of the MCM vessel. The major components are a 5,000-amp DC or AC gas turbine generator, an Influence Mine-sweeping Waveform Generator, and the Magnetic Sweep Cable assembly. The waveform generator regulates the minesweep generator current flow direction, rate of change, and duration. Waveforms created by the controller determine the characteristics of the magnetic sweep field. The Magnetic Sweep Cable (tail) consists of four rubber-insulated conductors and two uninsulated electrode sections. The conductors are quadded from the connection on the ship to a point astern where the first electrode is attached. Quadding tends to cancel the magnetic field of each wire so that the sweeper is not endangered. From the point where the quadding ends, the cable assembly forms a large loop through which current is passed. The current flow causes a magnetic field to be

generated that simulates the field produced by a ship. The following standard cable configurations are used:

1. The M-Mk 5(a) Open Loop Straight Tail is the basic configuration. The tail is streamed behind the ship with two uninsulated, nonbuoyant electrodes attached. Seawater is used to complete the electric circuit. This configuration is effective against vertical component mine sensors and, depending on the environmental conditions, some horizontal component sensors.
2. In the M-MK 6(a) Open Loop Diverted Sweep configuration, the long leg of the sweep is diverted to one side using a diverter wire, float, and otter. This improves the sweep effectiveness, making it effective against both horizontal and vertical component mines, and shifts the magnetic sweep signature to one side of the ship.
3. The M-MK 6(h) Closed Loop Diverted Sweep configuration replaces the open electrodes with an insulated connection link, providing a closed circuit that does not rely on water as a conductive path. This configuration is used where the water has low conductivity, such as fresh or brackish waters.

The SAM is a Swedish-built, diesel-propelled, remote-control catamaran craft. It has two pontoon hulls built of foam-filled GRP with built-in solenoid coils. The center platform, which supports the propulsion system and generator, also has a closed-loop coil around the perimeter. The SAM is used in shallow water or inshore operations but is limited by speed and sea state for open-water operations.

The SPU-1/W MOP is a towed magnetic sweep that was developed for AMCM use in shallow water, as well as fresh and brackish water. The MOP is a ferrous metal pipe that is 30 feet long, 10 3/4 inches in diameter, and weighs 1,000 pounds. It is filled with polystyrene foam to provide buoyancy and is capped at both ends with padeyes to allow towing from either end. The MOP must be remagnetized using a magnetic coil prior to each mission. It does not have a large magnetic field and is limited to use in water where other sweeps cannot be used. Up to three MOPs may be towed together by the MK-53E helicopter to increase the coverage provided.

The Mk-105 Magnetic Minesweeping System (Figure 3-8) is a hydrofoil sled towed by the MH-53E AMCM helicopter. Mounted on the sled is a 2,000-amp gas turbine generator. The generator functions are controlled from the helicopter, and constant current or pulsed modes are available. The in-water portion of the sweep is an open loop electrode set. The device will sweep both vertical and horizontal component mines in water as shallow as 12 feet.

Components of the Mk-105 system are used when outfitting an MCAC (LCAC converted for MCM operations) for magnetic sweeping.

3.5.3.2 Acoustic Mine weeping. Acoustic mine sweeping is that portion of influence minesweeping involved in generating an acoustic signal to satisfy a passive acoustic mine sensor and may also include systems to respond to active acoustic sensors.

Acoustic sweep systems may be simple mechanical devices, combination electromechanical devices, or all electronic devices.

U.S. Navy Acoustic Sweep Systems include the following:

1. A-MK-2(g) Rattlebars are a mechanical sweep consisting of closely fixed parallel pipes towed through the water. Water flowing through the pipes creates a venturi effect, which causes the pipes to bang together and produce the acoustic output. The acoustic frequency generated is uncontrolled medium- to high-frequency broadband

noise. The sweep is very effective but has a small actuation width because of limited volume. Frequency and volume are dependent on tow speed, but the device will self-destruct if towed too fast. An A-MK-2(g) is used in shallow water to simulate hull noise and cavitation.

2. The AN/SLQ-37 Influence Sweep System (acoustic components) is an old technology electro-mechanical system installed on the MCM-1 Class ships. It has an Acoustic Controller on the ship, which provides power via the tow cable to operate towed devices. Control options include steady state operation, modulated operation (which is continuous operation with alternating high and low output levels), and pulsed operation (which is cycles of high-level output followed by an off period). There are two towed devices:
3. The TB 26, originally called A-MK-6(b), is a low-frequency device that contains electrically driven eccentric oscillating diaphragms to create the acoustic signal. The eccentrics can be changed to alter the frequency range.
4. The TB-27, originally called A-MK-4(v), is a medium frequency device with an electric motor-driven hammer striking a steel diaphragm to cause broadband noise. It can be operated in steady, pulsed, or modulated patterns.
5. Mk-104 Acoustic Minesweeping Gear is towed by MH-53E AMCM helicopters. It consists of an upper buoyant section and a lower sound-producing mechanism. The lower section contains two rotating disks inside venturi tube assemblies. Water flow causes the disks to rotate and cause a cavitation effect in the venturi tube. This produces a steady acoustic output. A drag brake system permits the output frequency to be preset before the device is streamed from the helicopter.

3.5.4 Mine Neutralization. Countermining or counter-charging is mine disposal by using an explosive charge to cause sympathetic high-order detonation of the mine. The size of explosion should leave no doubt that countermining was successful. The major advantage to countermining is that it does not leave a minelike contact to clutter the environment. A disadvantage is that it requires a large explosive charge and/or closer placement to the mine, which may involve higher risk to the diver or ROV.

Mine neutralization is rendering a mine inoperative by using an explosive charge sized and placed to either damage the mine mechanism or rupture and flood the

case by overpressure. Following detonation of the neutralization charge, the mine case may continue to look like a mine on sonar. If time permits, a post-neutralization inspection should be made to verify that the mine is neutralized. This may occur as part of an administrative cleanup after any time-sensitive objectives have been attained. The major disadvantage to neutralization as compared to countermining is that it leaves a mine case with explosives on the bottom, which may contribute to bottom clutter.

Relocation of a mine to an area where it presents no hazard is called removal. This method might be used for mines located where detonation could cause damage to pipelines, wellheads, docks, or other fixtures. It is also used when trawl nets are employed for sweeping and mines are swept but do not detonate. Since mines will be a hazard wherever they are relocated, countermining or neutralization is still necessary, but it could be done as time permits where explosions represent no hazard to other facilities or units.

Recovery of a mine is conducted when exploitation or analysis is necessary. The purpose of exploitation is to collect intelligence data on how the mine operates or to use the mine for laboratory analysis to develop MCM tactics against that mine type. The purpose may also be to determine what types of mines are present and what settings are in use so that sweeping can be done more effectively.

A RSP is performed to render a mine inoperative by interruption of operating functions or separation of essential components prior to or during recovery.

EODMCM detachments are most effective when permitted to work independent of other MCM forces to conduct neutralization. The GPS permits the EOD team to relocate contacts previously localized by SMCM or AMCM. Using GPS, the EODMCM detachment arrives at the mine position by inflatable boat or other support craft. The diver relocates the mine by a visual search around the position or by using the PQS-2A hand-held sonar, then places the explosive charge. This technique is limited to the diver's operating depth of 200 feet (300 feet with Type II emergency breathing equipment). Divers cannot go to this depth continually because they become saturated with nitrogen gas.

The main battery of the MCM/MHC class ships for mine disposal is the AN/SLQ-48 Mine Neutralization System. This is a remotely operated, tethered MNV, which is powered down the cable. The MNV is equipped with a short-range sonar for contact location and terminal guidance. It also has lights and a high-resolution television camera for contact identification. The MNV is placed in the water from a specialized handling system

capable of operation up to sea state 3. The vehicle is then piloted into the sonar beam and vectored to the vicinity of the contact by the sonar operator. The vehicle pilot then approaches the contact based on his vehicle sonar and TV monitor. Mission time is dependent on weather, depth, current, and other factors, but it averages 30 to 45 minutes per contact.

The MNV can carry two explosive cable cutters for moored mine cables or an explosive bomblet for bottom mine neutralization. The cable cutters simply reclassify the mine as a drifting mine that must be countercharged by divers. A new mission package that is now under development will permit in-place countermining for moored mines. The MNS is installed on all MCM-1 and MHC-51 Class ships.

Chapter 4 discusses mine disposal procedures for non-MCM forces.

3.5.5 Mine Exploitation. For an influence mine sweeping operation to be successful, the sweep characteristics must to be matched to the mine settings. In some cases, with mixed mine types or mixed settings, multiple sweeping runs may be required. Unless other intelligence sources have provided data on the mine settings, the recovery and exploitation of several mines to determine their settings should be one of the highest priorities of the MCM Commander.

After field exploitation, the mine may be shipped to the EOD Technology Division at Indian Head, MD, and Coastal Systems Station, Panama City, FL, for technical exploitation and analysis. If the mine is an unknown type or new modification, a full exploitation and analysis to determine sweep tactics should be done. After sufficient exploitation has been conducted, mines of a type that have previously been exploited and analyzed may be disposed of by countercharging.

3.5.6 Brute Force Mine Clearance. Brute force refers to the highly desirable but rarely practical requirement to clear or neutralize the mines in an area all at once. It is theorized that by the use of a large enough force, sympathetic detonation or neutralization of all the mines in an area could be accomplished in the same instant. While in theory it is possible, in practice it has not yet proven to be feasible. Attempts have been made using saturation bombing and naval gunfire, with little success. However, these explosives delivery methods do not provide a uniform distribution of force over the area. Thus, while some mines may be detonated and others damaged, the commander cannot, with confidence, consider the area to be cleared to a safe level. Further development is ongoing with systems (such as line charges and explosive nets) that can provide a more

even distribution of explosives which can be detonated all at once. In the near future, it may be possible to clear the surf zone or other shallow-water zones with brute force techniques.

3.6 INTEGRATED MINE COUNTERMEASURES OPERATIONS

MCM operations require a variety of assets equipped with MCM capabilities to overcome the mixture of old and new mines that are in use today. Integrated operations involve the coordinated planning and application of these assets to achieve the objectives in the safest, most expedient manner. There are four basic steps to an integrated MCM operation:

1. Determine the tactical objective
2. Assess the threat
3. Assess MCM asset capabilities
4. Develop and implement a tactical plan.

The battle group or CATF (with advice from the MCM commander) will determine the MCM objective by considering general knowledge of the minefield location and enemy mission, the urgency of need to transit the area, and the acceptable degree of risk for MCM assets and traffic vessels. Assessment of the threat is a continuing process that must include the threat from the mines that might be encountered, the threat resulting from or compounded by the environment in which the operation must occur, and the threat from hostile forces. In assessing MCM asset availability, capabilities, and utilization, the MCM commander must evaluate the capability of each asset against each confirmed or suspected mine type and combination of types, evaluate the logistic support requirements for each asset type, and thereby determine the utilization factors of each asset.

Asset strengths that are exploited where possible include the following:

1. SMCM long operational endurance
2. SMCM influence sweep versatility
3. SMCM deep hunt, neutralize, and sweep ability
4. AMCM invulnerability to mines
5. AMCM speed at hunting and sweeping
6. AMCM shallow water sweep ability

7. EODMCM independent identify and neutralize ability
8. MMS shallow water and buried mine capability.

Asset weaknesses to be worked around include the following:

1. SMCM shallow water limits
2. SMCM vulnerability to mines
3. AMCM daylight only limits
4. AMCM inability to identify and neutralize
5. EOD/NSW environmental and bottom time limitations
6. EODMCM diver endurance.

Having considered individual asset capabilities, the MCM commander must now integrate those assets into a tactical plan that will exploit strengths and minimize weaknesses. Common aspects of an integrated plan may include rapid reconnaissance by AMCM to help refine planning for each area, precursor sweeping by AMCM to protect the SMCMV against sensitive influence mines and shallow moored contact mines, or precursory hunting by AMCM to determine the presence of moored mines. Once the tactical plan is prepared and implemented, it must be continuously reevaluated using the most current threat information to determine whether the plan needs to be modified and whether it is accomplishing the objectives as intended.

The battle group and MCM commander may also request MPA or national assets. These assets can monitor the area of operations to localize the mine threat and determine which forces pose a threat to MCM assets. NSW may be requested to assist in VSW operations. Air and surface platforms may be needed to provide defense for the MCM forces if operating in or near hostile environments.

3.7 COMBINED MINE COUNTERMEASURES OPERATIONS

Combined MCM operations are those conducted with a combination of U.S. and Allied MCM forces (NATO and/or other nations' assets). These multinational operations may involve forces used to operating under different doctrine, different tactical procedures, and with limited connectivity in C4I systems. To determine the best tactical application of all available assets, planning for combined operations can follow the same

procedure as for integrated operations. However, combined operations are sometimes affected by national political limitations which prevent free employment of some national forces. An example might be the prohibition of force employment in the territorial waters of the aggressor nation or as an integrated force with some other nation's assets. Although these limitations will complicate the planning problem, the same tactical approach (considering all asset capabilities and limitations) can be followed.

3.7.1 Primary NATO/Allied MCM Assets. MCM has been a high priority for many European countries during the Cold War years. Many NATO countries have been mined before and continue to face mine problems that are both left over from World Wars I and II and a result of the former Soviet threat.

The U.S. MCM-1 Class was developed to counter the ASW mining threat by the former U.S.S.R. (a deep water threat). The threat most NATO countries planned against was a shallow-water ASUW mining effort to stop troop movement and commerce. This is reflected in the capabilities and design of each country's forces. Forces and tactics are developed to suit the individual needs of each country, not necessarily to fill particular shortcomings in the NATO organization.

The following paragraphs highlight most of the significant NATO/Allied platforms. For additional detail and current numbers, recommended references are as follows:

1. DST-1260H-061-yr, Naval Weapons Systems, Less Missiles
2. DST-1260H-110-yr, Mine Warfare Capabilities: Selected Eastern European Countries
3. DST-1260H-120 yr, Naval Mines & MCM: Rest of World less Eastern Europe
4. COMINWARCOM MIW Assessment of NATO/Allied Nations
5. Jane's Fighting Ships.

3.7.1.1 Great Britain. Great Britain has an excellent MIW capability, which includes a career path for officers and enlisted personnel who wish to remain in the MCM community. Divers are an integral part of each ship's crew rather than a separate force. The FSU is a mobile engineering support unit that deploys to support British MCM forces as necessary, and an MCM force will normally deploy with a support ship with an MCMTA embarked.

There are 13 British HUNT Class ships. Their characteristics are as follows:

1. Conventional GRP frame structure with GRP hull covering
2. Very low magnetic signature
3. Hydraulic auxiliary propulsion for mine hunting
4. Hull mounted 193M minehunting sonar
5. PAP-104 identification/neutralization ROV
6. Mechanical, magnetic, and acoustic sweep.

There are 12 British SANDOWN Class ships; they are new and similar to the MHC-51 in capability.

1. GRP construction
2. Nonmagnetic diesel with Voith Schneiders and bow thruster
3. Electric auxiliary propulsion for mine hunting
4. Marconi 2093 VDS minehunting sonar
5. PAP-104 identification/neutralization ROV
6. Nautis M tactical display/command and control system.

3.7.1.2 France. France has a strong MCM force and maintains a serious route survey program. It maintains 10 ERIDAN Class (TRIPARTITE) ships. TRIPARTITE was a joint French, Dutch, and Belgian project to build mine hunters. Each built its own GRP hull but used French electronics, Belgian electrical equipment, and Dutch engines. Each have the following characteristics:

1. Two electrical active rudders for MH propulsion
2. DUBM 21A hull mounted sonar
3. PAP 104 identification/neutralization ROV
4. Mechanical sweep system.

3.7.1.3 Netherlands/Belgium. Eguermin, perhaps the best MCM school in the world (a bilateral agreement between the Netherlands and Belgium), is located in Oostende, Belgium. In addition to a museum, it has a complex simulator that can simulate any MCM unit in the world against any mine threat in the

world, and is used to run full interactive planning problems. The new Mine Warfare Training Center in Texas is patterned after Eguermin. The Netherlands has 15 TRIPARTITE minehunter/sweepers. Belgium has seven TRIPARTITE mine hunter/sweepers and two command and support ships.

3.7.1.4 Germany. Germany has a very strong mine warfare program with very active and capable mining and MCM programs. The following are Germany's MCM inventory and ship characteristics:

1. Six ELBE Class tenders for logistics support to MCM and FPBs
2. Ten Type 332 MHC ships
 - a. Nonmagnetic steel hull
 - b. Electric minehunting propulsion motor
 - c. Hull-mounted minehunting sonar
 - d. Two Penguin mine identification/counter-mining ROVs
3. Ten Type 343 Class MSC ships
 - a. Sweeper version of Type 332 without electric propulsion
 - b. Full sweep suite
 - c. Mine avoidance sonar
4. Ten Type 331 MHC ships
 - a. Constructed as sweeper then converted to hunter
 - b. Hull-mounted minehunting sonars
 - c. PAP 105 mine identification/neutralization ROV
 - d. Mechanical sweep system.
5. Six Type 351 TROIKA ships
 - a. Same as 331 but converted to Troika control ship rather than hunter
 - b. Controls three acoustic/magnetic sweeping drones by radar tracking and radio link
 - c. Retains mechanical sweep system.

3.7.1.5 Norway. Mining has priority in Norway where 50 percent of coastal waters are unsuitable for mine hunting, but they have recently built a new SMCM ship. Norway's MCM assets include four OSKOY Class (MHC) ships and five ALTA Class (MSO) ships. The following are their characteristics:

1. New class, first commissioned June 1994
2. GRP catamaran operating on surface effect between two hulls
3. Two diesel engines, two waterjet propulsion units
4. MHC fitted with hull-mounted sonar and two Pluto ROVs
5. MSO fitted with mine avoidance sonar and mechanical and influence sweep system.

3.7.1.6 Denmark. In Denmark, mining also has priority, and MCM assets are multipurpose ships. The country has 14 FLYVEFISKEN Class mine hunter/layer ships with six MCM suites. They have the following characteristics:

1. Stanflex 300 common hull and prop for MCM, patrol, attack, and minelayer variants
2. GRP hull, combined diesel/gas turbine propulsion, hydraulic auxiliary propulsion
3. The six MCM equipment suites can be fitted to any of the 14 ships
4. Suite includes side-scan sonar, ROV, and control over two SAV Class hunting drones (side-scan sonar).

3.7.1.7 Sweden. Sweden also places a heavy emphasis on mining. It has seven LANDSORT Class MHC ships, which have the following characteristics:

1. GRP hull with four diesel engines and two Voith Schneider props
2. Hull-mounted sonar and two ROVs
3. Mechanical and influence sweep systems
4. Control platform for SAM remote control influence sweeps (same as the two systems the U.S. Navy purchased).

Sweden has numerous craft listed as minelayers with dual roles as command/training/diver support, etc.

3.7.1.8 Italy. Italy has excellent MCM capabilities and exports much MCM equipment. Among its assets are the following:

1. Four LERICI Class MHC ships
 - a. GRP hull design was basis for U.S. Navy Osprey Class
 - b. Large diesel and prop for transit, three smaller diesels, and three hydraulic props for mine hunting
 - c. Italian-built SQQ-14 VDS minehunting sonar
 - d. MIN 77 mine identification ROV and Pluto mine destruction ROV
 - e. Oropesa mechanical sweep
2. Eight GAETA Class (LERICI II) ships
 - a. Enlarged LERICI design, 8 feet longer, 170 tons heavier
 - b. Improved hydraulics, ROV, electrical generation, and reduced magnetic signature.

3.7.1.9 Japan. Japan takes MIW seriously and has a large, capable SMCM force and a viable AMCM capability. Among its assets are the following:

1. Thirty HATSUSHIMA/UWAJIMA Class MHSC ships
 - a. Hull-mounted sonar (two with 2093 VDS)
 - b. ROV neutralization system (two on some ships)
 - c. Full sweeps system.
2. Three YAEYAMA MHSO ships
 - a. Very similar to U.S. Avenger Class
 - b. U.S. SQQ-32 VDS sonar, deep capable neutralization ROV
 - c. Deep capable mechanical sweep
 - d. Acoustic and magnetic sweep.
3. Several minelayer and minesweeper support ships are maintained as flagships.

4. Twelve MH-53E AMCM Helicopters
 - a. U.S., Japan and Russia are only countries with AMCM
 - b. Same aircraft as U.S. Navy AMCM
 - c. Mechanical, magnetic, and acoustic sweep systems

3.7.1.10 Spain. Spain has good capabilities, considering its limited funding. Following are its assets:

1. Four GUADELETE Class ex-U.S. MSO ships
 - a. SQQ-14 VDS sonar and some ID-capable ROVs
 - b. Mechanical and influence sweeps
2. Eight ex-U.S. Navy MSCs ships capable of performing mechanical and influence sweeps
3. Four CME Class ships being built using British SANDOWN design.

3.7.1.11 Australia. Australia is serious about MCM but has very limited ship assets. Its strength lies in the quality of its Mine Clearance Diver community. Following are its assets:

1. Two MHCAT ships
 - a. 100-foot catamaran hull limits operability
 - b. Hull-mounted sonar with PAP ROVs
2. A trawler type COOP craft capable of towing mechanical or influence sweep systems
3. Six new construction HUON Class MHC ships using the Italian GAETA Class hull
 - a. British 2093 VDS sonar
 - b. Two Double Eagle neutralization-capable ROVs

3.7.2 Other Mine Countermeasures Forces. Figure 3-9 provides a listing of other countries with MCM ship assets. The quality of ship maintenance and training varies greatly between countries. Some vessels are very old and have limited operational MCM systems.

COUNTRY	ASSET	ASSET	ASSET	ASSET
Argentina	4 MSC	2 MHC		
Brazil	6 MSC			
Bulgaria	8 MSC	11 MSI		
China	8 MSC	27 MSO		
Croatia	1 MHSO			
Cuba	10 MSC			
Egypt	10 MSO	3 MHC		
Ethiopia	1 MSO	1 MSC		
Finland	13 MSI			
Greece	14 MSC			
India	12 MSO	10 MSI		
Indonesia	2 MHSO (Tripartite)	2 MSO	9 MSC	
Iran	3 MSC	2 MSI		
Iraq	5 MSI			
Libya	8 MSO			
Malaysia	4 MHC (Lerici)			
Nigeria	2 MHC (Lerici)			
North Korea	23 MSC			
Pakistan	3 MHSO (Tripartite)			
Poland	8 MSO	13 MSC	3 MHC	
Romania	16 MSC			
Russia	58 MSO	90 MSC	2 MHC	25 Haze B
Saudi Arabia	3 MHC (Sandown)	4 MHC		
Singapore	4 MHC (Landsort)			
South Africa	4 MSC	4 MHC		
South Korea	8 MSC	8 MHC		
Syria	10 MSC			
Taiwan	7 MHC	4 MSO		
Thailand	3 MSC	2 MHSC		
Turkey	20 MSC			
Uruguay	4 MSC			
Vietnam	4 MSC	4 MSO	4 MHC	2 MHI
Yugoslavia	2 MSI	2 MHS		

NOTE: This figure lists assets that have significant capability or are suitable for ocean-going MCM operations. Some ships and craft that are only suited for harbor or river operations or whose MCM systems have been removed because of a change in mission are omitted.

Figure 3-9. Other MCM Assets

3.8 AMPHIBIOUS MINE COUNTERMEASURES OPERATIONS

Minefields and obstacles mixed with the minefield form an integral part of the antilanding defenses that must be overcome for a successful amphibious landing. The mission of MCM forces is to prevent the delay or disruption of amphibious operations due to enemy mining. MCM in support of amphibious operations is frequently referred to as SWMCM because of the relative shallowness of the depth zones involved. The littoral area is divided into three depth zones based on variations in environment, types of mines encountered, and limitations of asset capability.

The SZ is that area between the high water mark or zero feet out to 10 feet. In this area, any significant wave action will make a swimmer unable to maintain control and conduct a safe search for mines. The mines that might be found here include ground contact mines, ground influence mines, ground pressure plate mines, ground tilt rod mines, moored contact, moored influence, and anti-invasion mines. Additionally, mixed with the mines may be obstacles that can complicate the mine clearance problem.

The VSW zone is between 10 and 40 feet deep. Mines found in this zone may include ground or moored contact mines, ground or moored single influence mines, ground multiple influence mines, and ground tilt rod mines. Obstacles may also be found here, though probably not as many as in the SZ.

The SW zone covers the 40- to 200-foot area. Moored contact mines and ground or moored single and multiple influence mines will be found here. Obstacles are still possible but less likely because they are highly dependent on the severe tidal variations.

To avoid causing a delay in the amphibious landing, MCM must be performed prior to the assault to clear channels for landing craft and transport ships to approach the beach. During this time, MCM forces must remain undetected if the element of surprise is to be maintained. Problems which must be overcome include the following:

1. AMCM and SMCM forces are not capable of undetected operations where any radar system or visual watch is maintained.
2. AMCM is limited to daylight operations.
3. SMCM can do exploratory mine hunting at night but is detectable on radar and is defenseless.

4. MMS detachments could be used in exploratory/ marking operations at night but are also detectable and defenseless.

Current tactics used in support of amphibious operations are found in SWDG TACMEMO 6022-1-95/OH 1-17. Breach in stride, the breakthrough of an enemy minefield during an amphibious assault, is one of the methods and takes advantage of surprise and initiative to get through the obstruction with minimal loss of momentum. It maintains the momentum of the attack by denying the enemy time to mass forces to cover the obstacle or minefield. Subordinate units should be capable of independent breaching operations to accomplish the mission against weak defense, light defense, simple barriers, or unclear situations.

The NSW force conducts covert beach reconnaissance, which verifies that a mine threat is present. NSW is responsible for clearance of mines from 21 feet to the surf zone and may mark mines during reconnaissance for later planting of neutralization charges or plant charges during reconnaissance. To maintain covertness as long as possible, detonation of neutralization charges and charges on other obstacles will likely occur at the beginning of the assault. If there is any significant wave action, NSW swimmers are not able to safely and covertly operate in the surf zone, so even if total success could be attained in other areas, some mines may still be left where the concentrations of mines and obstacles are the heaviest.

If surprise is sacrificed and overt MCM is commenced prior to the assault using SMCM and AMCM forces in daylight, ships, helicopters, and EOD boats are vulnerable to any hostile fire from the beach. Heavy losses can be expected if all types of fire from the beach cannot be suppressed. If no preassault phase MCM is conducted other than NSW reconnaissance, it is unlikely the MCM force will be able to make a significant reduction in the threat without delaying the assault. MCM is a time-consuming process because of the slow pace at which sweeping and hunting are conducted. Even a single-pass mechanical sweep to cut moored mines is not quick because any cut mines must be prosecuted individually.

The varying depth environment forces a division of responsibility by depth capability. NSW is the only force that can operate in the SZ. AMCM systems (the fastest coverage rate of all systems) are not as effective in the SZ, but depending upon equipment used, they can operate as shallow as 8 feet. If any obstacles are encountered in this area, natural or manmade, gear losses may be a critical factor. From 30 feet and deeper, AMCM and SMCM can both be effective.

Mutual interference occurs when swimmers/divers are working directly adjacent to AMCM or SMCM conducting influence sweeping. Consequently these operations must occur at different times or have a carefully orchestrated separation distance.

When mines are present, waiting until after the assault for MCM probably would result in unacceptable losses. Continuing MCM after the assault will be necessary to expand cleared areas, increase clearance percentages, and counter any delay arm mines.

Coordination of MCM with other warfare areas during all phases is very important; however, the MCM chain of command may vary according to the phase of the operation. The MCM commander may be subordinate to the following:

1. The area commander, if MCM forces are in the area before the ATF arrives. It is also likely some forces will have to continue to support the area commander.
2. The CATF, who has the overall responsibility for MCM in the AOA. The CATF may delegate the conduct of MCM to the MCM commander and may assign the MCM force to the advance force commander.
3. The advance force commander may have control of MCM forces, particularly for the preassault phase. Careful liaison and coordination are required during planning to ensure the MCM commander can fully support the ATF commander during assault-phase MCM.

3.9 SUBMARINE MINE COUNTERMEASURES OPERATIONS

In most roles, the submarine is an independent operator counting on stealth to protect it from most threats. However, once in position, the mine is even more stealthy than the submarine and can easily target any passing within its detection envelope. Consequently, submariners have developed systems and tactics to detect and avoid mines. Some submarine sonars originally designed to detect ice have proven capable of detecting mines moored in the water column. Based on experience with these sonars, new submarine sonar systems have been developed with the necessary transducer arrays to permit searching for and detecting mines. However, submarines are not MCM platforms and should not be expected to transit mined waters on purpose. Nevertheless, they can be used to conduct reconnaissance ahead of a battle group to determine whether a clear channel exists. They can also transit to

forward operating areas without requiring supporting MCM forces to determine a clear channel.

Since submarines are capable of operating under the ice in polar waters, they may also be faced with mines either placed under the ice or laid in an area that has since iced over. This cannot be addressed by surface or airborne MCM forces and must therefore be dealt with by the submarine on its own. A discussion of equipment and tactics for this situation can be found in the NWP 3-21 (formerly NWP 70) series.

3.10 RIVERINE MINE COUNTERMEASURES OPERATIONS

Riverine MCM operations include all MCM operations in rivers, canals, and lakes that are significant inland traffic ways. The water may be saline, brackish, or freshwater and is assumed to have a considerably lower electrical conductivity than seawater. There may be a higher concentration of debris on the bottom; mud or silt bottoms are likely to be the norm. These environmental conditions combined with the limited depths and maneuvering room in many riverine scenarios make most current MCM platforms and systems poorly suited for these operations.

The last significant riverine MCM operation conducted by U.S. Navy forces occurred in the Vietnam Conflict. Although all of the specialized systems and platforms used during that period have been retired, the designs and procedures for employment are still available in archives and could be recalled for use if necessary.

Of the SMCM platforms and systems in current use, some would be employed in riverine MCM operations despite limited suitability. The MCM 1 and MHC 51 Class ships are limited in utility because of size and limiting depths: the navigation drafts of 12.2 feet and 9.2 feet, respectively, prevent employment in the shallow river environment except where deep channels exist or have been created. Additionally, the MCM systems installed are all designed to operate in water greater than 30 feet deep, and the sonars require a minimum water depth in the 50-foot range for deployment. The SAM system would be far more suitable for riverine operations, but there are only two SAM craft in the inventory.

AMCM helicopters could be employed in riverine operations, provided the surrounding geography provides room for maneuver. River banks shrouded with tall or overhanging trees could cause severe limitations. The AMCM shallow-water sweep systems (MOP and Rattlebars) would be effective in riverine operations, but the AN/AQS-14 Sonar, Mk-104, and Mk-105 Sweep Systems would probably not be usable.

EODMCM should be fully functional in riverine operations, although poor water clarity might hamper diver operations. EOD MMS systems would not be employable since they require a seawater environment.

A description of the mine threat and MCM systems employed in riverine operations can be found in the 1992 Mine Warfare Summary, published by the Mine Warfare Branch of the Office of the Chief of Naval Operations.

3.11 DEPLOYMENT OF MINE COUNTERMEASURES FORCES

MCM assets do not participate in normal rotational deployment cycles like other combatant forces. The force levels and ship characteristics necessary to maintain a continuous presence in overseas theaters do not exist in the MCM force. The necessary endurance and self-sufficiency for these cycles run contrary to the design requirement to minimize the influence signature of MCM platforms. Therefore, when an OPLAN calls for MCM forces, they must be transported to the area and provided the basing/support that meets their somewhat unique requirements. Transportation and support requirements vary by platform and unit type, but all must be included in the OPLAN TPFDL, and sufficient priority must be assigned to ensure that lack of MCM forces will not unduly hinder other force operations.

Prior to deploying an MCM force to an area where no recent operations have been conducted, a site survey should be conducted. The support requirements for MCM forces are sufficiently different from other naval forces to justify an advance party visit to the area from which operations will be supported. The advance party can conduct briefings of support personnel and survey ship mooring facilities or aircraft landing, parking, and maintenance areas to determine whether the existing equipment is suitable to support the MCM force. If additional arrangements need to be made, they can be started prior to arrival of the MCM force, and in some cases, the advance party will be able to determine whether additional equipment needs to be transported from the home base or whether some equipment may be left behind. Appendix B of NWP 3-15.1 (formerly NWP 27-1) contains a contingency plan survey list. More detailed lists are generally held by the MCM Squadron staffs, AMCM Squadrons, and EOD Mobile Units.

3.11.1 Surface Mine Countermeasures Forces.

Surface MCM ships can be moved to the area of operations in three ways: self-transit, towing, or heavy lift ship. The following characteristics may be advantages or disadvantages, depending on the scenario and distance to be deployed:

1. Self-transit
 - a. Maximum average SOA is 8 knots.
 - b. Builds engine wear on nonmagnetic engines.
 - c. Ships require refueling every 3 to 4 days using astern rig.
 - d. Must avoid heavy weather.
 - e. Maintenance period required on arrival for PMS/voyage repairs.
 - f. The full crew rides the ship.
 - g. Escort desired for long transits and to provide refueling services.
 - h. If escorted by MCS, the MCM Commander, AMCM, and EODMCM can also be embarked.
 - i. The escort may carry spare parts, engines, and sweep gear.
2. Towing
 - a. Depends on availability of a tow ship.
 - b. The tow speed may be less than self-transit speed.
 - c. Does not cause wear on engines.
 - d. Heavy weather may damage or delay tow.
 - e. May require maintenance period at end of tow for PMS.
 - f. Crew can ride the ships, but training en route is limited.
 - g. Tow ship may not be able to transport spare parts, engines, and sweep gear.
3. Heavy Lift Ship
 - a. Depends on lift ship availability.
 - b. Only a few lift ships can carry three or four MCM ships.
 - c. Some lift ships cannot transit the Panama Canal.

- d. Requires deep berth (60 feet) for onload and offload with calm weather.
- e. Onload requires about seven days, and offload requires about three days.
- f. Most lift ships are capable of a 12-knot SOA.
- g. Results in no engine wear, but there are potential power train alignment problems from docking.
- h. Lift ship is not as susceptible to delay by heavy weather.
- i. Crew support may not be available on lift ship.
- j. Lift ship can usually carry containers of spare parts, sweep equipment, C4I vans, and EODMCM equipment, etc.
- k. Requires significant additional funding.

If SMCM ships are deployed by towing or heavy lift, any portion of the crews who do not ride the ships can be given additional training and briefings to maintain or sharpen their skills for the anticipated operations. It may be feasible to assign another MCM or MHC as training ship and conduct refresher training underway, prior to the crews' rejoining the ship.

The crews should arrive in theater just prior to the lift or tow ship's arrival at the destination if messing and berthing can be provided. Otherwise it will be necessary to coordinate their arrival with the offload date so that they will be able to embark the ship immediately.

Once in the area of operations, SMCM forces require some unique support. The hulls of U.S. SMCM ships are constructed of wood with a GRP sheath (MCM Class) or solid GRP (MHC Class). Mooring facilities for the ships need to be equipped with Yokohama-style fenders to protect the hull from direct contact with the pier structure. Additionally, since these are relatively small ships, they frequently require some additional effort to rig brows when placed at commercial ship docking facilities.

Other than mooring support, the SMCM ships require frequent replenishment of supplies, often in smaller quantities than most ship chandlers are used to dealing with, and they have little crew support features. These ships have no disbursing, ship's store, barber, or dental facilities, and these services need to be provided by a shore base or other ship when not in company with the MCS or other assigned support ship. Additional logistics support requirements are discussed in NWP

3-15.1 and NWP 3-15.11 (formerly NWP 27-1 and NWP 27-2).

For long-term presence of MCM ships (forward deployment) or an operation longer than 6 months, MCM and MHC ship crews may be rotated between CONUS hulls and the deployed hulls to reduce the impact on PERSTEMPO. Since the number of MCM and MHC ships available and the time required for transiting to and from a forward base make normal rotational deployments impractical, crew swapping may be used to provide the personnel relief from the arduous lifestyle when deployed on board a small ship

3.11.2 Airborne Mine Countermeasures Forces. The AMCM mission includes a quick response readiness posture, being able to rapidly deploy worldwide via air or surface lift, and an ability to conduct AMCM operations from fixed land bases, aircraft carriers, and air-capable amphibious ships.

AMCM can transit by assisted self-lift, airlift, or surface lift. For short-range deployments, MH-53Es can fly cross-country with some support personnel and MCM equipment on board. Remaining support equipment and personnel can be carried by ground transportation or C-130/C-141 airlifters. Transportation of all support equipment and 90-day packup by ground requires 20 to 30 trailer trucks, depending on the sweep systems to be carried.

For longer range deployments, AMCM can be transported by C-5A/C-141 airlifters. Approximately eight C-5As and nine C-141s are required to deploy an 8-plane squadron. The squadron has a computerized Loadout Support System program to prepare the load plan which interfaces with the Air Force Computer Aided Load Manifesting program.

Surface deployment of AMCM requires a large-deck aviation-capable ship. CV, LHA, LHD, MCS, and LPD types are all capable of transporting and supporting AMCM operations. Operation from a CV/CVN displaces some of the air wing and requires significant modification of the normal flight operations routine. Operation from an LHD or LHA in conjunction with some Marine air assets creates less impact than on a CV, but still requires significant coordination. The LPH has been the most frequently used and suitable platform, but except for a few gunships and SAR/utility aircraft, the Marine air combat element is displaced. Although the LPH classes are being decommissioned, LPH 12 is being converted and will remain in commission as MCS 12. An LPD can accommodate only three aircraft, thereby limiting operations due to number of deck spots. It also provides no maintenance support (such as AIMD

or hangar deck maintenance area) and cannot accommodate utility aircraft. LSDs are unsuitable due to deck limits and lack of space. All platforms require 3 to 5 days on-load to properly stow equipment.

Whatever the method of deployment, the normal deployment package includes eight MH-53E helicopters, Mk 103/104/105 Minesweeping Systems, AN/AQS-14 Sonars, AN/ALQ-141 Countermeasures Sets, ground support and maintenance equipment, a 90-day packup (205 cubic meters, 2,650 kilograms), Rigid Hull Inflatable Boats for equipment launch and recovery, and approximately 450 personnel.

Logistics support required for AMCM deployed operations is similar for shipboard or shore operations. Requirements are summarized below, but more detailed requirements can be found in NWP 3-15.12 (formerly NWP 27-3).

1. Normal aviation support facilities aboard ship or ashore (runways, parking apron, fuel trucks, etc.)
2. Accommodation for 90-day packup: spare aircraft parts for 90 days (which weigh 72,000 pounds and occupy 7,000 square feet), most of which require covered storage
3. Space (4,120 square feet) for office and work-center
4. Berthing and messing for 450 personnel
5. Fuel (22,000 gallons of JP-5 will be used per day if each aircraft flies a single hop), as well as diesel fuel for RHIBs
6. Freshwater wash capabilities for aircraft and sweep systems
7. MK-105 sled launch and recovery require crane if ship is not well deck-equipped, or boat ramp for shore site
8. RHIB boats for sled operations require crane/davit for launch from trailers or pier berthing/parking area for shore operations
9. AMCM packup, which includes four MMFs set up to conduct equipment maintenance
10. Ground support equipment, including forklifts, mobile power units, hydraulic test stands, tow tractors, workstands, cranes, nitrogen carts, etc. If on board ship, many of these items will be provided by the ship.

For extended operations, especially when 90-day packup spares are expended, a dependable logistics pipeline is needed. Movement of engines, transmissions, and rotor blades to and from CONUS refurbishment facilities must be accomplished.

3.11.3 Underwater Mine Countermeasures Forces. The following paragraphs discuss briefly the logistics of deploying UMCM forces. Additional detail may be found in NWP 3-15.14 (formerly NWP 27-8).

3.11.3.1 Explosive Ordnance Disposed Mine Countermeasures. EODMCM personnel can deploy for operations in conjunction with surface MCM vessels, AMCM aircraft, or independently from both shore-based and shipboard facilities. EODMCM detachments are designed for short notice deployments and can operate for approximately 30 days without resupply (except for water, food, and fuel). A certified detachment can be deployed on very short notice.

For short range overland deployments, all EOD equipment is capable of being transported by three to four trucks that can tow 8,000 pound trailers. For long transits trailers may be loaded onto flatbed tractor trailer rigs. For overseas surface lift, all equipment may be embarked on board most large class ships. A detachment can embark on an MCM ship but will be able to carry only a limited operational equipment loadout. For long surface transits, it is preferred to deploy the EOD detachment on a larger ship and then transfer them to the MCM ship once in the operating area. For airlift, the entire EODMCM detachment can be loaded on various airlifter combinations. Refer to TPFDD documents for specific data.

One EODMCM Detachment consists of eight personnel, and the equipment to be transported may include:

1. FADL — This is a 20' x 8' x 8' trailer that stores all dive equipment and provides an O₂ clean area for diving equipment maintenance.
2. FARC — This is a portable recompression chamber with self-contained support systems (Life Support Skid), portable power generator, and three-man support crew.
3. RHIB — Each detachment has one 24-foot rigid hull inflatable boat for diving support operations and transport of divers to and from the dive area. The boat is equipped with a trailer for storage.
4. Inflatable boat — Each detachment uses an inflatable rubber boat (Mk-5 Zodiac) with engines suitable for

dive operations on mines. The boat can be placed on a trailer or deflated for transportation..

Logistics support required for deployed operations (described in detail in NWP 3-15.14) is summarized below:

1. Land transportation — If stationed ashore, the detachment will require trucks (which it may bring itself) to tow boat and equipment trailers and to transfer personnel.
2. Boat operations — If ashore, a small craft pier space or a boat ramp is required to support operation of both craft. If afloat, a crane or davit to launch and recover boats is required. Gasoline for boat engines is needed.
3. Recompression chamber — Unless supported by a local, certified recompression chamber, approximately 350 square feet is required to set up the FARC. The FARC can be self-supporting for 30 days except for diesel fuel.
4. Diving locker — The FADL requires about 200 square feet of deck space, a freshwater supply, and 3-phase, 60-Hz power.
5. Explosive storage — The detachment has a portable magazine for which 450 cubic feet of explosive storage is required.
6. Compressed gas storage — Aviation grade O₂ and a helium oxygen mix are required.
7. Communications — The detachment requires support to transmit and receive naval message traffic and may require support for obtaining keying material for secure voice radios.
8. Berthing and messing for eight to 12 persons.
9. Office/work space: Except for short-term operations, a covered, climate-controlled office and work space is necessary.

3.11.3.2 Mine Mammal System. MMS can be deployed to operate independently or as an integrated force with SMCM and AMCM. Certain conditions must exist in the area of operations for MMS.

MMS requires a safe base of operations on a friendly shore or a support ship with sufficient space and weight capacity to embark dolphin tanks, support systems, and personnel. The minimum water depth at a shore staging area must be 2.5 meters. Water temperature must remain between 42 and 91 °F during the period the dolphins are

in the area. There must be *no* significant environmental pollution, and water salinity must be at least 20 parts per thousand. If these conditions do not exist, the area is unsuitable for deployment of MMS.

Prior to deployment of MMS, a site survey is necessary to determine the suitability of the area and support available. The survey takes from 1 to 3 days and includes water chemical sampling, facility inspection, evaluation of the OPAREA for MMS, and logistics support arrangements.

Short-distance deployments of EOD MMS MILVANS and SEABEE shelters can be accomplished by truck. Boats require three to four trucks with an 800-pound towing capacity. The dolphins may be moved on trucks; however, it is preferable to transport them via cargo helicopters (internal load) to minimize transport time. Long-distance deployments require sealift or airlift. Maximum demonstrated sealift transit time is currently 11 days. Long-term embarkation on the lift ship without the opportunity for swimming in the open sea may affect the health and training of the mammals. If a long-range surface lift is envisioned, airlift of the mammals to the area of operations following surface ship arrival is preferred to preserve their operability. For airlift, the entire EOD MMS detachment can be transported on various aircraft combinations listed in the TPFDD. Staggered arrival of transport aircraft permits advance personnel to assemble support equipment prior to arrival of the MMS. Regardless of deployment method, once on scene, the mammals may require several days to acclimate to the new environment.

In addition to the limiting conditions mentioned before, deployed MMS requires the following:

1. A pier, causeway, quay wall, ship, or other stable platform to secure staging pens
2. 190 square meters of level ground for MILVAN and support equipment
3. A crane capable of lifting and positioning MILVAN and support equipment (15-ton capacity)
4. A freshwater supply
5. 220/110-volt, 60-Hz AC, 100-amp electrical service at the staging area
6. A suitable area for storage of Class A explosives
7. Messing and accommodations for up to 70 personnel (Mk 4 MMS has 24, Mk 7 MMS has 36, and

other personnel provide command element and maintenance support)

8. Communications support for transmission and reception of message traffic and periodic secure voice radio encryption update.

An EOD MMS detachment deploys with sufficient assets to support 15 days of sustained operations, with the exception of MOGAS. Mk 4 and Mk 7 MMS detachments conducting simultaneous operations may require up to 500 gallons of MOGAS per day. A 15-day replenishment will require the following:

1. 100 kg (240 pounds) of frozen fish per day (if full complement of both Mk 4 and Mk 7 are deployed)
2. Food for personnel if operating from a remote site
3. Explosives and minefield markers
4. Dry cell batteries for radios, electronic search, and navigation equipment
5. Spare parts as depleted by maintenance activities
6. 55 gallons of 2-cycle outboard motor oil.

Emergency support for MEDEVAC should be planned due to the inherent dangers of diving and MCM operations. Long-term operations may require additional maintenance support for equipment repairs.

3.11.3.3 Navy Special Warfare. NSW forces are embarked with an ARG and, as directed by CATF, have the capability to conduct MCM operations in relation to an amphibious landing. They would not be likely to deploy for MCM independent of an ARG. Essentially all support for NSW would be provided from within the ARG, although the MCS 12 may be called on for some support. Berthing, messing, and transportation of some equipment is within the capability of the MCS. The NSW combat rubber raiding craft can be launched and recovered from the MCS, and diving support facilities such as bottled gases and a recompression chamber are available.

3.11.4 Mine Countermeasures Staff. One of the first actions that should be taken when considering deployment of MCM forces (in addition to a site survey) is the deployment of one or more Staff Liaison Officers from the MCM squadron staffs. The primary purpose of these officers is to maintain the communications flow between a task group/force commander or theater commander and the MCM commander. They can be instrumental in making the initial decisions on which forces

are needed and laying the ground work for deployment of other assets.

The MCM commander and staff can be deployed by airlift independent of other forces or by sea embarked on the MCM support ship. MCS 12 is specially configured to support the MCM commander and should be used whenever possible. The staff consists of between 15 and 20 people (depending on the situation) with administrative support equipment and supplies packed in cruise boxes. They can be deployed on very short notice, but should not deploy until some support facilities are available in theater.

To effectively plan and control MCM operations, the MCM commander requires a dedicated command center with C4I capabilities. The MCM and MHC class ships are not equipped to support a staff; they have no berthing, insufficient communications, and no spare space in CIC to be used by a staff. If an afloat unit that is outfitted as a flagship cannot be made available to the MCM commander, it is possible for him to be set up in an ashore command center. Minimum basic requirements are as follows:

1. Adequate secure space for six to eight personnel (two to three maintaining a 24-hour watch)
2. Status boards and space for plotting on hydrographic charts (chart table or large flat table)
3. Communication suite to support sending and receiving message traffic, as well as maintaining secure voice and data communications with other command authorities and the MCM forces
4. 110-volt power source for operation of desk top computers
5. Messing and berthing for the deployed personnel.

If no established command center exists ashore to accommodate the MCM commander, an alternative is to use the COMINEWARCOM deployable C4I van. This new system is intended to be a self-contained command center that can be embarked on a ship or set up ashore. It is equipped with all necessary communications and tactical data systems to support the MCM commander. The characteristics of the C4i van were not available for inclusion in this publication, but they can be obtained by contacting COMINEWARCOM.

Although far less desirable, another option is to use an MIUW command van, which can fulfill the minimum communications requirements.

3.12 INTERFACE WITH THE ENVIRONMENT

3.12.1 General/Introduction. Mine warfare is the phase of littoral warfare most sensitive to environmental considerations. In strategic, tactical, and technical planning for both mining and MCM, the environment plays the dominant role. Minelaying missions will be conducted only if environmental conditions are favorable for delivery and weapon effectiveness after the lay. Mine weapon systems and components (mine cases, mine sensors, and target signals, for example) are all affected in significant ways by myriad environmental factors. Similarly, the fundamental decision in MCM (to conduct exploratory and reconnaissance operations to determine the presence or absence of mines, the extent of any mine fields present, and which mine hunting, sweeping, avoidance, or combination of these tactics and techniques can be effectively employed) is environmental in nature. A matrix summary of environmental factors affecting MCM is provided in Figure 3-10.

3.12.2 Environmental Factors. Many environmental factors affect mine, amphibious, and special warfare, and, because of the land/sea interface, they are more complex in the coastal/littoral areas than the open ocean.

Environmental factors affecting littoral warfare will be discussed in seven broad areas: oceanographic, meteorological, biological, acoustic, hydrographic and geophysical, and anthropogenic (manmade).

3.12.2.1 Oceanographic. Considerations unique to or magnified in the coastal oceanographic area are tides, tidal currents, surf conditions, wave height and direction, turbidity (and associated absorption of dissolved and particulate matter), and water visibility (both vertical and horizontal). Salinity (conductivity), water temperature, and temperature gradient as functions of depth should be considered in the evaluation of sonar performance.

3.12.2.2 Meteorological. The atmospheric elements are magnified in the coastal environment. Wind speed and direction, and therefore wave height, direction, and shape, are affected by diurnal effects (land and sea breezes). Ambient light available is affected by particulate matter such as smoke and dust. Ship safety may be affected by limited options for storm evasion. Weather in general, unless ideal conditions are encountered, will figure most significantly in the time required to conduct enabling mine warfare operations.

3.12.2.3 Biological. Marine life, from microscopic organisms to large marine mammals, plants, fish, must be considered in the planning and execution of littoral

warfare operations because of their special impact. Ambient noise, acoustic and optical scattering, false targets, biofouling, and the effects of seaweed, kelp, coral reefs, and coral heads are examples of marine life effects. Hazardous animals such as sea snakes, sharks, and jellyfish (e.g., the Portuguese man-of-war), are certainly taken seriously and considered carefully by divers.

3.12.2.4 Acoustic. The decision to sweep is based largely on the axiom, “mine hunt where and when you can; mine sweep when and where you must.” While there are some limited applications of nonacoustic mine hunting, acoustics are the primary medium for the detection and classification of minelike objects. The sound velocity profile is extremely important in the littoral minehunting problem. Scattering, reverberations, layering, ambient noise, and signal energy transmission loss determine in large measure minehunting effectiveness, efficiency, and safety. The minehunting measure of effectiveness will be used in the decision to hunt or sweep.

3.12.2.5 Hydrography, Bathymetry, and Geophysics. This combined category encompasses all the properties related to the bottom, or sea bed, and includes such factors as ambient magnetic background and anomalies, sediment (gases, gradient, conductivity, and stability), and pressure wave transmission. The hydrographic concerns of beach slope, topography, and depth range will be of primary importance to the amphibious planner, but the enabling mine warfare commander will consider bottom conditions: type, roughness, strength and stability, and clutter (which includes both magnetic and acoustic).

3.12.2.6 Anthropogenic. These effects in the littoral environment entail manmade influences on mine and MCM systems. The human influence in the regions includes different types of pollution, over-fishing, the creation of artificial reefs and fishing havens, and military operations in which ordnance and debris are left behind. Coastal merchant and fishing ships create noise and can produce sediment upwelling. Shipwrecks, trash, fishing traps, and well-heads are all manmade influences affecting littoral warfare operations.

The section that follows will discuss briefly some of the effects of these influences on mine warfare weapons and systems.

3.12.3 Environmental Effects on Mine Warfare Weapons, Systems, and Decisions. MIW planners and tacticians will know and take into consideration the problems facing the enemy miner, including the environment. The impact of the environment on mines as discussed in Chapter 2 is the starting point for the MCM effort.

CATEGORY	FACTORS	MAJOR OPERATIONAL IMPACT
Coastal Topography and Landmarks	Marginal topography, natural and man-made landmarks, aircraft flight path hazards, shoals, and other underwater hazards to surface craft	Navigational control and accuracy flight restrictions and pattern controls
Atmospheric Characteristics	Climatic conditions, duration of darkness and light, visibility, air temperature, winds, precipitation, storm frequency, and icing conditions	All operational limitations and restrictions common to adverse atmospheric conditions, platform and equipment selection, force level requirements, logistical concerns
Water Depth	Bathymetry; water depth fluctuations because of tides, seasonal storms, river runoff	Extent of operation area in relation to mine type to be countered, choice of countermeasures, platforms, gear, and tactics; limits to diver employment
Sea and Surf	Sea and swell conditions; surf characteristics	Operational limits for surface craft, EOD personnel, and MCM equipment; actuation probability for pressure mines; rate and direction of sweep or hunt; mine detection capability
Currents	Surface and subsurface current patterns, including tidal, surf, and river originated currents	Navigability and maneuverability of displacement craft and towed equipment; navigational error; diver operation limitations; effect on mine burial
Ice Conditions	Thickness and extent of sea ice	Modify, restrict, or preclude operations depending on extent and thickness of ice
Water Column Properties	Water temperature, salinity, and clarity	Temperature effects on diver operations; ability to visually or optically locate moored or bottom mines; temperature/salinity affect on conductivity for magnetic sweep; sonar depth and effectiveness
Sea Bed Characteristics	Bottom roughness, material, strength, and stability	Decision to employ minehunting techniques; limitations on mechanical sweep gear; extent to which a mine will bury
Acoustic Environment	Sound speed	Acoustic propagation/attenuation
Magnetic Environment	Electrical resistivity, number of magnetic minelike contacts, ambient magnetic background	Ability to employ open electrode sweeps; extent and strength of magnetic field established by magnetic sweep gear; number of minelike targets limiting magnetic hunt efficiency; effectiveness of magnetometer detectors
Pressure Environment	Natural pressure fluctuations due to wave action	Actuation probability for pressure mines and hence, the selection of conventional or guinea pig sweep techniques

Figure 3-10. Environmental Considerations in Mine Countermeasures

Environmental factors affecting the planning and execution of MCM operations will be discussed in two categories: stable and transient characteristics.

1. Stable characteristics, such as bathymetry and topography (in short, valid data from prior surveys).
2. Transient characteristics, such as the thermal properties of the water column and meteorological conditions (in short, information obtained in *situ*).

3.12.3.1 Stable Environmental Characteristics Affecting Minesweeping Operations.

3.12.3.1.1 Water Depth. The sweeping techniques used are often determined by water depth. Ships rarely operate in less than 10 meters of water, but they are well suited for deep ocean sweeping. Helicopters and non-displacement craft are better suited for shallow water sweeping.

3.12.3.1.2 Bottom Topography. Variations of bottom gradient, as well as holes, ridges, and peaks, will dictate special planning and handling of sweep gear. Track orientation and depth segmenting must be considered to increase sweep efficiency and reduce risk of damage to equipment. Further, a complex bottom topography may require both sweeping and hunting to reach the desired clearance level.

3.12.3.1.3 Bottom Composition. Mine burial will be determined by various factors, including bottom strength, composition, and stability. Burial will affect both the miner and the countermeasures effort (sensitivities of acoustics and pressure mechanisms may be lessened by burial). The potential for mine burial figures significantly in the decision whether to sweep or to hunt.

3.12.3.1.4 Underwater Obstacles. Wrecks and other anthropogenic objects restrict the depth and perhaps even the use of sweeping equipment. In aggravated situations, area avoidance may be the only viable option.

3.12.3.1.5 Geography. Prominent landmarks and special coastal features are of use in both planning and conducting MCM operations because these characteristics may affect navigation and maneuvers.

3.12.3.1.6 Magnetic Minesweeping Environment. While fairly complex in theory and planning, there are two principal elements to consider in magnetic mine sweeping: the electrical conductivity of water and the depth of water. Electrical conductivity will dictate the use of open- or closed-loop sweeps. Water depth is the only factor affecting the performance of closed sweeps against all magnetic mines and that of open

sweeps against the vertical component of magnetic mines. Seawater conductivity affects the amount of current that can be used in the open-loop sweeps.

3.12.3.1.7 Acoustic Minesweeping Environment. The most important factor in acoustic sweeps is the sound pressure level loss in transmission of acoustic signals. Transmission loss is a function of sweep-to-mine distance, frequency, water and mine case depths, and bottom geology. The exact determination of transmission loss is complex; for practical reasons average transmission losses are tabulated as a function of depth and frequency.

3.12.3.2 Transient Environmental Characteristics Affecting Minesweeping Operations

3.12.3.2.1 Tides and Tidal Currents. Planning and conducting MCM operations with respect to the rise and fall of the tide is a straightforward navigation problem. Tides will affect the case depth of some moored mines if near the surface. The effect of tidal streams and currents poses more complex problems, including mine dip. Currents can cause navigational, maneuvering, and sweep streaming problems and must be dealt with carefully. Displacement minesweepers must take current information into account when operating where pressure mines may be present since current must be figured in the ship's speed over the ground.

3.12.3.2.2 Climate and Weather. Rain, fog, sea state, and smoke all affect mine-sweeping operations. The streaming of minesweeping equipment, both airborne and surface, is extremely hazardous, especially as the sea state and/or turbulence increase.

3.12.3.2.3 Wind. Wind is one of the most significant environmental factors for all MCM operations because it drives sea state, affects current, induces maneuvering (and therefore navigational) problems, and limits helicopter operations. Wind combined with low air temperature produces wind chill factors that make exposed sweeper crews vulnerable to cold and fatigue, which in turn can limit crew on cycle time and lengthen the time required for mine clearing operations.

3.12.3.2.4 Air Temperature and Pressure. In addition to the effects described above, air temperature and pressure directly affect the performance of AMCM helicopters. Temperature and pressure combined will determine aircraft fuel limits (weight) and therefore mission time. Higher temperatures and lower pressures lower helicopter efficiency.

3.12.3.2.5 Visibility. Reduced visibility hampers sweeping operations, especially with regard to moored

minesweeping, in which the usual method of helicopter-spotting of cut mines on the surface is degraded. While influence minesweeping by ship is relatively unaffected by visibility, helicopter and diving operations (independent of the parent ship) may be precluded altogether because of poor visibility.

3.12.3.2.6 Sea Swells and Waves. Under the right conditions, swells/waves may cause pressure variations sufficient to actuate pressure mine firing mechanisms. Therefore when surface wave and swell conditions meet these requirements, combination magnetic/acoustic sweeps may be effective against pressure/magnetic/acoustic combination influence mines. Large swell/wave conditions may degrade the capability to perform more operations.

3.12.3.2.7 Marine Life. Biological fouling of a moored mine case will decrease the buoyancy of the mine and, because of its greater drag and surface area, increase its dip. Marine growth has little effect on magnetic and pressure mines, but acoustic mine sensitivity can be significantly reduced by biological fouling. Additionally, heavy seaweed, especially kelp, can fire explosive cutters and foul mechanical cutters.

3.12.3.3 Stable Environmental Characteristics Affecting Mine Hunting Operations

3.12.3.3.1 Water Depth. The types of mines used will be determined in large measure by the water depth in the area of interest. Water depth will affect the use of variable-depth mine hunting sonars and, in some instances, will be the determining factor between sweeping and hunting.

3.12.3.3.2 Clutter. Bottom clutter is a general term that may include both natural objects and anthropogenic debris. Clutter ranges from rock outcroppings, coral reefs and heads, and other bottom topography anomalies to fishtraps, well-heads, oil drums, and other such man-made items discharged overboard. Generally, as the density of clutter increases, the more degraded mine hunting operational performance becomes.

3.12.3.4 Transient Environmental Characteristics Affecting Mine Hunting Operations

3.12.3.4.1 Tides and Tidal Currents. These influences affect the maneuvering and navigation of the mine hunter as described for the minesweeper. Maintaining station while prosecuting a minelike contact presents a challenge to the mine hunter directly proportional to the adverse forces acting against the ship's control systems. Strong tidal currents in conjunction with sandy bottoms may produce the problems of

burial by scouring or displacement of cylindrical mine cases because of rolling. Currents, and especially tidal streams from rivers and estuaries, can carry large amounts of sediment, thereby adversely affecting water visibility. Tidal currents can also affect the salinity profile, which can affect minehunting sonar performance.

3.12.3.4.2 Climate and Weather. Mine hunters are subject to the same climate and weather factors as minesweepers; however, prevailing weather during a mine hunting campaign may have an even more pronounced effect. For example, sustained high winds and associated sea states will limit mine hunting operations more severely than minesweeping because of low-speed maneuvering requirements for the hunter, the quenching effect on hull-mounted sonar, and the loss of operator efficiency where great concentration is required. Ambient noise levels will be higher with more agitated sea states, with heavy rain and wind breaking upon the surface. Wind and sea will also affect the launching and recovery of remote underwater vehicles, as well as boats and divers.

3.12.3.4.3 Underwater Visibility. The ability of remotely operated vehicles to locate optically and identify both moored and ground mines depends heavily on horizontal underwater visibility. Although a remotely operated vehicle can localize a minelike contact for neutralization using sonar only, mine destruction cannot be ascertained without visual verification. Poor vertical visibility will adversely affect aerial mine hunting for ground mines, and poor horizontal visibility affects the search for moored mines by both visual and electro-optical means.

3.12.3.4.4 Sound Velocity Profile. Sound velocity varies because of changes in temperature, pressure, salinity, and density. The resulting velocity gradients cause bending of the sound paths. The mine hunting acoustic problems are very similar to those of antisubmarine warfare sonar systems, with the major difference being that of frequency and therefore range and resolution. All U.S. Navy mine hunting ships are equipped with variable-depth sonars and are able to minimize the adverse effects of sound velocity gradients.

3.12.3.4.5 Multipath Effects. Through forward scattering, sound energy may reach targets of interest through other than the direct path. The signal received will be the sum of the returns from the various paths. The net result of the multipath effect depends on the position and aspect of the mine itself to that of the sonar transducer.

3.12.3.4.6 Absorption. Suspended matter and bubbles can cause absorption to be greater than that expected

in normal seawater. Absorption of sound energy will degrade sonar performance because of transmission loss and signal return loss. Higher than normal seawater temperature will also increase attenuation loss at the higher frequencies used in mine hunting sonars. This temperature effect is negligible below about 4 °C, but the effect is significant at temperatures of 27 °C and higher, such as is found in tropical regions.

3.12.3.5 Stable Environmental Characteristics Affecting EOD/Diving Operations

3.12.3.5.1 Water Depth. The depth of water and whether the appropriate equipment for that depth of water is available determines the feasibility of diving operations. Physical effects on the diver are directly determined more by water depth than by any other factor. Depth also affects the operational capabilities of the diver, such as number of dives and length of dive. In shallow water, the diver is generally not limited, but the deeper the water, the more restricted the diving envelope. At maximum depth, the diver may be limited to only one dive per day and to very short bottom stay time.

3.12.3.5.2 Bottom Conditions. Once in the water and prosecuting a ground mine, the type and condition of the bottom becomes a prime concern for the diver. A rough sea bed will increase the degree of difficulty and make the dive more dangerous. Accordingly, the time and effort required will be much greater as bottom topography and clutter become more difficult and dense, respectively. Clutter and bottom objects, both natural and manmade, can render bottom hand-held sonar and visual searches more difficult.

3.12.3.5.3 Bottom Sediment. Underwater visual searches are largely dependent on bottom composition. Soft mud is easily stirred up by water movement, current, or by the divers themselves resulting in loss of visibility. Mines buried in mud, or sand may not be visible to divers and thereby exposes them to significant danger from inadvertent mine actuation. Magnetic ordnance locators may be required.

3.12.3.6 Transient Environmental Characteristics Affecting EOD/Diving Operations

3.12.3.6.1 Tides and Tidal Currents. Except in very shallow water environments such as river mouths, estuaries, and harbors, tides generally pose no special problems for MCM diving operations. Current, on the other hand, is of major concern for the planning and execution of diving operations. Surface currents will affect small boat handling and navigation, but underwater currents have an even more significant impact. The greater the underwater current, generally the greater the degree of

difficulty in managing underwater equipment such as hand-held sonar and explosive packages, and the harder it is to complete work on the bottom while fighting an adverse current. Planning for working in strong currents or adverse conditions is required.

3.12.3.6.2 Water Temperature. The colder the seawater temperature, the more adversely affected the divers' physical and mental functioning becomes. Efficiency and endurance are directly degraded by cold temperatures.

3.12.3.6.3 Sea State. Small boat launching and recovery operations may be limited by sea state; however, airborne insertions of EOD personnel may be made in worse conditions if necessary.

3.12.3.6.4 Water Density. Variations in water density can be caused by sharp temperature and salinity gradients, which in turn can affect diver buoyancy. These conditions may be most troublesome near large river mouths but, while they may hinder diving operations to some extent, will not preclude such operations.

3.12.3.6.5 Climate and Weather. Except for the disposal of drifting mines on the surface, once in the water, the diver is relatively unaffected by the weather. However, divers must be tended from the surface by boat; therefore the sea state limitations outlined above will govern whether the diver can attempt the mission.

3.12.3.6.6 Hazardous Marine Life. Biofouling on mine cases may make identification hazardous and difficult for mine investigation and exploitation missions. Also, marine growth on drifting mines designated for surface destruction by EOD personnel can make handholds that are necessary for the attachment of explosive charges slippery and dangerous. Sharks, barracudas, and other predatory animals such as sea snakes can make a diving mission significantly more dangerous, not only because of the immediate threat from such creatures but because of the distractions they present as well. Heavy seaweed (kelp, for instance), can present major entanglement and visibility problems for divers.

3.12.4 Environmental Data Collection. One of the most important keys to successful mine warfare combat operations is the accurate collection, collation, and dissemination of environmental information obtained during peacetime and immediately after the cessation of previous hostilities. The precision and quality of environmental data directly affects the time required for MCM forces to complete operations, the safety of MCM forces, and risk to friendly shipping after MCM forces have completed operations. The effort to provide accurate environmental data to the MCM force commander

should be the same priority as the effort to provide high-quality mine intelligence information to mine warfare forces.

Peacetime environmental data collection efforts are not always welcomed in belligerent countries' waters. In the past, old data collected years earlier, best estimates, and educated guesses have been used when more precise information was required for mining or MCM operations. While accurate and timely environmental data is available from the Naval Oceanographic Office, commercial and academic sources for environmental data frequently are available for most littoral nations of the world. Utilization of such sources in time of hostilities should not be overlooked. Every effort should be undertaken to ensure that the quality and precision of ephemeral and seasonal environmental data is the best available without violating ROE or unnecessarily arousing belligerent nation suspicions during peacetime. While of great importance, the environmental data collected during peacetime is generally insufficiently specific for the precision required for safe and efficient mine warfare operations. Real time *in situ* data is of paramount importance for MCM efficiency and safety.

Conflict creates a new and less hospitable feature to mine warfare environmental data collection efforts. While data precision and quality are in greater demand by mine warfare forces, the ability to gather environmental data is even more restricted than during peacetime. In the favor of the MCM commander, however, is the more precise geographic location of suspected minefields. Seasonal and ephemeral data is more closely monitored and the type of MCM operation to be undertaken can be better defined with the databases from peacetime collection coupled with the environmental data from seasonal anomalies and predictions in the specific geographic area of interest.

In situ collection of environmental data from forces on location for operations and actually engaged in operations is the best, most precise information available. The data collected can directly influence risk to MCM forces, efficiency of the MCM operation, risk to transiting forces, and ultimately, the time required to complete MCM operations. Data collected while on site in the MCM operation is done in real time. Much data that directly affects MCM combat system performance and environmental prediction models can be collected by MCM platforms. While bathymetry information can be collected by expendable BTs, much data can be collected by the AN/SQQ-32 sonar and the AN/UQN-4 fathometer. With signal processing technology and operator training, characterization of the sea bottom sediment and a prediction of conductivity of the sediment can be produced from the fathometer, for instance, and rever-

beration noise and clutter can be refined by the sonar. Added with visual and instrumentation systems on board MCM platforms and a family of small off-the-shelf off-board systems under evaluation by the Navy Research Laboratory, the environmental data collection capability of MCM forces while actually conducting operations can greatly affect efficiency, risk, and time in mine danger areas.

3.12.4.1 Sources for Environmental Data.

NAVOCEANO has databases and archives of environmental information for U.S. Navy applications. In addition, NAVOCEANO publishes the Mine Warfare Pilot, a compendium of environmental information that is general in nature, but that encompasses specific geographic areas within each pilot. More precise data can come from the environmental prediction models available at NAVOCEANO, and the prudent MIW commander will ask for these models and pilots well in advance of an operation or exercise. In particular, mine burial prediction models are the initial input to an MCM commander in selecting whether MCM forces will be engaged in minesweeping or mine hunting operations. Environmental information is available as well from commercial sources and academia in specific areas of interest. The collection of environmental information by other U.S. Navy forces on site should be made available to the MCM commander as rapidly as possible. Data on water column depth, temperature, salinity, and local atmospheric conditions is of great importance to the MCM commander and may only be available in real-time form from on-site U.S. Navy forces exterior to MCM platforms.

3.12.4.2 Prediction Models.

Prediction models generally fall into four categories: environmental prediction models (mine burial, current circulation, or magnetic surveys), acoustic prediction models (sound speed profile), combat system performance prediction models (sonar range prediction or magnetic sweeping safe current prediction), and tactical decision aid models (which integrate the first three model types). Model validity should be tested and refined during peacetime exercises for proper operation in time of conflict. Models require full and accurate environmental information and the collection of this information must be coregistered (acoustic data collected in the same geographic area as magnetic data, for instance) and in a usable format for MCM operational use, such as the Mine Warfare Pilot and the Mine Burial Prediction Model.

The Naval Oceanographic Office is the repository for all environmental models and can access models outside of DOD sources as well.

3.13 MINE COUNTERMEASURES FORCE COMMAND AND CONTROL

3.13.1 Concept of Operations. The command and control of MCM operations requires a high degree of expert planning and execution. The MCM commander and his staff are specially trained and experienced in the steps required to evaluate a mine threat, analyze possible techniques and tactics to counter that threat, and, once the most suitable option is determined, direct the execution of the operation.

As with any warfare command and control problem, there are certain key elements that enable the commander to perform effectively. Some of these are a supportive working environment, ready access to information, and efficient communications. For MCM command and control, this means a command center with certain capabilities, knowledge of the mission to be executed by the forces the MCM assets are supporting, access to the intelligence collected on enemy capabilities and movements, and two-way communication with other warfare commanders for coordination.

Successful MCM planning requires the following:

1. A designated MIWC must be responsible for mine warfare in the battle group, even when no MCM force is present. His duties and responsibilities are described in paragraph 1.7.1.
2. The MCM commander must be included in communications at the same level as other warfare commanders.
3. The number of levels of command between the overall commander and the MCM commander should be few. MCM forces should be in the same chain of command as the forces they support to avoid excessive delay and message traffic.
4. The MCM support ship should be under the tactical control of the MCM commander. This avoids a conflict in tasking and missions.
5. Protective forces for the MCM force should be under the MCM commander's tactical control.

Every operational staff, whether it is a naval component commander, numbered fleet commander, or amphibious squadron commander, should have a position with the responsibility for MIW. In some cases this may be a collateral duty of an officer who has had mine warfare experience (typically an attack or maritime patrol aviator who has some mining training). Because few of these officers have had sufficient experience or train-

ing in MCM to advise the commander effectively when a real mine threat is encountered, it is essential that MIW training for these officers be given a high priority.

When MCM assets are deployed to counter a threat, the battle group commander should be augmented by one of two tactical MCM squadrons. The MCM squadron commander will assume the duties of MCM commander, directing the battle force's MCM efforts.

The MCM squadron commander has one or two officers on staff designated as liaison officers. The mission of these officers is to be attached to a commander who requires on-scene advice and assistance in coordinating the support of an MCM force. Prior to the MCM squadron staff's arrival in theater, the liaison officer may be deployed as a quick response advance party and may be instrumental in determining what MCM forces may be required to counter a threat, as well as initiating planning against the threat while the rest of the MCM staff oversees deployment of the MCM force.

In amphibious operations, the command structure may take several forms and command relationships may change during the course of the operation. MCM forces may be assigned as part of an advance force conducting operations prior to the arrival of the amphibious task force, they may participate as part of a demonstration force intended to mislead the enemy as to the actual location of the assault, or they may arrive as part of the ATF to conduct operations just prior to and concurrent with the landing. Command relationships will be determined by the precise role of MCM as defined in the amphibious operation initiating directive and by emerging requirements as the operation develops. The CATF exercises operational control of all naval forces throughout the operation but may delegate control for some phases of the operation. If an advance force precedes the ATF to the AOA, MCM forces conduct operations as a task group under OPCON of the Advance Force Commander. The presence of a knowledgeable MIW officer on the advance force staff is critical to ensure close coordination with other advance components, such as fire support, reconnaissance, air element, and close covering groups. Upon completion of its mission and arrival of the ATF, the advance force will be disestablished and OPCON will revert to the CATF. As the operation progresses through the assault and post-assault phases and until conclusion of the operation, the closest coordination between the MCM Commander and other ATF and landing force elements possible is required to ensure effective MCM effort. If MCM operations are to continue after the termination of the operations of the amphibious operation and disestablishment of the ATF, OPCON may shift to the area commander.

3.13.2 Mine Countermeasures Staff Organization.

There are many aspects of a MCM operation that are unique, with no comparison to other warfare areas. The tactics and equipment often have no parallel and require experienced MCM officers to plan and execute operations. This is the compelling reason why commanders faced with a mine threat should request assistance from COMINEWARCOM. COMINEWARCOM can send an MCM squadron commander and staff to advise and assist even before MCM assets are deployed.

The composition and number of staff deployed are dependent upon the area and scope of the operation, availability of staff support facilities, and other tasking in progress or being planned. The typical MCM squadron staff that would deploy for a complex operation would consist of the following:

1. MCM Commander (O-6)
2. Chief Staff Officer (O-5)
3. Tactical Cell
 - a. Operations Officer (O-4, 1110)
 - b. SMCM Tactics Officer (O-3, 1110)
 - c. AMCM Tactics Officer (O-3, 1310)
 - d. UMCM Tactics Officer (O-3, 1140)
 - e. Two MIW Liaison Officers (O-3/4)
 - f. Intelligence Officer
 - g. Four Operations Specialists (one E7, one E6, and two E3-5)
 - h. Two Radiomen (E3-5)
4. Material Support Cell (TAD from other commands)
 - a. Engineering/Material Officer (O-3/4)
 - b. Supply Officer (O-3)
 - c. Medical Officer (O-3/4) (TAD Diving Medical Officer).

3.13.3 The Mine Countermeasures Command Center. To perform his duties effectively, the MCM commander requires facilities to set up an MCM command center and establish a watch. The function of the command center is to manage MCM operations and mining operations if the MCM commander is involved

in minefield planning. If minefield planning is assigned to another commander, the MCM commander must still plot mine positions and record mine settings in case he is required to clear the minefield. The command center should include status boards and tactical plots that display the status of each ongoing MCM task; the employment, readiness status, and material condition of MCM forces; the status of all MDAs and channels; and a database of all mines or minelike objects located.

The command center watch must manage a complex flow of information received in reports from MCM units and prepare status reports for transmission to other commanders. They must also evaluate the progress of each operation and prepare new tasking orders as necessary. Computer-based tactical data aids and databases are critical to maintain the rapid flow of information that occurs with a dynamic operation or exercise.

If USS INCHON (MCS 12) or other support ship is not available, and no established command center exists ashore that can accommodate the MCM Commander, there are two options for establishing a temporary center. One option is to use the MIW C4I MICFAC being built for COMINEWARCOM, which is designed to meet all of the MCM commander's needs. The other option is to use an AN/TSQ-108A command and control van that belongs to the MIUW commands and can fulfill the minimum communications requirements.

The MCM commander requires communications capabilities similar to that of other warfare commanders to exchange data with the battle force commander and with commanders supporting or supported by the MCM force. OTCIXS and secure record and data communications should be available by satellite and direct UHF means.

Communications with each of the MCM assets and protective forces must also be available full time. This will require the capability for plain and secure HF voice and data, plain and secure UHF LOS voice and data, secure UHF SATCOM voice and data, and possibly VHF voice circuits.

3.13.4 MIW C4I Systems. The purpose of the MIW C4I system is to link MCM forces with the MCM commander and integrate the MCM commander with all other expeditionary warfare elements using Navy standard C4I systems. To fulfill this mission need, a C4I system is being developed to provide MCM forces with the ability to communicate with each other and the MCM commander by using computerized data links, providing the MCM Commander and MCM forces with the JMCIS common to other warfare forces.

Computer-based tactical data aids that are used by MCM forces for planning and analysis are incorporated into the MEDAL, which is in development as a segment of JMCIS (available to all MCM planners).

The MIW C4I system can be deployed to support the MCM commander either as an integral part of the MCS 12 integrated C4I system, or in the COMINWARCOM MIW C4I MICFAC format. The portable system can be set up to operate from a shore site or could be set up on board a ship where sufficient deck space is available.

Included within the MIW C4I computer tactical data aids are capabilities for the following:

1. Mine danger area and mine contact plotting and management
2. MCM situation assessment and planning
3. MCM effectiveness evaluation
4. Mine area plotting and tactical data management
5. Mining situation assessment and planning
6. Mining effectiveness evaluation
7. Environmental database reference
8. Q-route and route survey data reference
9. Mine technical data reference
10. Mining and MCM asset data reference
11. Digital navigation chart reference
12. Message processing.

3.13.4.1 MCM Unit C4I (Comm Capability). The MCM 1 Class ship was designed with satellite transmit-and-receive capability but with insufficient depth. The MCM can receive satellite record traffic (CUDIX) with sufficient capability, but it has only a single-channel transmit capability on satellite. This means that satellite voice circuitry must be dropped to send record traffic. Additionally, the satellite transmit antenna is an omnidirectional design, which, due to location and performance limits, does not provide omnidirectional capability. When other forces are reducing HF transmissions, the MCM is still depending on HF ship-shore to send some message traffic.

On the other hand, the MHC 51 Class was designed as a coastal operations platform with no satellite trans-

mission capability. It is able to receive satellite broadcast record traffic, but it must transmit all outgoing traffic on HF ship-shore or by UHF TGO circuits to other surface units for retransmission. When conducting operations out of UHF LOS range from the MCM Commander, the MHC must use HF voice to keep in touch and make voice reports of progress.

Since HF transmissions create hazards to some ordnance systems, there are times when either ship class cannot communicate (while mine hunting or conducting neutralization operations). If casualties occur or assistance is required, the ship is unable to safely send a call for assistance on UHF satellite circuits as other platforms can do.

Programs to install new C4I capabilities into the MCM 1 and MHC 51 classes are ongoing. These programs include improved SATCOM antennae, additional UHF SATCOM transceiver capability with DAMA, an MIW tactical digital link, and JMCIS. Extension of tactical data exchange capability to AMCM and EODMCM forces is also ongoing.

MH-53E AMCM helicopters also have communications requirements that must be addressed to effectively use this asset. Coordination with AMCM must be done on HF, VHF, or UHF LOS circuits. It must be noted that the MH-53E does not have a data link capability; all tactical data is passed over a voice circuit. AMCM operations will require radio communication links for both secure and nonsecure tactical voice and navigational requirements.

3.13.5 Mine Countermeasures Planning. To plan MCM missions and provide tasking to MCM units, the MCM commander must be provided some specific information by higher authority. As the MCM commander begins to assess the situation, he obtains the following information:

1. Battle force mission priorities.
2. Risk estimates: how will mines affect the mission as planned?
3. Known or assumed intelligence (and which is which) on the following:
 - a. Enemy mine inventory, location of stockpile and laying doctrine
 - b. Enemy MIW order of battle and locations
 - c. Geography and political boundaries in the area

- d. Minefield structure (density, spacing, laying patterns, mine types, etc.)
- e. Defendability of the minefield by non-naval assets such as artillery, aircraft, infantry, or armor.

4. Critical timing of events.
5. Protective forces to be assigned.
6. Supporting logistics arrangement.
7. Tactical organization (who supports whom).

In accordance with this information, the MCM commander will brief the battle force commander on possible courses of action to prevent, limit, or eliminate the impact of enemy mining on the mission objective and will recommend an MCM objective, MCM MOE, and risk directive for the operation to be planned. The BF commander must select the MCM objective, MOE, and risk directive and issue an operational tasking directive based on these recommendations. The MCM risk directive approved by higher authority has a major impact on the approach to MCM operations and the techniques selected by the MCM commander. Each of these items will then determine the information contained in an MCM task order.

3.13.6 Mine Countermeasures Exercises. Exercises involving MCM forces are the primary opportunity to conduct integrated training of MCM forces and to integrate with battle group forces. The objective of all MIW exercises is to improve the fleet's capability to effectively use mines and MCM in the successful attainment of the overall mission

COMINEWARCOM coordinates the scheduling of national exercise participation with numbered fleet commanders. Participation in NATO or other allied exercises is coordinated through CINCLANTFLT. Whenever possible, an integrated MCM task group with MCM squadron commander will participate in major exercises. When participation by MCM forces in the exercise area is not feasible, an MCM force may participate in a separate operation area using scripted geography to duplicate the scenario of the fleet exercise. Although the forces may be separated by thousands of miles, using procedures developed for wargaming and the ENWGS, the MCM squadron commander can receive tasking from the battle group, carry out planning, direct execution of the MCM effort, and report results just as if the two forces were operating together. In the same fashion, if an insufficient number of MCM platforms (or no platforms) can be assigned to the exercise, the MCM squadron staff can employ the MIW C4I system to simulate MCM effort accomplished and report to the battle group.

3.13.7 Mine Countermeasures Exercise Analysis. COMINEWARCOM conducts analysis of MCM exercises as a tool to measure the effectiveness of MCM forces and identify the shortcomings that need additional attention. Analysis is performed on selected exercises that involve new systems or tactics requiring evaluation, and the results are used to support approval of tactics or to direct the revision of tactics for future evaluation.

CHAPTER 4

MCM for Non-MCM Ships

4.1 CONCEPTS

This chapter discusses concepts, systems, and tactics to be employed by ships that do not have MCM as a primary mission. These may apply when no MCM forces are in the area or when the ship is operating in the vicinity of a mine threat but outside the declared mine danger area where MCM forces are operating. Appendix E lists MIW references that provide more detailed information and may be used to expand the commander's knowledge of MIW.

4.1.1 Detect and Avoid. The most effective action to counter mining that can be taken by a ship that is not designed for MCM is to detect and avoid minefields. It is the task of the miner to make the minefields more difficult to detect and, if possible, to place them where they cannot be avoided. It is the task of any commander to take all precautions and actions that will enable the ship or ships under his command to avoid being damaged by mines. Most ships are not equipped to detect mines. Although some ASW sonars have been modified to improve their capability for mine detection, even these do not have a high enough probability of detecting all mines or are not accurate enough to give the commander confidence that the ship can safely transit a minefield. Therefore, avoidance is the primary tactic, and the purpose of detection is to enable avoidance.

4.1.2 Use of the Environment. The environment is of tremendous importance in MIW. Determining environmental conditions is one of the first steps for both the minefield planner and the MCM planner. If not properly considered, the environment alone can invalidate a minefield or MCM effort. Use of the environment can also be one of the most effective tactics for avoiding mines.

The environment determines where certain mines can or cannot be used. By correlating any available information on the types of mines the miner can use with a study of the environment, waters that are unsuitable for mining and are therefore safe for shipping may be revealed. The following are examples:

1. Ground (bottom) mines are not considered effective against surface ships/craft in anything over 300 feet of water unless they are rising mines. Even the largest bottom mine causes little concern to most U.S. Navy surface ships at a 250-foot depth. Rising mines may be effective in depths greater than 600 feet.
2. Moored mines will experience significant dip in areas where current flow is strong, and dip increases with water depth, so deep areas with current flow are difficult to mine.
3. On a sloping bottom, mines may not remain in place, but may collect at the lowest point.

When there is a choice of routes to follow, by evaluating the options that are available to the miner, it may be possible to use a route that will avoid most of the mineable water and at least know where mining is more likely.

4.1.3 Organic Mine Countermeasures. Organic MCM are the capabilities inherent to a ship or battle group that can be employed for detection and avoidance of or countering mines. Since the resurgence of MIW experience in the Persian Gulf, several projects have been initiated to develop new systems or modify existing systems to give individual ships greater capability for organic MCM. As with any effort to develop new technology, some systems have proven ineffective and development efforts have been discontinued, whereas other projects that have shown promise are continuing in development. Details of some systems are given in paragraph 4.3.

4.1.4 In-Stride Mine Countermeasures. In addition to developing organic MCM capabilities, a long term goal has been set for development of an in-stride MCM capability for use in amphibious operations. The mine threat is a show stopper to an amphibious operation, and current MCM capabilities are insufficient to counter the modern threat without causing significant delay to the operation. The concept of in-stride MCM is

to equip the amphibious force with MCM assets that will permit them to counter the mine threat without breaking stride in the assault process.

4.2 SYSTEMS AND PROCEDURES

4.2.1 Battle Group Capabilities. Most battle groups have some capabilities for self-protection within their ranks. Ships with helicopters embarked can provide visual and/or radar searches along the intended track of the battle group for drifting mines or signs of other mines. Surface combatants with sonars and radars can provide some degree of reconnaissance along the track ahead of other ships not so equipped. However, real battle group wide capabilities are not currently available to protect against ground or moored mines. Systems for this purpose are included in ongoing research and development projects.

4.2.2 Moored or Drifting Mine Self-Protection.

The majority of moored or drifting mines that might be detected by ships without a mine-hunting sonar will be contact actuated mines. Contact mines can be defeated by any means that prevents the ship from coming into direct contact with the mine. If it is possible to reduce the ship's draft by offloading material or water ballast, that will result in a direct reduction of the potential for interaction with a moored contact mine. During World War I, when the majority of mines encountered were moored contact mines, paravanes were employed by large ships to fend off mines. They were not always successful and frequently resulted in a drifting mine threat. As the threat shifted to moored or ground influence mines, paravanes lost their value. Modern self-protection systems focus on detection and avoidance of contact mines.

4.2.2.1 Lookouts. Additional lookouts should be employed by all ships when operating in mine threat waters. Normal lookouts may not be well placed or equipped to detect mines and may be distracted from the mine search by other duties. A mine lookout whose sole responsibility is to detect mines in the ship's path and who is specially equipped for mine spotting will be more effective. A mine lookout should be positioned to have the best available view forward of the ship and be provided with the following equipment:

1. Polarized lens sunglasses to reduce the glare and improve the ability to detect mines that may be just below the surface.
2. Binoculars, preferably stabilized 10 by 40 mm.
3. A night observation device (NOD), preferably the Mk 37 Mod 3 for night time watch.

4. Battle gear: helmet, flak jacket, gas mask, etc., as appropriate for a topside watchstation.
5. Sound-powered phone communications with the bridge.
6. Appropriate clothing for the weather: in environments such as the Persian Gulf, a canopy for protection from the sun may be appropriate.
7. Sun screen: the ship should provide protective sun screen lotion, particularly if there is no canopy.
8. Water bottle or canteen: in hot, dry climates, dehydration will reduce the watchstander's effectiveness, so a ready water source should be maintained.

4.2.2.2 Helicopter Visual Search. A helicopter can be very effective in conducting a visual search for mines along the ship or battle group track. The most effective choice will be an aircraft that has several crewmembers who can search for contacts while at least one pilot concentrates on flying. In some helicopters, additional crew may be added to increase the number of eyes conducting the search or to allow a rotation of searchers so that eye strain does not prevent effective search. If the conditions are favorable, it is possible to detect shallow moored mines as well as drifting mines from a helicopter. Optimum visual search conditions are clear water, a high sun (between 40° and 70° altitude) in a clear sky, and a calm sea. The apparent color of seawater is often an indicator of its clarity and consequently the depth to which minelike contacts are visible. Normally, a deep blue color indicates water of the greatest transparency. Green, green-yellow, brown, red, and white are progressively less transparent. From the air, mines in blue water appear as light green objects. The shallower the mine, the brighter its color. From the air, a group of mines is more readily detected than individual mines. Lessons learned in the Persian Gulf indicate that the best results in searching for single mines have been achieved at altitudes of 500 to 600 feet. However, mine patterns can be spotted more easily at altitudes of approximately 1,200 feet. Specific search procedures include the following:

1. Search within 40° of the vertical.
2. Avoid looking directly into the sun's azimuth.
3. The best solar altitude is approximately 65°.

When the sun is below 40° in altitude, not enough sunlight penetrates the water to detect mines below the surface. When the sun is above 70° in altitude, usually

not enough light appears on the sides of dark objects for the objects to be visible, and there is a relatively greater glitter interference from surface reflection.

An airspeed of 25 to 35 knots is recommended, but adjustments may be necessary to cover the entire area of a ship or battle group track in the mission time available.

If the search is concentrating on drifting mines only, a lower sun angle and lower altitudes may be acceptable.

4.2.2.3 Radar Mine Detection. Tests have been done to determine the effectiveness of various radars in detecting mines on the surface. Although some surface search and navigation radars have made detections, few have proven to be dependable mine search tools. This does not mean that radar contacts should be ignored; however, a mine on the surface presents a small target that may not be continuously detected and recognized as a valid contact by operators. Aircraft radars such as those used on the SH-60, S-3, and P-3 have given the best performance. Conversion of a radar contact detected by the aircraft to a visual contact is difficult. The contact is normally lost on radar before the aircrew are able to gain visual contact, and the fixed wing aircraft's minimum speed makes it very difficult to get positive contact identification.

4.2.2.4 Mast Mounted Sights. The mast mounted sight system has proven to be a valuable tool in searching for mines on the water surface. The mast mounted sight is a combination infrared and television optical system that can be used to search a 120° sector ahead of the ship. During hours of darkness, the infrared display can be used to detect mines that have been heated by the sun during the day. The mine case heats and cools at a different rate than the surrounding water and provides a sufficient temperature differential that can be detected. However, when the sea state builds and causes waves to wash over the case regularly, the wave action will cool the case quickly and eliminate the temperature differential.

4.2.2.5 Kingfisher. During Operation Earnest Will (1987-88, Persian Gulf), there was an urgent need to equip surface combatants for detection of moored contact mines. The Kingfisher Project included several technical efforts to provide this capability, one of which was a modification of the AN/SQS-53 and AN/SQS-56 sonars. The modification enabled the operator to detect small contacts in the water column. Although most of the Kingfisher Project efforts were found not operationally suitable, the AN/SQS-53 and 56 sonar modification was retained for further development. It has come to be known as the Kingfisher System and has been installed on a number of surface combatants.

Kingfisher consists of a modified waveform that provides detection beams from 340° to 020° relative. Detections in excess of 1,000 yards are normal, although the narrow beam coverage may not provide continuous tracking on contacts from that range. A special display allows operators to evaluate target strength and other characteristics.

Kingfisher has been accepted as a valuable system for object avoidance by surface combatants, but it was not designed as a minehunting sonar, and operators should not attempt to use it as such. The limited bearing coverage, as well as other characteristics of the platforms on which the sonar is installed, make it unsuitable for investigation of contacts. *It should be used strictly to detect contacts in the ship's path and, when a contact is detected, to determine a safe path to avoid that contact.*

4.2.3 Electromagnetic Self-Protection. All ships are vulnerable to magnetic influence mines if the proper sensitivity settings to target the ship's influence signature are used in the mine sensors. There are material and tactical measures that can be taken to limit the ship's vulnerability. The material measures include some obvious actions, such as maintaining the ship's degaussing system. A ship's magnetic signature consists of multiple components that come from several sources. The static magnetic field exists because of the permanent magnetism of the ship's structure. Each of the metallic components in the structure contributes to the overall signature, and the degaussing system is designed specifically to counter this magnetic field. When a steel-hulled ship is built, it is initially depressed to reduce the magnetic signature to a level that can be controlled by an installed degaussing system.

4.2.3.1 Degaussing. A degaussing system reduces the ship's magnetic field by creating a magnetic field that is, as nearly as possible, equal and opposite to the ship's permanent and induced magnetism. This is accomplished by means of installed wire coils through which a direct current is passed. An automatic degaussing control system determines the appropriate current settings. Degaussing systems are installed on most naval ships except submarines.

4.2.3.2 Check Ranging. The degaussing system is calibrated by transiting over a magnetic measurement range and making adjustments as directed by the MSF personnel. Over time, if the permanent magnetism increases to a level that can no longer be controlled by the degaussing system, it must be reduced by another visit to a deperming facility. U.S. Navy deperming facilities and capabilities are shown in Figure 4-1.

Magnetic Silencing Facility	Measurement Range	Deperming Facility	Minesweeper Test Facility
Norfolk, VA	YES	YES	
New London, CT	YES		
Charleston, SC	YES		YES
Mayport, FL	YES		
Kings Bay, GA ¹	YES	YES	
Ingleside, TX ²	YES		YES
San Diego, CA	YES	YES	YES
Bangor, WA ¹	YES	YES	
Pearl Harbor, HI	YES	YES	
Yokosuka, JA ³	YES		
Notes: <ol style="list-style-type: none"> 1. Bangor, WA, and Kings Bay, GA, are special facilities for submarines only. 2. Ingleside, TX, is a new facility with capability for ranging and special testing minesweepers only. Estimated IOC is 1997. 3. MSF Yokosuka is shared with the Japanese Maritime Self-Defense Force. 			

Figure 4-1. U.S. Navy Magnetic Silencing Facilities

4.2.3.3 Flash Deperming. Ships that do not have an installed degaussing system can be flash depressed. Current is passed through vertical and horizontal coils wrapped around the outside of the hull to disrupt the acquired magnetic orientation. Submarines and landing craft are flash depressed before deployment based on the geographic area of operations. If a change in the area of operations occurs, consideration must be given to the difference in the magnetic environment.

4.2.3.4 Other Sources. A static electric field is created by the presence of two or more types of metals in salt water. A small electric current is generated by the bimetallic corrosion process. Cathodic protection systems are designed to reduce bimetallic corrosion by creating a substitute electric current. This current also results in a magnetic field that can be detected and exploited by a mine sensor. UEP mines are designed specifically to target this type of signature. Consequently, the cathodic protection system should be turned off prior to transiting a minefield.

Moving machinery such as turbines, reduction gears, propeller shafts, and rudders and steering gear can create an alternating magnetic field by their motion and by generating alternating electric fields. Although these fields may seem small in relation to the ship's static magnetic field, they each are contributors to the overall magnetic signature. While it is not practical to eliminate the movement of machinery, it can be minimized and stabilized when in a minefield. Since a mine sensor measures the change in the magnetic field over time,

using the rudder minimally, making small speed changes, making small course changes, and shutting down noncritical machinery can all help to reduce the ship's vulnerability.

4.2.4 Acoustic Self-Protection. Mines target a wide range of acoustic frequencies. Acoustic signature sources include machinery noises, propeller cavitation, hull flow noises, and others, but machinery and propeller noises are the most prevalent and easiest to control.

Material methods to reduce the ship's acoustic signature for mine warfare purposes are the same as those employed for ASW. The installation and maintenance of vibration dampening systems and the proper maintenance of equipment are the primary actions that can reduce that part of the signature generated by machinery. Ships that have been subjected to a visit from the PMT will have been provided information that will permit selection of their quietest equipment for operation when a quiet ship condition has been directed. Additionally, ships that have been measured on an acoustic monitoring range will be able to avoid operation of equipment at a speed or configuration that has proven to generate unusually high noise.

4.2.5 Seismic Self-Protection. A seismic mine sensor responds to the vibrations that emanate from a ship and can be sensed through the ocean bottom. These vibrations are essentially low frequency sound waves and are generated by the same sources as discussed for acoustic sensors. There are no special methods to protect

against seismic sensors other than those described for acoustic self-protection.

4.2.6 Pressure Self-Protection. There is little that can be done from a material standpoint to reduce the ship's signature against a mine sensor that uses pressure as one of the influences. The Bernoulli effect between the moving hull and sea bottom determines the pressure signature, and the hull form cannot be modified. In some cases, reducing the ship's draft may be possible by reducing ballast, and this should reduce the pressure signature. Except in unusual cases, however, the change will be very slight and possibly insignificant. Reducing the ship's speed to bare steerageway can reduce a ship's pressure signature and is by far the most effective means available to reduce risks from pressure activated mines.

4.3 TACTICS

4.3.1 Ship's Self-Protection. Tactics for individual ships are separated into general, drifting/contact, moored, magnetic, acoustic, and pressure categories. If the type of mine threat has been verified, some tactics may be ignored, but in most cases all tactics that do not prevent performance of the ship's mission should be put into effect. General precautions to be taken by ships when transiting an MDA or any area suspected of mining (whether or not designated an MDA) include the following:

1. Set and maintain maximum watertight integrity. Condition Zebra, or a modification of Zebra for main deck and below, will minimize damage should a mine be detonated.
2. Station a damage control party with full gear in a topside area. Once a mine detonation occurs, it may be difficult for key damage control personnel to get to the repair locker and obtain equipment.
3. Have all personnel don protective gear, such as battle helmets, life jackets, and flak jackets. Topside personnel should wear kapok or other naturally buoyant life jackets.
4. Muster all unnecessary personnel topside in an area not subject to falling debris.
5. When the tactical situation permits, consider reducing the readiness state of some or all weapons systems and stowing ordnance in the configuration that will best withstand shock.
6. Proceed over the same ground as other traffic. In the case of contact mines, if other traffic has passed safely, the track has been proven safe; if other mine

types are present, at least the track has been proven clear of contact mines, and there is no increased risk by following another vessel.

4.3.2 Drifting/Contact Mine Tactics. The only other action that can be certain to reduce the potential for striking a contact mine is to find a ship with a larger draft/beam and follow in its path. The following are recommended precautions:

1. Post mine lookouts. See paragraph 4.2.2.1 for a discussion of equipment for mine lookouts.
2. Watchstanders must be given special training to be effective. They should report *any* contact, and the OOD should take interest in every contact so that the watch understands the importance of his mission.
3. Use any available aircraft (helicopters are most effective) to conduct a visual search for drifting or floating mines along the intended track of the ship. A search should be conducted in the morning, at midday, and in the afternoon along the intended track adjusted for set and drift. See paragraph 4.2.2.2 for a discussion of visual search techniques.
4. Increase surveillance following rough seas or storms that may have caused mine mooring cables to break, setting the mine adrift.
5. Plot drift patterns for the area. NAVOCEANO has a prediction program for drift patterns that can be used to estimate the danger area of mines that break loose or are set adrift. If prevailing currents and winds are not known for the area, special buoys that are tracked by satellite to reveal the drift pattern can be dropped.

4.3.3 Moored Mine Tactics. Generic mine avoidance sonar procedures, where a mine avoidance sonar has been installed and specific tactical procedures have been developed, should be followed. The following description of procedures is intended to give the commander an appreciation for the tactics used with a mine avoidance sonar installed in any unit other than an MCM ship.

Mine avoidance sonars typically are effective for mine detection at speeds of 8 knots or less. Above this speed, the sonar picture is degraded, and the detection range may be insufficient for safe avoidance. Detection ranges can vary greatly, but few will be greater than 600 to 800 yards. Once a contact is detected, it must be

recognized as a possible mine, and the decision to maneuver must be made very rapidly.

The time for maneuvering to avoid a contact is determined by the ship's speed, the dangerous distance for the particular mine, and the range at which the decision is made. The dangerous distance is the minimum range at which a mine can be passed without endangering the ship. For a contact mine, that might be 100 yards. If there is reason to believe the mine may be an influence type, the dangerous distance should be increased to at least 300 yards.

To the maximum extent possible, prior to executing the turn, the mine avoidance sonar should be used to investigate the new heading. This is particularly important if the turn is ordered to avoid a sonar contact. Mines are usually spaced just a few hundred yards apart, and if the ship is approaching a mine line, the avoiding turn for one mine may lead to collision with another mine.

4.3.4 Magnetic Mine Tactics. Tactical measures for self-protection against magnetic mines are as follows:

1. Ensure each ship's degaussing system is energized and operating properly. Do not energize or deenergize a degaussing system when a ship is in mined waters.
2. Secure the cathodic protection system several hours prior to entering an area believed to have a magnetic mine threat.
3. Secure all unnecessary electrical equipment that has a significant power draw.
4. Travel in the deepest water possible and transit shallow areas at high water. When possible, consider reducing water ballast to reduce draft. The magnetic signature decreases with distance from the hull, so the greater separation that can be maintained between ground mines and the ship, the better.
5. Slow the ship's speed. Faster speeds generally mean higher signatures from moving machinery and a higher rate of change in magnetic signature compared to the earth's magnetic field.
6. Avoid dropping or raising the ship's anchor because these actions cause a change in the magnetic signature, not only from the electric motor driven winch, but also from the relocation of a large mass of metal. The same is true for movement of large weapons or aircraft and vehicle elevators.

7. Avoid starting and stopping electrical machinery that has high current because those actions draw a momentary spike in the ship's magnetic signature. It may be better to start equipment and leave it running if it must be used during a minefield transit.

4.3.5 Acoustic/Seismic Mine Tactics. Tactical measures for self-protection against acoustic/seismic mines are as follows:

1. Implement the Quiet Ship Bill, which should result in minimizing running equipment and selecting the quietest equipment options. Avoid noisy operations, such as operation of grinding or chipping tools or unnecessary use of weapons handling systems.
2. Operate Prairie/Masker systems, when installed and, if appropriate, at the ship's intended speed to mask machinery and propeller noises.
3. Transit the deepest channel possible. As with the magnetic signature, the acoustic signature decreases with distance between the ship and the mine.
4. Transit during high water to increase the available depth.
5. Transit at the slowest speed consistent with the tactical situation to reduce machinery, hull, and propeller noises.
6. Minimize speed and rudder changes to reduce machinery noise and flow noise generated by propulsion system changes and rudder movement.

4.3.6 Pressure Mine Tactics. Tactical measures to reduce the pressure signature are relatively limited. They are as follows:

4.3.6.1 Maximize Water Depth. Remaining in the deepest channel and transiting at high water will reduce the pressure signature sensed by a ground mine.

4.3.6.2 Minimize Speed. Maintaining the minimum speed permissible in the tactical situation, while still maintaining steerageway, will reduce the relative water flow between hull and bottom and reduce the pressure signature generated. If the ship could drift through the minefield on natural current, there would be no pressure signature generated.

4.3.6.3 Use Masking Techniques. A high sea state, which increases the ambient pressure against which the mine is trying to detect the ship, will tend to mask the

ship's passage. (Unfortunately, the tactical situation does not usually allow a delay until favorable weather conditions exist.)

4.3.6.4 Defeat the Firing Sensor. Pressure sensors are not generally used independently, and the secondary sensor may be more easily defeated.

4.3.7 Group Self-Protection Tactics. Tactics for single ships also apply to groups of ships. Conducting a helicopter search ahead of a dispersed battle group requires a lot of helicopter time to cover the large area. Therefore, if transiting in mined waters, a column formation is the best for mine avoidance, although other warfare considerations may not be satisfied.

If Kingfisher-equipped ships are available, they should be placed in the front of the formation, and other ships should attempt to follow in their path.

A Q-route system is a pattern of preplanned, dormant shipping lanes to be activated by the area commander in time of war. The routes are designed to maximize the effectiveness of MCM by limiting the amount of area MCM forces must cover and by allowing the ship to traverse the most favorable bottom environment that is practical for the area. A Q-route system includes coastal routes, which follow the coastline for transit from port to port; approach routes, which connect coastal routes to the port entrance; breakout routes, which connect the coastal route to open water (beyond mine threat); and link routes, which provide connections between coastal routes where useful.

Q-routes are listed in the AHP-7 series of publications, including a U.S. Supplement for routes of U.S. Navy interest only. (A volume listing Atlantic and Gulf Coast routes has not been published yet. These routes are listed in an unofficial COMINEWARCOM supplement to AHP 7.)

Navigational warning messages, sent via the "Q" message system, distribute classified information on known or suspected minefields and channel status (up to the NATO Secret level). The messages are originated by an area commander, such as COMUSMARDEZ-LANT or COMUSMARDEZPAC, if activated. The Q-message information is also sanitized and provided to merchant ships or civilian convoy commanders.

Convoying of ships allows for the concentration of defensive assets (i.e., MIW, AAW, ASW, and SUW) to protect merchant shipping. This results in reduced efficiency for high speed merchant traffic that must wait for the convoy departure and travel at the speed of the slow-

est convoy member. However, on the positive side, it permits mutual support, allows the best navigation system to lead, and if escorts have mine detection and avoidance capabilities, results in a significant reduction in threat.

4.3.8 Preplanned Responses. Preplanned responses to certain situations should be promulgated prior to encountering mines. The MIWC provides standardized procedures in the OPTASK MIW or OPTASK MIW Supplement. These should include quick reporting procedures, standard maneuvering instructions for different types of mine threats, and mine contact identification and disposal policy.

A preplanned response should include steps to avoid any contact that has been detected while still holding contact and procedures for marking contacts with smoke or dye markers dropped *near* but not on the contact.

4.3.9 Mine Disposal. Mines may be discovered by non-MCM units when no MCM force is available. Specific procedures to be followed are found in the Navy Wide Standing OPTASK MIW. If the mine is a tethered or bottom mine, an MDA will be designated and an EODMCM detachment dispatched to conduct disposal. If the mine is drifting, an MDA may be designated because of the potential for other mines, but immediate action is necessary. Drifting mines are difficult to track in darkness, so disposal before darkness is desirable. After receiving a mine report, the MIWC will determine whether an EODMCM team can be transported to the scene. EOD mobile detachments deployed within the CVBG and ARG have limited MCM capability and are available within the battle group for immediate response. EOD swimmers can be delivered directly to the mine by helicopter if they are available. If no EOD swimmers are available, the MIWC may direct the ship to dispose of the mine by gunfire. Disposal by gunfire is the method of last resort. On the average, one in seven mines hit by gunfire detonates, resulting in a shrapnel hazard to ships and helicopters. Before firing, the ship should be prepared for blast, with topside personnel wearing flak jackets and helmets; shots should be fired from the maximum practical range. A 50-caliber machine gun has sufficient range and power to dispose of a mine, although, again, this is a last resort option. Firing at a mine from a helicopter is not recommended. The 700-foot radial range and arc of shrapnel from a mine exploding on the surface places any helicopter nearby in danger. Mines that do not detonate remain functional and, if they sink to the bottom, may detonate if disturbed by fishing nets or anchors. Mines may also flood partially and float somewhere in the water column as a serious threat to ships.

Any ship that is equipped with a helicopter or small boat may at some time be tasked to provide transportation for EODMCM detachments and other EOD teams. Helicopters are not threatened by mines as long as they remain clear of explosive disposal procedures and do not attempt to dispose of mines by gunfire. Small boats, however, can be threatened not only by contact mines, but they also may provide sufficient magnetic or acoustic signature to actuate influence mines. EODMCM detachments normally use a rubber boat with low magnetic and acoustic signature. If other surface craft are being used, they should restrict engine operations to medium or low speed to reduce acoustic signature and stay well clear of the mine contact.

4.4 PASSIVE MINE COUNTERMEASURES FOR SUBMARINES

Submarines have many of the same concerns for reducing the threat from mines as do surface ships. A major difference, however, is that many of the actions needed to reduce acoustic/seismic and magnetic signa-

tures for a submarine are the same actions they carry out to maintain the maximum effectiveness of their primary sensor and reduce all other threats to their existence. High quality maintenance to reduce noise and EMI sources on the submarine also reduces the magnetic and acoustic source level for mines.

U.S. submarines do not have a degaussing system. They have their signature read periodically and are flash depressed when required. If a change in the area of operations occurs, consideration must be given to the difference in the magnetic environment, and extra precautions must be taken if the submarine cannot revisit the deperming facility.

More specific information and tactics about submarine MCM exceed the classification of this publication. Sources of additional information include NWP 3-15.53 and COMSUBDEVRON TACMEMO FZ-6060-1-90.

APPENDIX A

MIW TERMS

A.1 INTRODUCTION

MIW has its own language using many terms that, although some may appear in other warfare areas, carry different or more specific definitions when applied to MIW. Additionally, there are terms used by allied MIW forces that seem similar to U.S. terms, but have meanings that differ to some extent. Allied or coalition force operations can be far more difficult when the forces and commanders are not able to communicate freely because of the misunderstandings caused by different terminology or the different connotations of terms.

This appendix provides a compendium of terminology found in the primary Allied MIW reference, ATP 6, and the NWP 3-15 series (formerly the NWP 27 series) publications, as well as some new terminology that has come into common use within MIW. In paragraphs A.1.2 and A.1.3 and their subparagraphs, key definitions of mining and MCM are given with some discussion. Paragraph A.2 provides an alphabetical listing of Allied terms from ATP 6, shown in normal style type, and U.S.-unique terms/definitions, shown in italics. In some cases, italicized type is used to provide further interpretation of an Allied term as it applies to U.S. MIW forces or systems. These are terms that are not listed in Joint Pub 1-02 or whose meanings differ from the version listed in that publication.

A.1.1 Mining. Mining is one of the two distinct subdivisions of MIW. Mining operations are used to support the broad task of establishing and maintaining control of essential sea areas and embrace all methods whereby naval mines are used to inflict damage on enemy shipping and/or hinder, disrupt, and deny enemy sea operations. Mines may be employed either offensively or defensively to restrict the movement of surface ships, submarines, and underwater systems and personnel. Mines can be used alone to deny free access to and from ports, harbors, and rivers, as well as movement through SLOC. Mines can be used as a force multiplier to augment other military assets to reduce the enemy surface and submarine threat. A mining campaign is intended to inflict damage on enemy ships that challenge

the minefield, thereby having an adverse affect on their defense, offensive operations, and logistical support efforts, but it can also force the enemy into conducting a heavy mine countermeasures effort that may exceed the magnitude of the mining operation itself. Enemy ships kept at their base or deterred in transit by mining may be rendered as ineffective for the immediate war efforts as if they were otherwise sunk or destroyed. Further, delays in shipping may be as costly to the enemy as actual losses. The threat posed by a minefield may be real or it may only be perceived, but mining does have a significant psychological impact on the enemy by forcing him to combat an unseen force.

A.1.1.1 Defensive Mining. Defensive mining operations are those conducted in undisputed international waters or straits with the declared intention of controlling shipping in defense of sea communications. Defensive mining is designed to provide protection by denying enemy access to the friendly force's SLOCs, harbors, beaches, chokepoints, and surface and submarine operating areas. A key element to a defensive mining campaign is that safe passage must be provided for the merchant and combat shipping of friendly forces, as well as those of neutral nations. Either a safe, mine-free lane must be left in the minefield, or another route must be available that will take the traffic around the minefield. These safe areas would require monitoring from other forces to ensure that they are not also used by the enemy, unless the intent of the mining operation is to force the enemy through a secondary route.

A.1.1.2 Offensive Mining. Offensive mining operations are those conducted in enemy territorial waters or waters under the control of the enemy. The intent of an offensive mining campaign is to deny, delay, or disrupt enemy ship movements. This is accomplished by destroying or obtaining mission abort damage on the naval and merchant ships that challenge the minefield and/or by requiring the enemy to conduct a large MCM effort to reduce the mine threat.

A.1.1.3 Protective Mining. Protective mining is conducted in a nation's own territorial waters or waters

under the control of an allied nation to protect ports, harbors, anchorages, coasts, and/or coastal routes from enemy maritime traffic. Safe passage for friendly and allied combat forces must be provided through the mined areas. If merchant shipping will be transiting through the mined area, it also must be provided with safe passage. Since protective mining operations are conducted in restricted waters that the nation's or friendly maritime forces will be transiting, it is extremely important that the mines be accurately placed so that they do not pose a threat to traffic transiting through the safe channel.

A.1.2 Mine Countermeasures. MCM is the other distinct subdivision of MIW, and it includes all offensive and defensive measures for countering a mine threat, including the prevention of enemy minelaying. MCM includes any actions taken to counter the effectiveness of and/or reduce the probability of damage to surface ships and craft or submarines from underwater mines. Further discussion of offensive and defensive countermeasures terms and definitions can be found in Chapter 3.

A.1.2.1 Offensive MCM. Offensive MCM includes all actions taken to prevent the enemy from successfully laying mines. Offensive MCM includes any action resulting in the destruction of enemy minelayers and mine stockpiles, as well as the laying of defensive minefields in friendly waters to prevent mine delivery by enemy surface or subsurface vessels.

A.1.2.2 Defensive MCM. Defensive MCM include those operations intended to reduce the effect of enemy minelaying once the mines have been placed in the water. In broad terms, defensive MCM is divided into two classes of action or concepts: passive MCM and active MCM.

A.1.2.3 Passive MCM. Passive MCM include all measures employed to reduce the susceptibility of ships and submarines to mine actuation and explosion. This would include but not be limited to minefield location

and avoidance, as well as the reduction of the ship's magnetic signature (e.g., degaussing, deperming), acoustic signature (e.g., quiet ship bill), and pressure signature (e.g., slow transit through deep water).

A.1.2.4 Active MCM. Active MCM include the use of ships, aircraft, systems, and personnel to locate and neutralize mines. Active MCM can be divided into two categories: mine hunting and mine sweeping.

A.1.2.5 Mine Hunting. Mine hunting involves the location of individual mines so that actions may be taken to avoid, remove, or destroy them. It is a one-on-one operation, as opposed to minesweeping, which seeks to clear an area of mines. Mine hunting includes mine detection, classification, localization, identification, and neutralization.

A.1.2.6 Mine Sweeping. Minesweeping is the MCM technique of sweeping a region of water either by traversing it with mechanical or explosive sweep gear designed to sever the moorings of moored mines or by producing the influence fields necessary to actuate the firing mechanisms of influence mines using a sweeping system or guinea pig ship. Minesweeping operations affect all mines located in the area that is covered by the sweep being employed, instead of combating just one mine at a time.

A.1.2.7 Brute Force Mine Clearance. This is a mine clearance technique that may take place independent of minehunting or minesweeping operations. Brute force involves the use of high explosives in such a manner to cause sympathetic detonation, neutralization, or physical displacement of a significant number of the mines in an area. It is most frequently considered in relation to amphibious operations where very shallow water and surf zone clearance is desired in a rapid manner and where a relatively narrow path through a minefield can permit landing craft to transit to the beach and establish a foothold.

A.2 ALPHABETICAL TERMINOLOG COMPARISON

A

Acoustic Signature. *The characteristic pattern of the target's acoustic influence as detected by the mine.*

Active Acoustic Mine. A mine actuated by the reflection from a target of a signal emitted by the mine.

Actuation. *The response of a mine-firing mechanism to an influence (or series of influences) in such a way that all requirements of the mechanism for firing or for registering a ship count are met.*

Actuation Level. *The minimum influence signal level needed to actuate a mine. The level of intensity and the duration of time that the influence field must be applied to satisfy the firing circuit requirements of the mine.*

Actuation Mine. *A mine used for training MCM forces in mine sweeping. It has an inert loaded mine case, operable components, and a flare and smoke signal to indicate actuation. The mine may be delivered by either air or surface craft.*

Actuation Mine Simulator (AMS). *A device used for MCM training and fleet exercises to simulate in-service mines. It contains the service mine intelligence supplemented with components to control timing, detection functions, six flare and smoke signals, and an actuation recorder to indicate actuations.*

Actuation Probability. *The average probability of a mine of given type being actuated by one run of the sweep within the actuation width.*

Actuation Probability Area. A horizontal plane within which the sweeper-sweep combination will intercept an armed mine or its appendages, causing a buoyant mine's mooring to be cut, a contact mine to be fired, or an influence mine to be actuated.

Actuation Width (W). *The total area under an actuation curve. The path width over which mines can be actuated. Also called "average firing width."*

Aggregate Actuation Width. This is numerically equal to the area under the graph showing how mine actuation probability varies with distance from the sweep's center of influence.

Aggregate Danger Width. For a given mine, this is the integral of $Pd(y)$, where y is the athwartship dis-

tance from the track of the MCMV and Pd is the probability of an actuation within the MCMV's danger area.

Aggregate Detection Width. This is numerically equal to the area under the graph of mine detection probability for detectable mines against distance from the track of the detection gear.

Airborne Mine Countermeasures (AMCM). *MCM operations conducted from an aircraft platform. Includes spotting, watching, hunting, sweeping, and destroying.*

Amphibious Breach. A type of deliberate breach specifically designed to overcome antilanding defenses to conduct an amphibious assault. It is characterized by thorough reconnaissance, detailed planning, extensive preparation and rehearsal, and a buildup of combat power. One or more subordinate units are specifically tasked to perform the role of support, breach, and assault forces. The amphibious breach is centrally planned and executed. Units conduct an amphibious breach when there are no other suitable landing areas.

AN/ALQ-141. *An acoustic sweep device electrically powered from the helicopter via a tow cable.*

Analytic Countered Minefield Planning Model (ACMPM). *A model developed for planning countered minefields. It uses a scenario in which an enemy chooses a channel in a minefield and then employs countermeasures to remove the mine threat.*

AN/AQS-14. *An AMCM side-scanning, minehunting sonar towed by the MH-53E helicopter.*

AN/PQS-2A. *An active/passive, hand-held sonar used by divers to locate submerged objects or to detect active acoustic pingers.*

AN/SLQ-37. *The magnetic/acoustic minesweeping system aboard the MCM-1 Class ships.*

AN/SLQ-38. *The mechanical minesweeping system aboard the MCM-1 Class ships.*

AN/SLQ-48. *A mine neutralization system (MNS) utilizing a remotely operated vehicle (ROV) carrying cable cutters and a bomblet.*

AN/SLQ-53. *The single ship deep sweep (SSDS) mechanical minesweeping system developed for the MHC-51 Class ships that utilizes converted lightweight mechanical AMCM sweep gear.*

AN/SPU-1W. *Magnetic orange pipe (MOP) AMCM magnetic minesweeping gear.*

AN/SQQ-30. *A variable depth SMCM minehunting sonar aboard some of the MCM-1 Class ships.*

AN/SQQ-32. *A variable depth SMCM minehunting sonar aboard some of the MCM-1 Class and the MHC-51 Class ships.*

AN/SSN-2. *The precise integrated navigation system (PINS) aboard MCM-1 Class ships.*

AN/SYQ-13. *The navigation/command and control system used on MHC-51 Class ships.*

Antenna Sweep. *A shallow wire sweep configuration that actuates the mine by contact with the antenna.*

Anti-Invasion Mine. *A mine capable of use in very shallow water against landing craft, fast patrol boats, surface effect vehicles, and other amphibious assault vehicles.*

Anti-MCMV Mine. A mine that is laid or whose mechanism is designed or adjusted with the specific object of damaging MCM vehicles.

Anti-SMCM Mine. *A mine that targets MCM ships. Includes shallow water moored mines, snagline mines, highly sensitive magnetic mines designed for well-degaussed ships, and medium actuation level acoustic mines. Also called an antisweeper mine.*

Antisubmarine Minefield. A field laid specifically against submarines. It may be unsafe for all vehicles, or it may be deep and safe for surface vessels to cross.

Antisweep Device. Any device incorporated in the mooring of a mine or obstructor or in the mine's circuits to make the sweeping of the mine more difficult.

Antiwatching Device. A device fitted in a moored mine that causes it to sink should it watch (i.e., show on the surface), so as to prevent the position of the mine or minefield being disclosed.

AN/WQN-1. *The special acoustic sweep used on MCM-1 Class ships.*

Approach Route. A sea route that joins a port to the coastal or a transit route.

Arming Device. *A safety mechanism that interrupts the primary explosive firing train until a unique combination of environments is satisfied.*

Assembly Configuration of Mines. This is a means of referring to the assembly configuration of mines by various numbered configurations.

Asymmetrical MCM Gear. Any MCM gear whose center of actuation, influence, detection, or cutting is displaced from the centerline of the MCM platform.

Attrition MCM Operations. The continuous application of MCM to keep the risk from mines to all vehicles as low as possible. *These operations are appropriate against minefields that are being replenished.*

Attrition Objective. *The objective of attrition is to keep the threat of mines to ship traffic as low as possible when traffic must continue to transit the mined waters for a comparatively long period of time and when the mines cannot be cleared in a short time because of factors such as replenishment or the use of mine mechanisms with delayed arming or high ship count settings.*

Audio Frequency (AF). See also "Acoustic Circuit." Frequencies between 30 and 1500 Hz.

Avenger Class. MCM-1 Class Mine Countermeasures ships.

Average Actuation Area. The integral, over a plane perpendicular of the centerline of the target ship, of the probability, $P(y,z)$, of actuation of a mine under specified conditions.

Average Actuation Width. The integral, over athwartship distance between the mine and the keel of the target ship, of the probability, $P(y)$, of actuation of a mine at a given depth and under specified conditions.

Avoidance. *Actions taken to change a ship's course for the purpose of avoiding a mine. The deliberate act of maneuvering around a mine or minefield once it has been localized.*

B

Bogie. A device mounted on the minelayer's rails at the foremost end of a mine train, around which passes the hauling aft wire that will push the train aft when the wire is hove in.

Bomblet. *Explosive charge for mine neutralization.*

Bottom Sweep. A sweep, either wire or chain, used either to sweep moored mines close to the bottom or to remove mines from a channel by dragging them to a nominated area. *The sweep configuration may be one or two ships dragging a wire or chain over the bottom.*

Breakthrough. *A time-critical operation applied to the mine countermeasures tactic of channelizing through a minefield to gain passage for ships.*

Buried Mine. *A mine that is partially or fully covered by bottom sediment.*

C

CAPTOR. *Acronym for “EnCAPsulated TORpedo.” This weapon has the official designation of Mine Mk 60. This is a passive/active acoustic deep water ASW mine that launches an Mk 46 torpedo at the target when the detection and validation criteria have been satisfied.*

Case Depth. *For moored mines, this is the water depth at which the explosive charge is held by the mooring line. For ground mines, the case depth is the same as the water depth.*

Casualty Distribution. *The set of probabilities for every possible number of casualties from zero to n out of n transit attempts (e.g., 40 percent probability of 3 casualties in 10 transits).*

Casualty Rate. *The expected number of casualties per time period in a sustained attrition mining campaign.*

Channel Conditioning. An operation that removes minelike objects from channels, harbor approaches, and Q-routes to reduce the number of minelike and nonminelike bottom objects detectable by minehunting systems.

Channelization. *The tactic of sending all transitors through the same strip of a minefield.*

Check MCM Operation. An MCM operation to check that as far as possible no mines are left after a previous MCM operation.

Classification Range. The range at which a contact is classified. (This may be amplified by the prefixes “actual expected” or “maximum.”)

Clearance Diver. Diver who is trained for air scuba and mixed gas scuba diving and qualified to carry out tasks in mine/ordnance search, investigation, recovery, and removal, both underwater and ashore.

Clearance Diving Team. Group of clearance divers established to conduct clearance diving tasks. It may be embarked in an MCM vessel or operate from an ashore mobile support facility. The group includes a leader and medical personnel. *(Allied equivalent to EOD plus salvage divers.)*

Clearance MCM Operations. Operations whose objective is to clear all mines from an area, channel, or route.

Clearance Rate. The area that would be cleared per unit of time, with a stated minimum percentage clearance, using specific MCM procedures.

Clearance Operations. *The process of sweeping or hunting in a mined area with the aim of clearing all or a high percentage of mines from an area, channel, or route. A specific percentage of clearance is usually specified.*

Clearing. *The level of MCM effort required to sweep, hunt, or otherwise neutralize a high percentage of the mines in a field, whether of a certain type or total possible/known types.*

Clearing Objective. *The objective of clearing is to remove most mines from the assigned area. Since it is generally impossible to guarantee that all mines are cleared, a goal is assigned, such as removing or neutralizing 99.5 percent of the mines.*

Closed-Loop Sweep. *A magnetic sweep in which the sweep current is carried entirely by insulated electrical conductors and does not depend upon seawater to complete the electric circuit. The conductors are diverted to one or both sides using components of the oropesa mechanical sweep.*

Clutter Density. *The number of NOMBOs per square inch in an operational segment.*

Coastal Route. A sea route, normally following the coastline, that joins adjacent approach routes.

Coincidence Method. The method whereby an explosive charge or a marker is guided until its position coincides with that of the mine as shown on the sonar display.

Contact Level. The minimum suction that will first operate the pressure unit contact.

Continuous Traffic. *A flow of targets and/or sweepers at a steady average rate over the time period of interest.*

Controlled Mine. A mine that, after laying, can be controlled by the user to make the mine armed or safe or to fire the mine.

Countered Field. *A minefield in which some level of mine countermeasures is undertaken by the enemy. For planning purposes, the various levels of expected MCM are defined as follows:*

a. *NONE.* *Airspace not controlled by enemy, no mine hunting, no mine watching, no guinea pig activity, no minehunting/sweeping assets nearby, primitive countermeasures only.*

b. *LOW.* *Minesweepers/hunters available or nearby, low guinea pig activity and mine watching.*

c. *MEDIUM.* *Minesweeping/hunting available, airspace controlled by enemy, moderate guinea pig activity, high value units targeted.*

d. *HEAVY.* *Minesweeping/hunting assets deployed in the area, line and depth charges available, airspace controlled by enemy, heavy guinea pig activity.*

Counter-Countermeasures Setting (CCM). *Options on the weapons available to the minefield planner to lessen the effectiveness of anticipated enemy mine countermeasures efforts.*

Craft of Opportunity (COOP). *Nonmilitary craft that, in an emergency, can be shifted from normal use to military use with little or no cost and effort.*

D

Damage Distance (Yd). *The athwartship range within which a mine must detonate to cause a specified level of damage to the target.*

Damage Level. *Measure of desired danger. Four standard categories are Kill, Imminent Loss Likely, Mission Abort, and Onboard Repairs Possible.*

Damage Width (Wd). The integral of the probability, $P(y)$, of actuation of a mine under specified conditions, integrated only over those values of athwartship distance y for which the explosion of the mine is likely to do at least a specified amount of damage.

This is the area under an actuation probability curve within the damage distances on each side of the ship.

Dangerous Front. *The athwartship distance in which there is a likelihood that an MCM platform could be damaged by a mine that the MCM platform has swept.*

Deep Moored Mines. *Moored mines with strong, small gauge cables that permit employment at great depth.*

Delay Arm. *A feature on a mine causing it to remain unarmed for a selected period of time after laying.*

Delay Rise. *A feature on a moored mine causing the case to remain attached to the anchor for a selected period of time after laying.*

Delay Time. The time between the application of the minimum pulse field and the registration of the look under consideration.

Delayed Rising Mechanism. *A device used with moored mines that enables the release and rising of the mine to be deployed.*

Deperming. *The use of high currents in coils temporarily arranged around a ship to reduce its magnetic signature.*

Depressor. *A hydrodynamic planing device used to obtain depth in a mechanical sweep.*

Destruction Radius. The maximum distance from an exploding charge of stated size and type at which a mine will be destroyed by sympathetic detonation of the main charge, with a stated probability of destruction, regardless of orientation.

Destructor Mine (DST). *A mine developed for use in Vietnam against junks and sampans. It uses a modification kit to convert an Mk 80 series general-purpose, low-drag bomb into a mine that can be used either on land or in the water.*

Detecting Mechanism. *A mine subassembly, including sensors, relays, timing, and delay mechanisms, that detects the presence of a targetlike influence and that provides the necessary initiation signal to the mine-firing mechanism to actuate the mine.*

Detection Probability (Pd). *The ratio of the number of mines detected on a single run to the number of detectable mines within the characteristic detection width.*

Detection Width. *The width of path over which mines can be detected on a single run at a given Pd.*

DG Code Number. The peak vertical component of the magnetic field in microtesla under a ship on the worst heading and at a certain depth.

Directive. Ordered as A, B, or C. The directive ordered indicates the risk of MCM vessels acceptable while carrying out an MCM operation.

Dispose. *Elimination of mines by either countermining, mine neutralization, or removal.*

E

Electrical depth. *In some cases, the electrical depth is greater than the actual depth. This occurs when the upper layer of the sea bed becomes saturated with seawater such that the conductivity of this layer approximates the conductivity of the seawater.*

Electrodes. *Components of a magnetic sweep. The cables from which electric current is passed from one to the other via seawater return.*

Enabling MCM. *Enabling countermeasures are designed to counter mines once they have been laid. Some enabling MCM operations are undertaken following the termination of conflict solely to eliminate or reduce the threat to shipping posed by residual sea mines. However, most enabling MCM operations are undertaken during conflict to permit (enable) other maritime operations, such as power projection, to be conducted. Enabling MCM includes passive and active MCM.*

EODMCM Detachment. *Personnel with special training and equipment to relocate, neutralize, countermine, or render safe and exploit sea mines.*

Exercise and Training Mine. A mine suitable for use in MIW exercises that is fitted with visible or audible indicating devices to show where and when it would normally fire. A device to assist in mine recovery may also be fitted.

Expected Casualties. *The average number of casualties in n transits of a minefield.*

Exploratory MCM Operations. An MCM operation in which a sample of the route or area is subjected to MCM procedures to determine the presence or absence of mines.

Exploratory/Reconnaissance Objective. *The objective of exploratory/reconnaissance is to determine whether mines are present and, if present, the limits of the mined area. This is usually the first objective when an enemy-laid minefield is suspected.*

F

Fleet Service Mine Test Program (FSMTP). *A program with the primary purpose of determining the operational reliability of stockpile service mines.*

Fraction of Area Covered. Used in MCM operation to denote progress of the task; it is that fraction of the assigned task area that has to date been covered by the tasked MCMVs.

G

Gas Bubble. *Gas produced by an explosion expands rapidly, producing a bubble of extremely high pressure. When the pressure falls below the pressure in the surrounding water, the bubble collapses. The bubble and the shock wave it propagates are the damage effects of an underwater explosion.*

Geophone. *A sensor used in seismic mines.*

Guillotines. *A portable, explosive, cable-cutting device used to sever the tow wire in an emergency (helicopter installed).*

Guinea Pig. A ship used to determine whether an area can be considered safe from influence mines under certain conditions or, specifically, to actuate pressure mines.

H

Harassment Mines. *Those mines specifically set to target sweepers or to enhance the psychological threat of a minefield.*

Hold-On Time. The time during which the threshold requirements of the mine must be satisfied.

Holiday. A gap in MCM coverage left unintentionally during MCM operations due to errors in navigation, station-keeping, buoy-laying, breakdowns or other causes.

Homing Mine. A mine fitted with propulsion equipment that homes onto a target. *The mine normally rests on the sea bed or is secured to an anchor and is set in motion by a ship's influence.*

Horizontal Component. That component of the total magnetic field in the horizontal plane.

Hunting. *The act of searching for mines. This term also covers the marking and/or neutralization of mines.*

I

Identification. The determination of the exact nature of an *underwater* object that has been detected and classified.

Initial Threat. The probability that the first ship to attempt to transit a minefield will be damaged to at least a specified level.

Intensity Mine Circuit. A circuit whose actuation is dependent on the field strength's reaching a level differing, by some preset minimum, from that experienced by the mine when no ships are in the vicinity.

Intercount Dormant Period (ICDP). The period after the actuation of a ship counter before it is ready to receive another actuation. *This is an interval during which mechanism functions are reset and another ship count cannot be registered. It is used as a counter-countermeasures feature to prevent the runoff of multiple ship counts on a single sweeper pass.*

Interlook Dormant Period (ILDLP). The time interval after each look in a multilook mine during which the firing mechanism will not register. *During this period of time, the firing device either will not recognize certain events or will respond in a unique manner.*

Intermediate Water Depth Mine (IWDM). A weapon system targeted against both high- and low-speed surface and subsurface targets in the gaps between shallow-bottom and deep-moored mines.

J

Jettisoned Mines. A mine that is laid as quickly as possible to empty the minelayer of its mines without regard to their condition or their position relative to each other. *Jettisoned mines are normally released in a safe mode (without pulling arming wires). The wire may, however, withdraw at water entry, arming the mine. A mine that is discarded from the delivery vehicle and normal operation is not intended.*

K

Kite. A device that, when towed, submerges and planes at a predetermined depth without sideways displace-

ment. *This is a towed planing device that causes the inboard end of the sweep to assume a determined depth. Also known as a depressor in mechanical sweeping.*

L

Leadthrough Operations. Leadthrough operations are intended to assist traffic in the transit of parts of a mined area that have previously been subject to an MCM effort.

Leadthrough Vessel (LTV). A vessel that provides navigational accuracy so that accompanying ships can transit the area of least threat. No MCM techniques are employed. The LTV is equipped with precise navigation equipment and has knowledge of the threat present.

Link Route. A sea route, other than an approach, coastal, or transit route, that links any two or more routes.

Live Mine. A mine with an explosive filling and a means of firing the explosive charge.

Live Period. *In multilook mines, the maximum time interval after the first look during which additional looks will be accepted to satisfy all of the subsequent looks and mine logic to cause an actuation.*

Locate. To establish the precise position of an underwater object relative to a ship or to a specific navigational reference position.

Loop Sweep. A magnetic cable sweep in which the current-carrying conductors are insulated from the water throughout. *In a single-ship sweep, the working portion of the sweep is spread by diverters to form a loop in the water. Also called a closed-loop sweep.*

M

Magnetic Orange Pipe (MOP) (AN/SPU-1W). AMCM magnetic minesweeping gear. Primarily used for very shallow water AMCM operations.

Magnetic Self-Protection. *The protection of ships and submarines by degaussing to reduce the magnetic signatures and to minimize the possibility of detection by magnetic mines.*

Magnetic Signature. *The characteristic pattern of the target's magnetic influence as detected by the mine.*

Magnetic Silencing. *The reduction of the magnetic signature of a ship through construction materials and techniques, degaussing, and the control of magnetic items aboard ship.*

Marine Mammal System. *An Explosive Ordnance Disposal Detachment that employs marine mammals to conduct mine countermeasures operations.*

Marker Float. *A mechanical sweep support device; visual reference of sweep performance.*

Master Reference Buoy (MRB). *F Mk 6 Mod 0 minefield marker designed to have a small watch circle and good position-keeping ability. It can be configured as a single- or three-point moor.*

Maximum Output Conditions. *Sweeping carried out under maximum output conditions when sweeps are used at the full output of the generating source.*

Maximum Towing Speed. *The speed through the water that may not be exceeded without causing damage to the MCM gear or the towing vehicle.*

MCM 1. *USS AVENGER Class mine countermeasures ship.*

MCM Command and Support Ship (MCS). *A ship equipped to provide the command functions, support services, and repair resources to an MCM force.*

MCM Commander. *The officer who exercises tactical control of all assigned MCM units.*

MCM Commander's Tactical Decision Aid (MCM CTDA). *A set of computer programs that provides the capability to analyze, evaluate, and reconstruct MCM operations.*

MCM Efficiency Parameter (Y). *A measure of the effectiveness of a sweep/search technique. Used to account for efficiencies in the navigation and control of MCM systems.*

MCM Level (M). *The average number of times that a representative mine is exposed to an MCM system.*

MCM Objectives. *Four specific types of MCM objectives have been identified that respond to the different needs/requirements of the MCM force: exploratory/reconnaissance, breakthrough, attrition, and clearing.*

MCM Stage. *The use of a specific MCM technique to counter a particular type of mine.*

MCM Task. *A stage or combination of stages related to a specific channel or area of execution, time of execution, and MCM forces for the execution.*

MCM Technique. *The use of a specific MCM vehicle and its equipment in a particular way.*

MCS 12. *The Mine Countermeasures Command, Control, and Support Ship, USS INCHON (formerly LPH 12).*

Measures Of Effectiveness (MOE). *The effectiveness of an MCM operation can be expressed in terms of delay to the battle force while MCM is conducted, the traffic casualties suffered after MCM is conducted, and casualties suffered by the MCM force during countermeasures operations.*

Mechanical Sweeping. *The minesweeping procedure by which mines are cut from their moorings, removed, or detonated through mechanical contact between the gear and the mines or their attachments.*

MH-53E. *The Sea Dragon AMCM helicopter.*

MHC 51. *The USS OSPREY Class Coastal Minehunter.*

Mine Actuation Level. *The change in magnitude of the field, rate of change, etc., required to actuate a mine.*

Mine Countermeasures Buoy Runner. *A vehicle running along a line of MCM buoys whether the vehicle is in fact conducting MCM operations or only being used for reference by other MCMVs.*

Mine Countermeasures Vehicle (MCMV) Track. *The prescribed line over the ground to be made good by the MCMV to ensure the MCM gear follows the track.*

Mine Danger Area (MDA). *An area, varying in size, drawn around the position of each discovered mine for an initial estimate of the minefield.*

Mine Danger Warning System. *Provides up-to-date shipping information on new mining or navigational dangers.*

Mine Density. *The number of mines per square nautical mile.*

Mine Evaluation. *This technique uses EOD personnel to render safe, recover, and field-evaluate a mine. The information gained by this intelligence gathering mission provides the MCM Commander with data that will help him in planning the type of MCM actions/efforts needed.*

Minefield Activation. *An occurrence wherein the first mine of the field becomes armed.*

Minefield Category. *A classification of the minefield as offensive, defensive, or protective.*

Minefield Clearance. *An operation designed to remove all mines from an area.*

Minefield Length. *That dimension of a minefield segment parallel to the anticipated target track. The transit distance through the minefield.*

Minefield Performance Objective (MPO). *A goal stating what the minefield is intended to accomplish.*

Minefield Threat. *The probability of a vessel exploding at least one mine on each pass through the minefield.*

Minefield Width. *That dimension of the minefield segment that is perpendicular to the anticipated target track. The width is across the front of the minefield.*

Mine Marking. *The marking of mines for avoidance and/or later neutralization.*

Mine Neutralization. *An action using external means to render a mine incapable of detonating on the passage of a target, although it may remain dangerous to handle.*

Mine Neutralization System (MNS). *A tethered vehicle with handling and control systems developed for the combat system of the Avenger and Osprey classes of ships.*

Mine Recovery. *The process of recovering a mine as nearly intact as possible to enable further investigation for intelligence and/or evaluation purposes.*

Mine Reference Number (MRN). *Assigned to all plotted minelike contacts. consists of a letter prefix (C for minelike contact, M for a known mine, N for a nonmine, or R for a minelike contact reclassified as a nonmine), followed by a three-character code to identify the unit that reported the contact, followed by a three-digit number showing the sequence of that contact as the one reported by that unit.*

Mine Report (MINEREP). *Report used to record the location of a newly found mine or to update the status of a mine previously reported. Refer to APP 4 for format.*

Mine Sensitivity. *A measure of the threshold level at which a mine's sensors and firing logic will respond to target influence signals as determined by the variable settings available on the mine.*

Mine Warfare Commander. *The officer in tactical command of a MIW operation.*

Mine Warfare Coordinator (MIWC). *A qualified MIW officer assigned to the staff of a senior operational commander (battle force/group) responsible for all mining and MCM operations.*

Mine Warfare Environmental Survey (MWES). *A survey conducted to provide environmental data on specific MCM operation areas.*

Mine Warfare Pilot. *A comprehensive collection of environmental and geographic data as well as mine and MCM environmental characteristics of a specific area.*

Minimum Mine Spacing. *Minimum mine spacing refers to the least distance that the weapons must be separated to prevent failure or sympathetic detonation. In the case of the Mk 60, simultaneous detection and subsequent mutual interference could result.*

Minimum Towing Speed. *The slowest possible speed through the water at which it is possible to proceed with MCM gear streamed and still counter the mines.*

Mission Abort Damage. *That level of damage necessary to prevent a target vessel from completing the mission it was assigned. A mission abort would not be repairable at sea, but it may not be so severe as to cause immediate sinking or destruction. The degree of damage required will vary with target hardness.*

Mission Package. *A deployable component of the AN/SLQ-48 MNS. Used either for severing the cable of a moored mine or neutralizing a ground mine.*

Mixed Bag. *A collection of mines of various types, firing systems, sensitivities, arming delays, and ship counters' settings.*

Mk 2 Mod 1. *Flotation bladder used by EOD personnel to raise an object to the surface.*

Mk 4. *MMS used to detect moored mines, including close-tethered, deep-moored mines.*

Mk 7. *MMS used to detect proud mines and buried ground mines.*

Mk 25 Ordnance Locator. *A magnetic anomaly detector used to locate hidden or buried ferrous objects.*

Mk 16. *An acoustically quiet, low magnetic signature, mixed-gas underwater breathing apparatus (UBA).*

Mk-103. *AMCM mechanical minesweeping gear.*

Mk-104. *AMCM acoustic minesweeping gear.*

Mk-105. *AMCM magnetic minesweeping gear.*

Mk-106. *AMCM combined magnetic and acoustic minesweeping gear (combination MK-104 and MK-105 gear).*

Modification Kit Mk 75 (DST Kit). *A kit containing the necessary components (less battery) to convert standard general purpose bombs to Destructor mines.*

Modulation. *Variation of the amplitude of the sound output of an acoustic sweep.*

Moving Mine. *A collective description of mine types, such as bouquet, creeping, drifting, homing, oscillating, propelled, and rising.*

Multilook Mechanism. *An influence mine-firing mechanism that requires more than one directional look for actuation.*

Multipurpose Air Cushion Craft (MCAC). *A variant of the LCAC designed to conduct mine countermeasures operations.*

N

Navigational Error. *The lateral distance between the actual position of a ship and its intended track over the ground at any given moment.*

Navigational Margin. *The navigational margin is equal to twice the likely maximum navigational error.*

Neutralization Radius. *The greatest horizontal distance from an exploding charge of specified use at which a mine will be neutralized.*

Nonmagnetic. *A term used in conjunction with any gear, equipment, or material carried aboard a mine craft that is constructed of a nonmagnetic substance to minimize the vessel's magnetic field.*

Nonmine Minelike Bottom Object (NOMBO). *An object, such as an outcropping, coral reef, or man-*

made debris, that may give a minelike response on minehunting sonars.

Nonmine Minelike Echo (NOME). *An echo from within the clutter. The source may not be a NOMBO.*

Number of Tracks (N). *The total number of parallel tracks in the area.*

O

One-Look Mine Circuit. *A mine circuit that requires actuation by a given influence once only.*

Open-Loop Sweep. *A loop sweep in which the after catenary (transverse portion of the cable) is omitted, each side leg of the loop terminating in an electrode. This magnetic sweep uses seawater to complete the electric circuit. A loop sweep generates magnetic fields in all directions on each portion of the bottom under the sweep, making it effective against horizontal and vertical component mines in all orientations. Open-loop sweeps can be used only when the salinity of the water is suitable.*

Operational Assembly. *A mine of a given Mk and Mod configured to the highest level of assembly to meet a specific operational requirement by employing selected assembly-level items, such as tail sections, fairings, time-delay mechanisms, batteries, and sterilizers, to satisfy the specific operational requirement.*

Operational Directive (OPDIR). *Provides tasking instructions from the MCM Commander. May be promulgated in briefings or by regular naval message.*

Operational Speed. *The highest speed at which ships will be required to proceed during a particular operation or during a stated period.*

Optimum MCM Speed. *The speed over the ground for a given set of conditions that provides the greatest sweeping/hunting rate.*

Oropesa Sweep. *A form of sweep in which a length of sweep wire is towed by a single ship, lateral displacement being caused by an otter, and depth being controlled at the ship end by a depressor and at the otter end by a float and float wire.*

Oscillating Mine. *A moving/drifting mine that maintains its depth by means of a hydrostatic depth control mechanism, which causes it to oscillate about a set depth.*

Osprey Class. *MHC-51 Class Coastal Minehunter ships.*

Otter. In naval Mine Warfare, a device that, when towed, displaces itself sideways to a predetermined distance.

Overlap. The width of that part of the swept path of a ship or formation which is also swept by an adjacent sweeper or formation or is re-swept on the next adjacent track.

P

Paravane. A towed body with planes and a cutter with a means of depth-keeping that displaces itself sideways and can be used as a ship protection measure against certain moored mines.

Pass. See "Run."

Pattern Minelaying. The laying of mines in a fixed relationship to each other.

Penetration. *The act of entering a minefield to either transit or sweep that field area.*

Percentage Clearance. The estimated percentage of mines of specified characteristics that have been cleared from an area or channel.

Pinger. *An active acoustic transmitter used in exercise mines to aid in location for recovery.*

Precise Integrated Navigation System (PINS). *A computer-based navigation system developed to serve command and control functions of the Avenger Class's combat system.*

Precursor MCM Operation. Operations in an area or channel using relatively safe methods and techniques to reduce the risk to MCM vehicles.

Preliminary Technical Report (PRETECHREP). *A report that forwards the results of the examination of a mine or minelike object before it is disturbed.*

Pressure Mine. A mine whose circuit responds to the hydrodynamic pressure variation caused by a passing ship.

Prevention of Stripping Equipment (PSE). A booby trap included in a mine to fire the main or an auxiliary charge when an attempt is made to open the mechanism chamber or any other compartment. *An antitamper device.*

Probability Actuation Circuit (PAC). *A device similar to an actuation counter or ship counter. It controls an electronic mine-firing circuit by interrupting it for specific periods of time. It is used as a counter-countermeasures device.*

Probability Actuator. *A counter-countermeasures feature in the mine firing logic designed to allow only a certain probability that a target or countermeasure signal will actuate the mine.*

Progressive Sequence. *The normal sequence chosen to most quickly create a channel safe for shipping with minimum risk to the sweeper.*

Protective Minefield. A minefield laid in waters under own or allied control to protect ports, harbors, anchorages, coasts, and/or coastal routes.

Proud Mine. *A mine protruding from or lying on the bottom. A mine that is not buried and is therefore susceptible to minehunting operations.*

Psychological Threat. *The unmeasurable effect a minefield has on the enemy based upon his perception of its danger.*

Pulse Cycle. (a) Standard Pulse Cycle (SPC). This is a nationally established pulse program that is ordered for the respective sweep gear if no information on the actuation levels of mines being countered is available. **(b) Recommended Pulse Cycle (RPC).** This is one of several alternative pulse programs that are ordered if minesweeping operations are not achieving a satisfactory result using the Standard Pulse Cycle or if information on actuation levels has been obtained.

Pulse Cycle Period. The time interval between the beginning of one pulse and the beginning of the next similar pulse in the same direction.

Q

Q-Route Survey. *The process of searching and mapping all significant contacts along a preplanned dormant shipping lane (channel).*

Q-System. *Existing mine danger warning system that provides up-to-date shipping information allowing for action to be taken to avoid new mining or navigational dangers.*

Quickstrike Mine. *An aircraft-delivered family of bottom mines that is an improved follow-on to the Destructor Mk 36 and Mk 40.*

R

Rattle Bars. *Acoustic minesweeping gear (A-Mk-2(g)) made up of pipes.*

Reconnaissance Operation. *That phase of the exploratory/reconnaissance objective designed to make rapid assessment of the limits and density of a minefield.*

Recovering Sweeps. *The process of retrieving all the sweep gear aboard or into the towing vehicle on completion of a minesweeping operation.*

Reduced Current Operation. *When sweeping sensitive magnetic mines, the output of the gear is reduced to avoid danger to the sweep vehicle from the cable or electrode field. Also referred to as safe current.*

Release Delay. A device fitted to a moored mine or its anchor to delay the rising of the mine case, either for a preset interval or until the influence of a passing target or sweep is received.

Removal. To take a mine out of an area where its detonation would be unacceptable.

Render Safe Procedure. An explosive ordnance disposal procedure involving the application of special explosive ordnance disposal methods and tools for the interruption of function or separation of essential components of unexploded ordnance to prevent an unacceptable detonation. Action to make a mine inoperative by direct interference with its firing system or explosive train. May be done underwater or after recovery.

Replenishment. *Replacement or addition of mines to a minefield. Has the same meaning as "reseeding."*

Resonant Frequency. The resonant frequency of an object is the frequency at which it will vibrate when struck when free to do so.

Reverberation. *The total of all nontarget sounds returned to the minehunting sonar.*

Rigid Hull Inflatable Boat (RHIB). *Boat design with rigid GRP hull and inflatable rubber collar gunwale.*

Rising Mine. A mine having positive buoyancy that is released from an anchor by a target ship's influence or by a timing device. The mine may fire by contact, hydrostatic pressure, or other means.

Route. The prescribed track over the ground to be followed from a specific point of origin to a specific destination. A sea route has no width, and shipping must keep to the track over the ground.

Route Survey. *An acoustic survey of designated routes to detect any change in the acoustic profile such as mines or minelike objects.*

Run. The transit of an MCMV and MCM gear combination along a track. A run produces a swept path and may cause more than one actuation in a mine.

Runs Per Track (J). *The number of successive passes that will be made along one track through the minefield.*

S

Scuttle. *Intentional flooding of a buoyant mine case by means of an internal device.*

Segmentation. *The division of the operational area into segments with similar water depth.*

Seismic Mine. *A version of a passive acoustic mine that uses geophonic elements to detect acoustic energy emanating from a ship. A mine that responds to the acoustic energy transmitted through the ocean bottom rather than through the water.*

Self-Destruct Circuit. *A timing circuit in a mine that causes the mine to detonate after a set period.*

Self-Destruction. *Intentional detonation of a mine by means of programmed actions taken by an internal device.*

Self-Protection Measures. Measures taken by all vehicles to reduce the risk from mines while in mineable waters.

Self-Protection Output Conditions. When the output of the sweep is reduced sufficiently to give safety to the sweeper from the mines being swept for.

Sensitive Mine. A mine whose detecting circuit requires a relatively small magnitude of influence (as from a slow, small, quiet, and degaussed vessel) to actuate it.

Sensitivity. A classification of a mine's likelihood to actuation by an influence field; the higher the sensitivity, the smaller the magnitude of the influence required. It is a qualitative term, and if a measurement is to be included, the specific term (e.g., "actuation level") should be included.

Sensitivity Switch. *A switch by which the sensitivity of an influence mine may be adjusted.*

Ship Count Setting. *The number of times the mine mechanism must be actuated to produce a fire.*

Short-Term Operation. *A short-term operation consists of mine sweeping and/or mine hunting carried out when the time available before ships are passed through a mined (or suspected mined) area is insufficient to carry out clearance operations.*

Short-Tethered Mine. *A mine having a short mooring line or using only a portion of the line (usually only a few feet) so that the buoyant case remains close to the anchor. This reduces susceptibility to mechanical sweeping.*

Signature. *The characteristic pattern of the target's influence as detected by the mine.*

Simple Initial Threat. *The probability that the first ship to transit a minefield will be damaged.*

Single-Look Mechanism. *A mine-firing mechanism requiring only one look for actuation.*

Single Pulsing. *The operation of magnetic gear on a schedule consisting of forward or reverse pulses only.*

Skip-Track Sequence. *A run sequence where distance between tracks swept is in multiples of normal track spacing. One run is made on each track, then the tracks are repeated in the same order until all required runs per track have been accomplished.*

Sled. *Mk-105 device.*

Standard Deviation of Navigational Error (e). *The root mean square value of the navigation error. This is a measure of the ability of an MCM system and its operating platform to adhere to the intended track through a minefield.*

Step-Look Circuit. *A circuit in which the same influence must be detected twice before actuation occurs, the magnitude of the influence at the second look bearing a predetermined ratio to that during the first look.*

Sterilization. *Permanently rendering a mine incapable of firing by means of a device within the mine. Self-destruction is considered a form of sterilization.*

Stopped Penetration Distribution. *The set of probabilities for every possible number of safe transits prior to some postulated event that would cause the enemy to stop his transit attempts.*

Streaming. *The process of deploying minesweeping gear in preparation for a sweep operation.*

Submarine Launched Mobile Mine (SLMM). *An Mk 67, a ground mine launched from a submarine and propelled to a predetermined point.*

Survey Operations. *Operations to collect data on the MCM environment. They are conducted in peacetime to ascertain the suitability of conditions for the MCM operations.*

Sustained Threat. *The ability of a minefield segment to present a continuous threat level for a specified period of time despite transitors or MCM efforts.*

Sweeper. *The vehicle that tows or carries minesweeping equipment in a minesweeping operation.*

Sweeping. *The act of a sweeper towing and operating a sweep. This term also covers the destruction of floating mines cut loose from their mooring cables.*

Sweeping Speed. *The speed that is the result of the effect of the MCM gear streamed on the signaled speed.*

Sweep Offset. *The athwartship separation between the track of the sweeper and the center of the characteristic actuation width for the sweep device.*

Sweep Resistance. *The counter-countermeasures quality of a mine that inhibits its actuations as a result of enemy minesweeping efforts.*

T

TARLOC. *Target location computer program developed as an aid in determining the position of AN/SQS-14 sonar contacts.*

Task. *A stage or combination of stages related to a specific channel or area of execution, time of execution, and MCM means for the execution.*

TB 26. *An in-service U.S. acoustic device aboard MCM 1 Class ships. (Formerly called A-Mk 6(b).)*

TB 27. *An in-service U.S. acoustic device aboard MCM 1 Class ships. (Formerly called A-Mk 4(V).)*

Team Sweep. (a) Two or more sweepers linked together by a mechanical sweep. (b) In influence sweeping, the interaction of sweep fields is an essential feature of the technique in use (e.g., synchronization of magnetic sweep fields).

Technical Report (TECHREP). *A report that provides the results of mine exploitation efforts.*

Technique. *The operation of a specific MCM platform and equipment in a particular way.*

Thermocline. *A horizontal velocity layer produced by temperature variations. It can cause a refraction of the sonar signal, which can limit the sonar range.*

Threat. The probability that a target ship passing once through a minefield will explode at least one mine and be damaged to a specified level.

Threat Profile. *The expected threat to each of a sequence of transitors.*

Track Course. The true course of the track.

Track Policy. The policy for carrying out runs on the track, including the order in which tracks are to be run and the number of runs to be completed on each track before proceeding to the next track.

Track Spacing (D). *The perpendicular distance between adjacent tracks.*

Track Turn. The method of completing the end of a run on one track and preparing to commence the next run either on the same track or another track.

Traffic Ships. *Normal kinds and numbers of ships using the given area, usually considered major cargo and military ships.*

Transit. *The passage of a ship through a minefield.*

Transitor. A surface ship, submarine, or naval craft that passes through or attempts to pass through a naval minefield.

Two-Frequency Acoustic Mine. A mine whose circuit must receive acoustic actuation on two frequencies

before the mine can fire. The relative volume of sound at the two frequencies must bear comparison with the sound spectrum of the target.

Two-Look Random Circuit. A mine circuit in which the influence must be detected twice before actuation occurs; the second look may follow consecutively or within certain time limits, and the polarity of the second look can be either the same as or opposite to that of the first look. The mine may be dormant during the interlook period.

Two-Look Reversal Circuit. A mine circuit in which the influence must be detected twice before actuation occurs; the second look may follow consecutively or within certain time limits, and the polarity of the second look must be opposite to that of the first. The mine may be dormant during the interlook period.

U

Uncountered Fields. A minefield against which the enemy takes no mine countermeasures actions.

Underwater Electric Potential (UEP). *Alternating and static electric fields caused by the electric current flowing through dissimilar metals in a ship's underwater hull.*

Unfitted Mine. A mine not containing a detonator or some other essential part of the explosive train.

V

Versatile Exercise Mine System (VEMS). *An exercise mine system that can be programmed to represent a variety of mines for sweep evaluation and training purposes.*

Vertical Component. That component part of the total magnetic field in the vertical plane.

Vibrator. *The acoustic device in certain acoustic mine circuits. These are normally called seismic mines; they depend on ships' sounds transmitted through the ocean bottom rather than through the water.*

APPENDIX B

MIW Program and Support Organizations

B.1 MINE WARFARE PROGRAM ORGANIZATION

B.1.1 Director, Expeditionary Warfare. The Director, Expeditionary Warfare (CNO N85), within the Office of the Deputy Chief of Naval Operations (N8), is the resource and platform sponsor for MIW ships and aircraft, equipment, and systems. N85 is responsible for the establishment of military requirements and formulating budget and program plans associated with staffing, training, and maintenance for all MIW ships, aircraft, and systems. COMINEWARCOM serves N85 in an additional duty capacity as an advisor.

N85 is also the resource sponsor for amphibious warfare. With emphasis on littoral warfare and the associated mine threat, sponsorship of both warfare areas by the same division fosters close coordination and cooperation between forces dependent on each other. Relationships of N85 and other program offices are shown in Figure B-1.

B.1.2 Program Executive Officer for Mine Warfare. The PEO MIW is assigned the acquisition responsibility and management accountability for mines and MCM programs, including airborne, surface, EOD, NSW, and magnetic silencing systems. PEO MIW reports directly to the Assistant Secretary of the Navy for Research, Development and Acquisition, with appropriate coordination with OPNAV and Headquarters Marine Corps staffs. NAVAIR, NAVSEA, and MARCORSYSCOM are designated as support systems commands for PEO MIW and his program managers. NAVSEA, NAVAIR, and SPAWARSYSCOM sponsored warfare centers (laboratories) provide support and are assigned work as appropriate by PEO MIW and the PMO offices. Systems excluded from PEO MIW responsibility are ships, aircraft, submarine off-board sensor systems, submarine mine avoidance sonars, submarine degaussing facilities, and unmanned air vehicles.

B.1.2.1 Program Management Office for Surface Mine Warfare Systems. The PMO for Surface Mine Warfare Systems (PMO 407), under the PEO

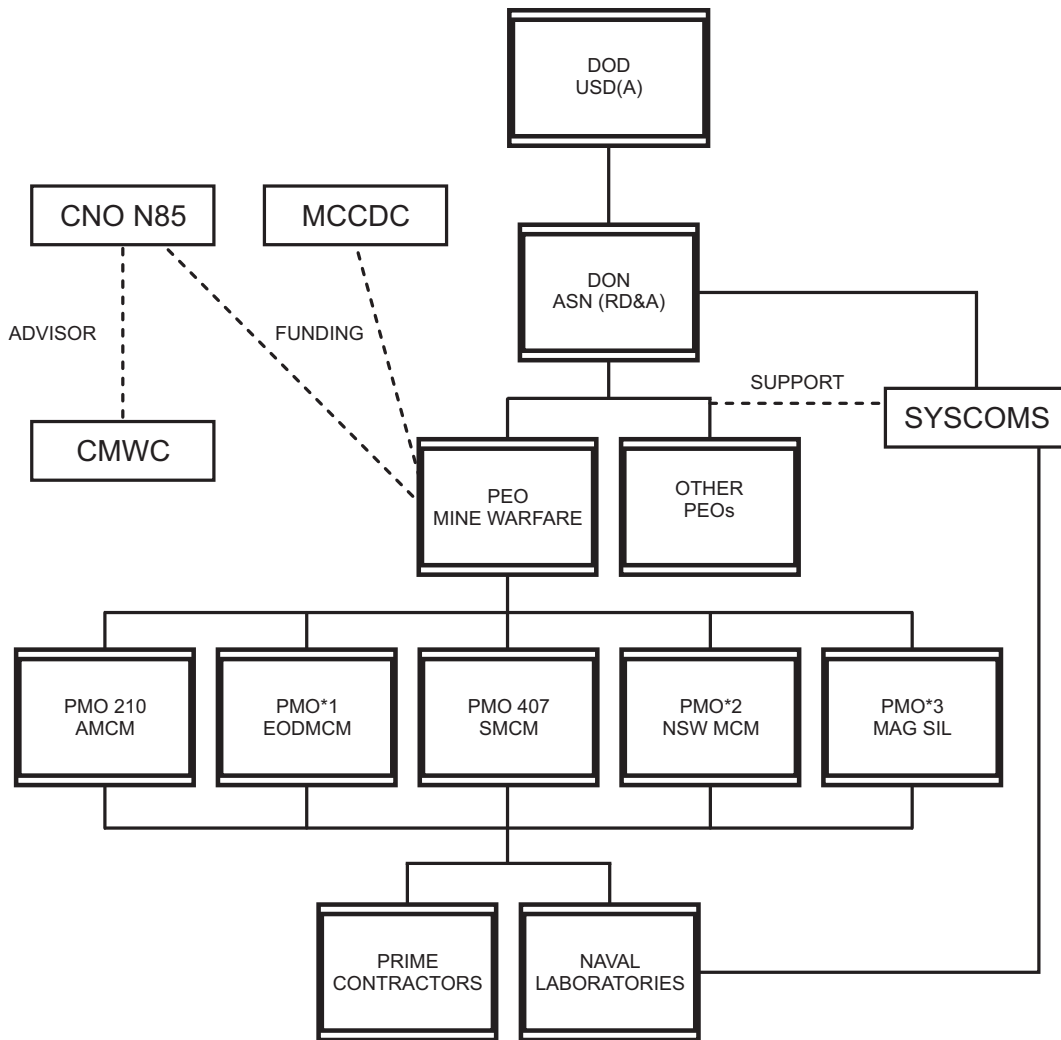
MIW, is the program manager for all mine systems and surface MCM systems. PMO 407 is responsible for acting on requirements established by the operating forces once they have been approved and forwarded by CNO N85. Oversight of new mine and surface MCM projects and product improvement programs for existing mines and surface MCM systems lie within the PMO 407 arena. The combat systems of the MCM and MHC class ships are managed by this office. PMO 407 maintains liaison with NATO mine warfare organizations through data exchange agreements and joint development programs.

B.1.2.2 Program Management Office for Airborne MCM Systems. The PMO for Airborne MCM Systems (PMO 210) is the program manager for all MCM systems associated with the AMCM helicopter and other systems that are employed from aircraft to conduct MCM related tasks.

B.1.2.3 Program Management Office for Explosive Ordnance Disposal. PMO EOD is an additional duty of personnel at the EOD Technical Center. Responsibilities include all Navy and tri-Service EOD systems associated with mine detection, localization, classification, or neutralization.

B.1.2.4 Program Management Office for Naval Special Warfare. The PMO for NSW USN MCM (PMO SPECWAR) is an additional duty of personnel in the NAVSEA 06Z office. Responsibilities include systems employed by NSW units in conducting very shallow water MCM and obstacle removal.

B.1.2.5 Program Management Office for Magnetic Silencing. The PMO MAGSIL is an additional duty of personnel in the NAVSEA 56Z office. Responsibilities include current magnetic silencing systems and new system development projects for closed loop degaussing, portable degaussing ranges, and advanced degaussing technology demonstrations.



ADDU OF:
 *1 NAVSEA 06X
 *2 NAVSEA 06Z
 *3 NAVSEA 56Z

Figure B-1. Mine Warfare Program Organization

B.1.3 MCM Ship Acquisition Program Office.

The NAVSEASYSKOM MCM Ship Acquisition Program Office (PMS 303) is responsible for the acquisition of ship assets for MCM. PMS 303 managed the acquisition programs for the MCM 1 and MHC 51 Class ships and is also the life cycle manager for surface MCM ships responsible for planning and executing the Class Maintenance Plan, as well as for overall management for modifications and improvements.

B.1.4 Program Executive Officer for Air Warfare.

PEO A responsibilities in MIW include acquisition and life cycle management of the MH-53E Minesweeping Helicopter through PMO 261. PMO 261 is responsible for the airframe and all equipment that is

considered part of the aircraft rather than part of the MCM weapons systems. PMO 261 is also involved in flight certification for MCM systems that interface with the aircraft. Other NAVAIR codes, depending on aircraft type, are responsible for aircraft interface and flight certification for mine delivery systems.

B.1.5 Space and Naval Warfare Systems Command.

The SPAWARSYSCOM supplies non-MCM specific combat systems and C4I equipment to SMCM ships and EODMCM detachments. These include communications, radar, and navigation systems. The GPS navigation system and all user equipment are one example of the significant contribution of SPAWARSYSCOM to the MIW mission.

B.2 TRAINING/CERTIFICATION SUPPORT ORGANIZATIONS

B.2.1 Fleet Mine Warfare Center. The FMWC at Ingleside, TX (formerly Fleet and Mine Warfare Training Center, Charleston, SC) is the primary site for MIW specific training in the Navy. FMWC supports all formal training for mine personnel and all MCM schoolhouse training for MCM staffs and surface MCM vessels. Courses currently include the following:

1. Mine Warfare Core Course
2. Mining Specialty Course
3. MCM Specialty Course
4. Staff Minefield Planner
5. Staff MCM Planning
6. MCM Ship Operations Course
7. MCM First Lieutenant Course
8. Surface MCM Vessel PCO Course
9. Mineman "A" and "C" schools
10. AN/SQQ-30 Sonar Operations & Maintenance
11. AN/SQQ-32 Sonar Operations & Maintenance
12. AN/WQN-1 Operations & Maintenance
13. AN/SLQ-48 MNS Operations, Maintenance & Handling
14. AN/SSN-2 Precise Navigation System
15. AN/SYQ-13 Navigation/C2 System
16. MCM Electrician's Mate Course
17. MCM Boatswain's Mate Course.

The goal for the FMWC is to provide fully integrated training for surface, air, and underwater MCM forces. The installation of AN/SSQ-94 simulation equipment and C4I systems will allow the integration of schoolhouse training with fleet exercises [BFTT] and wargaming ENWGS.

B.2.2 AMCM Training Support. Training for active and reserve AMCM pilots and crewmembers is conducted in three phases. Initial aircraft flight qualifi-

cation on the MH-53E (or requalification when necessary) is conducted by Marine Helicopter Training Squadron 302 (HMT-302). Following aircraft qualification, pilots and aircrew attend the AMCM Weapons Systems Training School located at Norfolk, VA. This school provides classroom and simulator training in operation and maintenance of all aircraft MCM systems. Finally, live flight training and qualification for MCM missions and equipment are conducted at the operational squadrons (HM-14 and HM-15).

B.2.3 EOD Training Support. Formal EOD schooling is conducted at the Naval School EOD, which is split between Eglin Air Force Base in Florida and Naval Ordnance Station Indian Head, MD. Prior to commencing EOD training, officers and enlisted must be certified Navy divers. Upon completion of EOD school, they are assigned to an EOD Mobile Unit. When an MCM detachment is assigned a deployment, EOD team training is conducted by an EODTEU located at Fort Story, VA, or Pearl Harbor, HI. These units also conduct training for EODMCM detachments prior to certification.

B.2.4 Mine Warfare Readiness Certification. COMINEWARINSGRU is responsible under COMINEWARCOM for assessment of MIW readiness throughout the U.S. Navy. Teams from COMINEWARINSGRU provide assistance visits to commands preparing for the MRCI and assist the senior inspector, who is normally the unit's ISIC, in conducting the MRCI. MRCIs are required for commands responsible for mine storage, preparation, and delivery, as well as MCM ships, air squadrons, and EODMCM or MMS detachments. Inspections are also conducted to certify the readiness of magnetic silencing ranges.

B.3 NAVY LAB AND SUPPORT ORGANIZATIONS

B.3.1 Naval Surface Warfare Center, Coastal Systems Station. The NAVSWC COASTSYSTA at Panama City, FL, is the principal Navy activity responsible for conducting RDT&E in support of naval missions and operations that occur primarily within coastal or continental shelf regions. COASTSYSTA maintains RDT&E capability for the following:

1. MCM, including mine hunting, mine neutralization, and minesweeping
2. Fire control systems and remotely piloted vehicles and launchers associated with MCM, including theory, tactics, and documentation.

3. Analysis of foreign mines for response to targets or sweeps.

The COASTSYSTA laboratory combines MCM experience with simulation equipment, nonmagnetic facilities, a heliport for AMCM testing, and proximity to bay, riverine, and open sea environments. As the only warfare-oriented laboratory significantly devoted to MCM, COASTSYSTA carries out a large share of the Navy's MCM research and development and continues to assist in the preparation of MIW tactics.

B.3.2 Naval Mine Warfare Engineering Activity. NAVMINEWARENGACT at Yorktown, VA, provides engineering support for mines, surface deployed MCM systems, and related equipment. NAVMINEWARENGACT provides engineering, logistics, inventory, budgetary, procurement, test and evaluation, quality assurance, technical publication, and technical data management support for all in-service mines and mine components, surface MCM sweep and neutralization systems, and associated test equipment. NAVMINEWARENGACT also provides engineering, technical, and logistics support to foreign nations for those mines and MCM systems acquired from the United States.

B.3.3 Explosive Ordnance Disposal Technology Division. The EODTECHDIV at Indian Head, MD, is responsible for conducting RDT&E relating to explosive ordnance disposal and RSP. EODTECHDIV designs, develops, conducts technical evaluation of, and performs in-service engineering for all tools and equipment employed by EOD divers. EODTECHDIV also establishes and validates EOD procedures for rendering safe or disposing of all types of domestic and foreign ordnance. Once procedures are established, EODTECHDIV maintains a database of procedures and produces EOD publications for joint Service use.

B.3.4 Naval Surface Warfare Center Dahlgren Division, Detachment White Oak. NAVSWC White Oak has an experienced staff of scientists and engineers. NAVSWC conducts research into all aspects of MIW, including minefield theory; target detection, tracking, localization, and classification; mine delivery; warheads and fusing; and energy sources. Based on this research, mine systems are developed and evaluated for use by the Navy. NAVSWC White Oak functions are being relocated to Panama City, FL, where they will share facilities with NAVSWC COASTSYSTA. NAVSWC also maintains facilities at Fort Monroe, VA, and Fort Lauderdale, FL. These facilities provide for testing in-water Navy mine performance against various targets and countermeasures, as well as specialized fa-

ilities for environmental, magnetic, pressure, and laboratory acoustic testing of mines and related components.

B.3.5 Naval Surface Warfare Center, Crane Division. NAVSWC Crane Division, at Crane, IN, is the in-service engineering agent for minehunting sonars and other electronic equipment.

B.3.6 Commander, Naval Oceanographic Office. NAVOCEANO has the responsibility for collection and dissemination of environmental data to support MIW operations, development programs, and ordnance and equipment performance predictions. Additionally, this data supports force level requirement decisions. NAVOCEANO compiles data and prepares environmental planning guides known as Mine Warfare Pilots that are disseminated to all commands responsible for planning mining or MCM evolutions.

B.3.7 Office of Naval Research. The ONR is an independent organization that controls research funds (6.1) and funds for exploratory development (6.2) of new MIW concepts. ONR supports studies (such as the investigation of low-frequency broadband acoustic mine hunting) by evaluating the feasibility of proposed solutions to specific MIW needs. ONR also administers and funds the NSAP, which makes the capabilities of Navy laboratories directly available to the operating forces for the solution of operational problems. NSAP advisors are assigned to major fleet staffs and submit proposed projects via fleet and type commanders. MIW related tasks are normally submitted through the COMINWARCOM NSAP advisor.

B.3.8 Naval Research Laboratory. The NRL, Stennis Space Center, located at Bay St. Louis, MS, performs RDT&E in ocean science, ocean acoustics, atmospheric science, and related technologies. NRL develops environmental sampling systems that support MIW.

B.3.9 Naval Research and Development Command. NRaD San Diego, CA (formerly Naval Undersea Warfare Center) is the principal Navy RDT&E center for command, control, communications, ocean surveillance, surface- and air-launched undersea weapon systems, submarine arctic warfare, and supporting technologies. NRaD San Diego was the technical agent for development of the AN/SSN-2(V) Precise Integrated Navigation System (PINS) and the AN/SLQ-48(V) Mine Neutralization System (MNS). It is also the technical agent for development of Marine Mammal Systems.

B.3.10 Naval Underwater Warfare Center. The NUWC Division in Newport, RI, is the development

center for surface and submarine sonar systems. NUWC Division Newport is responsible for modifications and additions to the AN/SQS-56 and AN/SQS-53 surface ship sonars (known as Kingfisher), which have increased their effectiveness as surface ship mine detection and avoidance systems.

B.3.11 Naval Doctrine Command. NAVDOCCOM is responsible for developing naval concepts and integrated doctrine, including a coordinated Navy and Marine Corps voice in joint and multinational doctrine development. In Mine Warfare this includes approval of the addition or deletion of publications in the NWP series and the coordination of review of existing NWPs. NAVDOCCOM designates appropriate commands as primary review authorities, coordinating review authorities, and technical review authorities for NWPs.

B.3.12 Surface Warfare Development Group. The SURFWARDEVGRU is the coordinating command for tactics development in the surface community.

SURFWARDEVGRU is involved in development of tactics for integration of mine warfare forces with amphibious forces in littoral warfare situations.

B.3.13 Marine Corps Combat Development Command. The MCCDC is responsible for development of tactics for the Marine Corps and works closely with Navy tactical development cells at COMINWARCOM and SURFWARDEVGRU to develop and refine tactics for MIW in amphibious operations.

B.3.14 Operational Test and Evaluation Force. The OPTEVFOR, located in Norfolk, VA, conducts operational testing on new MCM ship classes or equipment and new mine systems. OPTEVFOR's purpose is to certify the ship's or system's suitability for operational use as specified in the applicable requirements document.

APPENDIX C

Mine Warfare Historical Perspective

C.1 MINING HISTORY

Mine Warfare has played a critical role throughout modern history, and the strategic, economic, and political effects of mines are evident from a review of naval operations during the major hostilities of the last two centuries.

The first known sea mine was developed in 1776 by an American, David Bushnell, during the Revolutionary War. This first mine was a tar-covered wooden beer keg filled with black powder and suspended a few feet below the surface on a float. A flintlock firing mechanism was assembled inside the keg so that a light shock would release the hammer and fire the powder charge. The keg was then set adrift, relying on the tides and currents to bring it into contact with the enemy. In 1777, under orders from General Washington, a number of these kegs were set adrift in an attempt to destroy a fleet of British warships anchored in the Delaware River off Philadelphia. No keg mines struck a ship, but the British crews panicked and fired into the water at these mines, in what has come to be known as “The Battle of the Kegs.” This first use of sea mines was unsuccessful in that no ships were sunk, but the field of mine warfare had begun.

Mines were first put to use on a relatively large scale during the American Civil War. The Confederate Navy was inferior to the Federal Navy and needed a weapon that could be quickly and cheaply produced to compensate for this disparity. They chose to use mines, which were called torpedoes at that time, as their equalizer because they were much cheaper and easier to build than warships. The Confederate Army Corps of Engineers designed and implemented sea mines of many sizes and shapes, each of which contained encased explosives detonated either by contact with a vessel’s hull or by remote control from a shore station.

One of the most well-known uses of mines during the Civil War was during the battle of Mobile Bay in 1864, where a minefield of 80 mines had been laid in three staggered minelines. Admiral Farragut received the or-

der to attack Mobile with a squadron of his vessels. His lead ship, the *Tecumseh*, led the way and struck a mine long before it was within reach of the shoreline to effectively use its guns. The *Tecumseh* quickly sank and most of the crewmembers were lost. Another ship in the squadron saw mines in the water and began to alter its course through the minefield. This action angered Admiral Farragut, who was heard to say, “Damn the torpedoes! Captain Drayton, go ahead!” A number of other mines were struck by ships in the squadron, but none of them exploded. (Many of these mines had been corroded by the water and made ineffective.)

Although this mining operation did not stop the attack by Admiral Farragut’s ships, other squadrons of Union ships were not as lucky. The Confederates made a very effective use of their mines, even though many of them were of crude design, plagued with faulty fuses and detonators or poor waterproofing techniques. Nevertheless, despite these problems, more than twice as many ships were sunk by mines as were sunk by opposition naval gunfire. The number of ships lost to mines would have been much higher except that many of the Confederate mines were rendered inert due to immersion and wave action.

It is equally important to note Admiral Farragut’s mine countermeasure efforts. His force had been mine watching and mine hunting, although primitively, for a significant period before his advance. The real lesson of this battle should be how seriously Admiral Farragut took the Confederate mine threat and his attention to preparation for and countering of the mines.

In the years following the Civil War, the United States paid little attention to mine warfare. However, other countries, particularly Germany, Great Britain, Russia, and Japan, were very active in the development of underwater mines. Although defensive minefields were laid during the Franco-Prussian and the Crimean Wars, it was not until 1904, during the Russo-Japanese War, that mines first received attention as offensive weapons. The Russian and Japanese navies were both well equipped with effective mines and minelaying

assets when this war began, and mines were used extensively during the early stages of the war by both sides. The Russians planted 300 mines in a defensive field to protect Port Arthur, and the Japanese offensively laid mines just outside of Port Arthur. These Port Arthur minefields inflicted grave losses upon the Russian forces. In retaliation, the Russians wanted to mine Japanese shipping, and to do this they laid mines in the open sea. This indiscriminate mining of open international waters threatened the merchant shipping of nonbelligerent nations and brought protests from the Western powers who were not involved in the conflict. Additionally, many of the contact mines that were laid in the harbors broke free from their moorings and drifted into international shipping lanes, also threatening nonbelligerent shipping. To deal with this mine threat to nonbelligerent shipping, the Hague Convention (VIII) of 1907 was held to establish legal guidelines for the use of sea mines.

Mine warfare played a very significant role in World War I; in fact the naval mine emerged as the Allies' primary weapon against German submarines. During World War I, American inventors developed a new moored mine that featured a copper antenna attached to a float. This antenna enabled the mine case to maintain a predetermined distance beneath the surface, as opposed to maintaining a set distance above the sea bed. This feature provided the Allies with the ability to plant mines that would effectively target submerged submarines in varying water depths while allowing surface ships to pass over them unharmed. Between 1914 and 1918, the Allies laid numerous minefields to bottle up German submarines, as well as minefields designed to protect harbors and ship channels from these same submarines. From June to November 1918, American and British minelayers planted nearly 73,000 mines during the largest mining campaign ever conducted. This minefield, known as the North Sea Barrage, was a 250-mile barrier that extended across the North Sea from Aberdeen, Scotland, to the coast of Norway. The objective of this barrier was to prevent the transit of submerged German submarines out of the North Sea to Allied shipping lanes, and the effectiveness of this minefield was augmented by patrol boats to deny passage to surfaced submarines.

Although this minefield was not laid until the final days of the war, it was considered to have been highly effective. The barrage sank at least six submarines and damaged many more, and there were cases of mutiny among German crews, who feared to transit the field. Moreover, the submarines that did manage to transit the barrage and reach the Atlantic had to employ the necessary evasive tactics to avoid the mines, which wasted valuable time and fuel. The mine played an important and significant role in World War I naval strategy.

Improvements in underwater mine design and development added new dimensions to mine warfare at the outbreak of World War II. A major improvement was the development of the influence mine, which fired when the mine sensed the proper ship-generated magnetic, acoustic, and/or pressure influence field. This improvement did not require the mine to come into contact with the ship to actuate, and it enabled each mine to cover a larger volume of water. The development of this influence technology, coupled with the introduction of submarines and airplanes as minelaying vehicles, made the sea mine an important and effective offensive weapon. The effectiveness of these sea mines was also improved by the introduction of ship counters and various timing devices.

German offensive mining during World War II was extensive, and they used the full range of mine types available to them at the time, including moored contact, influence, and bottom influence mines. The Germans were very aggressive in their use of mines, as is evidenced by the 350 bottom magnetic and moored magnetic submarine-laid mines planted off of various Western hemisphere ports from Trinidad to Nova Scotia. Eight of these offensive minefields were laid in U.S. waters. One minefield was laid off New York and the Delaware Capes, four off Norfolk, VA, and three off Charleston, SC. Several of the ports were closed for up to 16 days by these mines, and 12 ships were sunk or severely damaged.

The U.S. Navy's principal mining campaigns during World War II were carried out in the Pacific against the Japanese. There were a number of offensive campaigns conducted using surface, subsurface, and aerial mine delivery assets, but the largest single mining campaign was Operation Starvation. This was a multiphased aerial mining operation that was conducted in 1945, during the final stages of the war in the Pacific, against the Japanese mainland. During Operation Starvation, U.S. aircraft laid more than 12,000 influence mines in Japanese shipping routes and harbor approaches. Japan was totally unprepared to cope with the influence mines that saturated its home waters, and as a result, Japan's seaborne transportation and heavy industry virtually collapsed. Six hundred fifty ships (75 percent of Japan's total military and merchant fleet) were sunk or seriously damaged by these mines. Those ships that were not sunk by mines were either forced to stay in closed ports or diverted to a few overcrowded ports where they became prey to submarine and aircraft attack.

During the Korean war, Communist forces laid 3,000 to 4,000 moored contact and magnetic bottom mines to block such major ports as Wonson, Hguam, Chongjin, Chinnanpo, Po Hang-Do, Inchon, and Kunsan. This was

one of the most successful mining operations ever conducted against U.N. forces and it caught the U.S. Navy off guard. The United States was planning to land at Wonson and support ground forces ashore so that they could cut off Chinese and North Korean forces. The minefield at Wonson delayed the initial landing eight days, and 15 days were needed to clear a safe channel.

A new family of mines, called Destructors, was developed during the Vietnam Conflict and first came into use in 1967. The Destructor consisted of a highly sophisticated firing mechanism that was inserted into the fuse cavity of a general-purpose bomb. The name "Destructors" was used to circumvent an objectionable political implication that resulted from the term "mine." Early versions of the firing mechanism were entirely magnetic, but by the end of the mining campaign, Destructors also incorporated a seismic influence capability. Destructors employed the most advanced mechanisms in mine design since the development of the bottom influence mine, and they gave mine planners an effective weapon suitable for rapid deployment. Destructors were designed to self-destruct at a preset time, rather than become sterilized (permanently disarmed) as all other U.S. mines had done. That is, Destructors actually destroyed themselves, disappearing both as an explosive threat and as an obstruction to navigation.

The United States hesitated to use conventional mining to stop the influx of seaborne war supplies to North Vietnamese ports and did so only when few offensive options remained open. There were three separate mining campaigns. The first mining campaign occurred in early 1967 and was a very limited conventional mining effort carried out using conventional magnetic bottom mines in selected river mouths and waterways in the southern portion of North Vietnam. The second mining campaign was conducted in June to July 1967, using Destructors made with 500-pound general-purpose bombs. Carrier-based aircraft mined the ferry crossing of the river Vinh, and an extensive mining effort was conducted that concentrated on depriving the North Vietnamese of inland waterway and roadway supply lines.

The third and by far the largest mining campaign began in May 1972 and continued until January 1973. This successful mining campaign closed North Vietnamese ports to shipping and was conducted in response to the North Vietnamese invasion of South Vietnam. U.S. forces laid a total of 108 conventional bottom magnetic mines and more than 11,000 (500-pound) Destructors that incorporated magnetic and magnetic/seismic influence mechanisms.

The cornerstone of this mining campaign was the planting of the 36 conventional ground mines in the

approaches to Haiphong Harbor. (The mines were set to sterilize after a prescribed period of time, and the field was replenished twice, each time with 36 mines.) This minefield trapped 27 merchant ships in Haiphong Harbor before the United States cleared the mines. A DIA assessment of N.V.A. mining stated, "The mining of Haiphong Harbor was a potent lever for U.S. negotiations both before and after the Peace Agreement was signed." The Destructors were also used to mine other ports, coastal shipping routes, and inland waterways.

During the Falklands/Malvinas Islands War, the Argentines laid mines to interfere with the British landing at Port Stanley. Both Iran and Iraq laid moored contact mines during their long war, which began in 1980. Many of these mines broke free from their moorings but did not become harmless in accordance with the Hague Convention (VIII). As a result, these floaters threatened tanker and other nonbelligerent merchant shipping transiting the Persian Gulf. Most recently, following the Iraqi invasion of Kuwait, the Iraqi forces laid approximately 1,500 mines to threaten the multinational forces involved with Operations Desert Shield and Desert Storm. These mines ranged from very simplistic, moored contact mines made around 1900 to very modern, sophisticated bottom and moored influence mine types. Two U.S. warships, USS PRINCETON (CG 59) and USS TRIPOLI (LPH 10), were severely damaged when they actuated Iraqi-laid mines.

C.2 MINE COUNTERMEASURES

The United States made use of its mine countermeasures capability as a diplomatic quid pro quo to obtain a peace settlement in the Middle East during the mid-1970s and as a member of the multinational force conducting minehunting operations in the Gulf of Suez. Mine countermeasures also played an essential part in the U.S. actions to protect reflagged Kuwaiti tankers in the Persian Gulf in 1987/1988 and during the 1990/1991 Desert Shield/Desert Storm operations in the Persian Gulf.

Since mines were first used during the Revolutionary War, it is only natural that the first mine countermeasures efforts also took place during that war. However, the MCM efforts used during the Revolutionary War, like the mines, were relatively unsophisticated by today's measures. To counter the threat posed by the keg mines, the British were limited to either exploding the kegs with musket fire or steering the vessel away from the keg.

Moored mines were first employed in the Civil War, and so were the techniques to counter them. Union forces developed a number of MCM tactics in an attempt to

counter the Confederate mines, but none of them was very successful. Devices called bow rakes, which were similar to a snow plow on a truck, were developed and placed on the bow of river craft to fend off any mines in their path. Grapnel hooks and line drags were also rigged between two ships to snag the cable of an anchored mine and pull it out of the ship's path. Another MCM effort was the development of a mine raft that was pushed ahead of a ship to clear mines from the path of transiting ships. Even though these techniques were relatively effective, it was realized that measures were needed to combat this new warfighting capability.

The first major MCM effort was conducted immediately following World War I, as the United States introduced the use of mine countermeasures ships into its navy. After the armistice was signed, the mines laid in the North Sea Barrage and other minefields had to be cleared in accordance with the guidelines set forth by the Hague Convention (VIII). U.S. and British forces worked together to clear the North Sea Barrage. To accomplish this, the U.S. used several tugs and trawlers that were converted into minesweepers, as well as a number of specially designed 200-foot Bird Class steel minesweepers that had been built. These ships used oropesa mechanical sweeps (O gear) that had been developed by the British, to cut the mine mooring cables. This allowed the buoyant mine case to rise to the surface, where it was destroyed by gunfire. This technique worked, but problems were encountered. For example, many of the mines would foul the sweep wires and explode before the ships could sink them by gunfire, and these explosions frequently caused other mines to explode, often damaging the sweeping ships and their sweep gear up to 1 mile away. Various sweeping techniques were experimented with to find the best one.

In addition to the North Sea Barrage, another major minefield had to be cleared following World War I in the Dardanelles. Both Turkish defensive minefields and British offensive fields had been laid. It was difficult for the minesweeping ships to determine where the boundaries of each minefield were, so the British sent up observation balloons to locate the different mine lines and mark where they were. The minesweepers followed these lines very closely while conducting their sweeping operations to provide greater protection for the sweeping ships. The British also used some air-dropped depth charges in an attempt to counter the mines. These British efforts were the first use of air MCM.

During the years between World War I and World War II, a number of advances were made in mine countermeasures techniques and equipment accompanying the similar advances with mines. The British developed many of these significant advances, which included

shipboard degaussing systems, deperming/flashing techniques, magnetic minesweeping systems, and acoustic minesweeping systems. Mines and mine countermeasures were both becoming fairly sophisticated. During World War II, the mining threat to U.S. and Allied shipping and submarines became worldwide in scope and required an active response. Minesweeping equipment and ships were used to counter the new influence mine mechanisms, and passive response in the form of self-protective measures were used to reduce ships' magnetic and acoustic signatures. The use of mines with ship counters and arming delay devices placed an immense burden upon the mine countermeasures forces of both the Allied and Axis powers.

The United States had minesweepers based in all of its major ports, as well as at advance bases in Europe, South America, and the Pacific. Minesweepers were also used to accompany all invasion forces. The U.S. minesweepers carried out daily exploratory sweeps and could respond quickly when a minefield was discovered by other craft. U.S. Navy minesweepers encountered German mines off the beaches of Normandy, throughout the Mediterranean, and on the east coast of North and South America. Many of these mines were located and removed by routine minesweeping missions, but others were discovered only when passing ships struck mines and set them off.

In total, there were more than 1,200 U.S. minesweepers that participated in sweeping operations during and after World War II. U.S. MCM forces continued to clear minefields throughout the Pacific and European theaters until the opening of the Korean war in 1950. (There was a gradual reduction in the size and readiness of this MCM force.) A total of 45 U.S. Navy minesweepers were lost to mines or other hostile action during World War II and postwar sweeping.

The Communist mining of Wonson and other major ports during the Korean war coincided with a U.S. postwar minesweeper force reduction program. The United States had approximately 50 mine warfare ships in commission at the outbreak of the Korean conflict, 15 of which were assigned to the Pacific Fleet. Only seven of these were considered to be in a high state of readiness, since they had come directly from sweeping missions in Japanese waters. Initially, these ships were ill-prepared to deal quickly with the 3,000 to 4,000 moored contact and bottom magnetic mines laid. The planned landing at Wonson had to be delayed until a channel could be cleared.

The Korean minesweeping operations proved costly to U.S. forces. On 1 October 1950, one of these minesweepers, USS MAGPIE, struck a mine and sank. The

sweeping of Wonson Harbor gained notoriety when two 180-foot minesweepers, USS PLEDGE and USS PIRATE, were also lost. Despite these casualties, minesweeping operations continued until the end of hostilities in July 1953. There was a total of four U.S. minesweepers and one fleet tug sunk by mines and five destroyers were severely damaged. South Korea also had several small craft that were sunk or damaged.

During the Korean war, the United States re-commissioned 63 minesweepers from the reserve fleet. In addition to these ships, the United States contracted with Japanese sweepers to assist with the sweeping of minefields laid south of the 38th parallel. Navy minesweepers worked throughout the conflict to clear moored contact mines and sensitive magnetic induction mines from harbors, fire support areas, channels, and amphibious landing areas. Once cleared, they continued sweeping operations to ensure that additional mines were not laid. It was during this clearance operation that the helicopter was first used in an MCM role to spot mines in the path of surface sweepers.

This Korean experience taught U.S. naval authorities a valuable lesson in mine countermeasures. Over 90 percent of the Communist-laid mines were of a moored contact design dating to the early 1900s, and only a few incorporated modern firing mechanisms, arming delays, or ship counters. Nevertheless, these mines delayed the landing at Wonson in 1950 and prevented troop and support ships from entering the port for more than a week while all available minesweepers worked to clear a channel into the harbor. Rear Admiral Allan E. "Hoke" Smith, Commander, Amphibious Task Force, used the following words to inform the Chief of Naval Operations of the situation: "We have lost control of the seas to a nation without a navy, using pre-World War I weapons, laid by vessels that were utilized at the time of the birth of Christ."

Following the Korean war, the U.S. Navy designed and constructed a completely new and sophisticated surface MCM force of more than 150 ships and boats, including MSOs, MSCs, and MSBs. These ships and boats were constructed entirely of wood and equipped with nonmagnetic materials to reduce their magnetic signatures. In addition, the MSOs and MSCs were outfitted with minehunting sonar systems, and all of the new ships had elaborate degaussing systems installed to further reduce their susceptibility to magnetically actuated mine mechanisms. In addition to these new surface vessels, various helicopters were examined for their suitability in an MCM role, and helicopter-towed moored, magnetic, and acoustic sweep equipment was developed.

During the Vietnam Conflict, the U.S. conducted extensive MCM operations in the rivers, waterways, canals, and coastal areas of both North and South Vietnam. The Viet Cong and North Vietnamese forces planted primitive but effective homemade mines, as well as sophisticated Soviet influence mines, in the rivers and principal waterways of South Vietnam throughout the war. This forced the United States and South Vietnam to develop special riverine and shallow water mine countermeasures. A new family of MCM technology emerged as existing craft and equipment were converted and adapted to the riverine environment.

The U.S. mining of Haiphong and other North Vietnamese ports and the subsequent clearance operations played a major role in peace negotiations. On 27 January 1973, an agreement to restore peace in Vietnam was signed by the United States and the Democratic Republic of Vietnam. Article 2 of this peace agreement stated that "the United States is to conduct mine clearance operations in the coastal areas of North Vietnam to clear all United States laid mines from those waters." This mine clearance operation was the first to rely on helicopter minesweeping methods. Titled Operation End Sweep, the clearance was carried out in 1973 by Task Force 78, which consisted of 37 Navy and Marine CH-53A helicopters and 6 MSOs supported by Amphibious Transport Docks and Amphibious Assault Ships. During the many hours of sweeping, airborne units cleared the inner channels while surface units cleared the outer 3 miles of the main Haiphong Channel. Only one mine, a conventional magnetic bottom mine, was actually swept. Most of the mines had self-destructed or sterilized by the time major clearance efforts had begun. To demonstrate the success of Operation End Sweep, the U.S. Navy sent a Minesweeper Special (MSS 2) on an uneventful check-sweep of the Haiphong Channel. This demonstration of U.S. adherence to the cease-fire agreement proved useful in later treaty disputes.

Following the Vietnam Conflict there were various Middle Eastern conflicts, such as the Six-Day and Yom Kippur Wars, associated with the use or suspected use of sea mines. In the aftermath of these wars, the United States provided, at Egypt's request, assistance in sweeping the Suez Canal for suspected mines and other ordnance that had closed the canal for almost 6 years. In the spring of 1974, minesweeping operations known as Operation Nimbus Star were conducted by Helicopter Mine Countermeasures Squadron Twelve (HM-12) helicopters operating from the Amphibious Assault Ships USS IWO JIMA (LPH 2) and USS INCHON (LPH 12), as well as shore bases located in the canal area. These AMCM forces conducted sweeping operations in a 120-square mile area that extended from Port Said to Port Suez. There were no mines detonated during this

operation, which was deemed a massive success. While these sweeping operations were being conducted, there was a joint team of American, British, French, and Egyptian EOD personnel conducting clearance operations in approaches to the canal. Over an eight-month period, these forces cleared away 8,500 pieces of unexploded underwater ordnance, including bombs, shells, mines, etc.

In 1975, RH-53s from HM-12s operated from the USS INCHON (LPH 12) to sweep five fields of Egyptian- laid, Soviet-made magnetic/acoustic mines in the northern approaches to Alexandria, Damietta, and the Suez Canal. Following these casualty-free sweeping operations and those conducted in Haiphong Harbor, the Navy declared helicopter minesweeping to be a great success. Admiral Zumwalt claimed that "the ability of the helicopters to sweep areas much faster than surface ships and with less manpower demonstrated that this concept was a winner." In actuality, air MCM required the involvement of more personnel than surface MCM, but that fact was lost on the naval leaders at that time. The helicopter's success during the Haiphong and Gulf of Suez sweeping operations, coupled with Admiral Zumwalt's policy decisions, unfortunately resulted in another decline of surface MCM forces. In 1970 there were 64 MCM ships in active service, and only 9 in 1974.

The next 10 years were relatively uneventful for mine warfare forces, but in the summer of 1984, MCM operations were once again required in the Red Sea and Gulf of Suez. During July and August of that year, at least 16 minelike explosions were reported by merchant ships. No ships received any significant damage, although one or two had dents in the hull. The reported explosions caused Egypt to ask for minesweeping assistance. The Gulf of Suez was divided into sectors, and a different sector was assigned to each participating MCM force. MCM assets from Egypt, Britain, the United States, France, Italy, and the Netherlands all participated in mine clearance operations. The former U.S.S.R. also had MCM vessels in the area. The United States sent AMCM assets to participate in this campaign, which was called Operation Intense Look. During this operation, which terminated in September 1984, U.S. forces located a number of minelike objects but did not locate or detonate any mines in their assigned sector. Several old mines, believed to have been left from either the Six-Day or Yom Kippur Wars, were found and detonated by allied navies. Britain recovered and exploited one mine that had been laid recently and was believed to be part of the mines that caused the recent explosions.

The mine recovered by the British was determined to be an export version of an advanced Soviet-made influence bottom mine. A Libyan RO/RO ship is suspected

of laying this and other mines during its transit of the area, but this could not be proven. The mine was a very sophisticated magnetic, seismic, and pressure capable mine, and it is believed it was intended to target a ship with a very small signature. The mine detonations that did occur caused no significant damage because they were detonated while the ship was still too far away to receive critical damage.

Mines were laid by both sides during the long Iran-Iraq War, which started in 1980. By 1983, moored mines laid by both sides had broken loose from their moorings and drifted into the Persian Gulf, causing a significant threat to oil tankers and other nonbelligerent ship traffic. This threat was caused by drifting contact mines that did not become harmless as required under the Hague Convention (VIII). The problem was intensified in 1987 when Iran laid additional pre-World War I vintage contact mines in the Persian Gulf. During May and June of 1987, four ships were damaged by mine explosions off Kuwait. A minefield off the entrance to Kuwait City was discovered. The mines in this field were destroyed by U.S. and Kuwaiti EOD personnel. (The Kuwaitis had been trained by the Egyptians.) To prevent further damage, U.S. naval forces began to escort re-flagged Kuwaiti tankers, as part of Operational Earnest Will, to protect them from surface and air attack. During the first escort operation, the re-flagged VLCC M/V BRIDGETON hit a moored mine off Farsi Island.

The mining attack resulted in the decision to deploy MCM forces from the United States, Britain, France, Italy, Belgium and the Netherlands to the Persian Gulf and Gulf of Oman. A total of 25 MCM ships, four MSBs, six AMCM helicopters, and numerous EOD/clearance diving units were utilized. The MCM operation was carried out from July 1987 to at least January 1989. At least 26 mines were swept. A total of nine ships were hit by mine explosions; two ships were sunk, and USS SAMUEL B. ROBERTS (FFG 58) suffered extensive damage. Although it was able to take on a partial load of oil and complete another transit out of the Persian Gulf, the M/V BRIDGETON had to be drydocked to repair a huge hull rupture.

A rare case of a successful offensive MCM mission was conducted when the U.S. Navy captured and destroyed the Iranian ship IRAN AJR as it was laying a minefield. The MCM effort covered the entire Persian Gulf from Kuwait to the Strait of Hormuz, a distance of more than 500 miles and into the Gulf of Oman. Of the ships hit by mines, four were off Kuwait, two off Farsi Island, one (USS SAMUEL B. ROBERTS) off Sjah Allum, and two ships in the Gulf of Oman off Khor Fakhah.

Mine countermeasures played a prominent role in the operations that were conducted in 1990 and 1991 by joint allied naval forces during Operations Desert Shield and Desert Storm. Iraqi forces planted an estimated 1,300 sea mines in the Persian Gulf, ranging from simple (but deadly) moored contact types designed in the early 1900s to some of the most modern types of magnetic and acoustic influence mines obtained from the Soviet Bloc and commercial sources in the free world. U.S.

MCM forces were part of the coalition MCM forces, which included air, surface and underwater MCM forces. These MCM forces conducted operations to locate, sweep, and neutralize Iraqi weapons during both wartime and the postwar period. The heavy damage sustained by two U.S. warships that struck Iraqi mines, USS PRINCETON (CG 59) and USS TRIPOLI (LPH 10), generated considerable efforts to improve the U.S. Navy's MCM capabilities.

APPENDIX D

U.S. MINES

DESIGNATION	WEIGHT IN POUNDS	FINAL POSITION	ACTUATION METHOD	DELIVERY METHOD
MK 36 DST	500	BOTTOM	MAG/ SEIS	AIR
MK 40 DST	1,000	BOTTOM	MAG/ SEIS	AIR
MK 56	2,000	MOORED	MAGNETIC	AIR
MK 59	750	BOTTOM	MAG/ SEIS	AIR (USAF)
MK 60	2,000	MOORED	ACOUSTIC	AIR/SUB
MK 62	500	BOTTOM	MAG/ SEIS	AIR
MK 63	1,000	BOTTOM	MAG/ SEIS	AIR
MK 65	2,000	BOTTOM	MAG/ SEIS	AIR
MK 67	2,000	BOTTOM	MAG/ SEIS	SU

Note

(DST): Uses a special firing mechanism with a General Purpose Bomb. QUICK-STRIKE (Q/S): Mk 62 and Mk 63 use Target Detection Devices (TDDs) with General Purpose Bombs. Mk 65 uses a TDD with a case built as a mine body. CAPTOR: EnCAPsulated TORpedo SEIS: Seismic (geophone) Sensor SLMM: Submarine Launched Mobile Mine NWP 3-15

APPENDIX E

MIW References

E.1 GENERAL

This appendix provides a list (and in some cases a brief description) of publications that may be useful for further reference. U.S. references are grouped into mining interest only, MCM interest only, and both interest categories. Allied references are listed together because, in some cases, one volume is mining and the other is MCM (although many are of interest to both). Revision numbers have been omitted throughout; the reader should ensure the current version of each publication is used. NWP 1-01 and the NTIC CD-ROM are sources of current edition information. Additionally, most NWPs and some other publications of interest can be found on the CD-ROM.

E.2 NAVY PUBLICATIONS FOR MINING

1. NWP 3-15.5 (formerly NWP 27-4), Mining Operations: Sets forth broad principles of mining. Describes planning factors, organization, execution of mining operations, and actions required to marshal ordnance and delivery vehicles. Describes functional operation of U.S. mines.
2. NWP 3-15.51 (formerly NWP 27-5), Minefield Planning: Describes technical information and philosophy to be considered in planning naval minefields. Documents Navy minefield planning doctrine.
3. NWP 3-15.52 (formerly NWP 27-6), Mine Mk 60 (CAPTOR) ASW Tactics: Provides detailed description of procedures and tactics for Mk 60 CAPTOR mine employment.
4. MFPP 00, Minefield Planning Folder Double Zero: Discusses the Uniform Mine Warfare Planning System and provides detailed information on the content and availability of minefield planning folders.
5. OP 2637 Vol. I, Systems Descriptions & Operational Characteristics of U.S. Naval Mines, Stand-

ard Naval Mines: This publication provides information on the various user selectable settings available on current U.S. mines.

6. OP 2637 Vol. II, Mine Setting Guide & Actuation & Damage Data (4 parts in separate covers): Data tables that the minefield planner uses to select the appropriate mine type for a given scenario, as well as the sensitivity settings that should be used.
7. OP 2637 Vol III, Systems Descriptions & Operational Characteristics of U.S. Naval Mines: Provides Secret data to supplement Unclassified/Confidential information in volume I.
8. OP 2637 Vol V, Systems Descriptions & Operational Characteristics of U.S. Naval Mines, Mk 60 Mods 0 and 1
9. DIA Naval Order of Battle (area), Air Order of Battle (area), and Electronic Order of Battle (area): Sources (3 separate pubs for each area) of intelligence used in minefield and mine delivery planning. Where available, theater produced Orders of Battle may be more up to date and should be used.
10. NWP 3-15.53 (formerly NWP 79-0-2), Submarine Special Operations Manual, Mining: Procedures and tactics for mine-laying by submarine.

E.3 PUBLICATIONS FOR MCM PLANNERS

1. NWP 3-15.1 (formerly NWP 27-1), Mine Countermeasures Operations: Overview and discussion of MCM concepts, procedures, and equipment.
2. NWP 3-15.11 (formerly NWP 27-2), Surface Mine Countermeasures Operations: Detailed information about SMCM platforms, equipment, operating procedures, and tactics.
3. NWP 3-15.12 (formerly NWP 27-3), Airborne Mine Countermeasures Operations: Detailed information

about AMCM helicopters, equipment, operating procedures, and tactics.

4. NWP 3-15.14 (formerly NWP 27-8), Underwater Mine Countermeasures Operations: Detailed information about EOD and NSW units, equipment, operating procedures, tactics, and logistic support.
5. NWP 3-15.13 (formerly NWP 55-8-H53), AMCM Tactical Information Document (AMCM TACAID): Quick reference tactical information for AMCM helicopter operations.
6. NWP 3-15.21 (formerly NWP 27-1-1), MCM Planning and Procedures (General Inst.): Detailed procedures for calculations necessary in planning and evaluating an MCM operation.
7. NWP 3-15.22 (formerly NWP 27-1-2), MCM Planning and Procedures (Data Appendices): Data on systems needed for planning calculations described in NWP 27-1-1.
8. NWP 3-15.23 (formerly NWP 27-1-3), MCM Planning and Procedures (Data Supplement): Secret supplement to data on systems needed for planning calculations described in NWP 27-1-1.
9. NWP 3-15.3 (formerly NWP 68-1), Passive Mine Countermeasures Systems and Tactics: Describes procedures for operation of special passive systems. In future revision, additional chapters will include description of passive countermeasures tactics.
10. NWP 3-15.61 (formerly NWP 65-10), MCM-1 Class Tactical Manual: Tactical reference for employment of MCM-1 Class ships. Contains description of ship, equipment, staffing, operation of systems, and tactics. Valuable reference for other ship types and staffs who operate with or employ this class ship.
11. NWP 3-15.62 (formerly NWP 65-32), MHC-51 Class Tactical Manual: Tactical reference for employment of MHC-51 Class ships. Contains description of ship, equipment, staffing, operation of systems, and tactics. Valuable reference for other ship types and staffs who operate with or employ this class ship.
12. NWP 1-10.1 (formerly NWP 12-5-1), Tactical Action Officer Handbook: Contains quick reference section for threat mines and tactics.

13. COMINELWARCOM MCM Experimental Tactics Notebook: Part 1, TACNOTES; Part 2, TACMEMOS; Part 3, Lessons Learned for MCM operations.
14. OPNAVINST 8950.2, Magnetic Silencing: Establishes CNO requirements for magnetic silencing of ships.

E.4 PUBLICATIONS OF INTEREST TO BOTH MINING AND MCM PLANNERS

1. NAVOCEAN SP xxxx (publication numbers supplied by port or location) — Mine Warfare Pilot (MWP): Environmental data for planning, and executing mining and mine countermeasures operations.
2. COMINELWARCOM MIW Assessment of NATO/Allied Countries: Provides brief assessment of mining and MCM capabilities of countries friendly to U.S.
3. COMINELWARCOM OPORDER 2000-yr: Prescribes standard operating procedures for forces operating under COMINELWARCOM control.
4. FXP 5, Amphibious Warfare (AMW) and Mine Warfare (MIW) Exercises: Describes exercises designed specifically for MIW forces.
5. Joint Pub 3-15, Joint Doctrine for Barriers, Obstacles, and Mine Warfare: Describes mine warfare for the joint staff officer, including interfaces with U.S. Army, U.S. Air Force, and U.S. Marines.
6. NWP 1-14 (formerly NWP 9), Commander's Handbook on the Law of Naval Operations
7. NWP 3-10 (formerly NWP 39), Naval Coastal Warfare Doctrine: Describes operations in coastal zones, including interface with Maritime Defense Zone Commander
8. CNO Mine Warfare Summary, 1992: General information on mine warfare, including a brief history and summary of mines and countermeasures systems previously used and in current use.

E.5 ALLIED PUBLICATIONS

1. ATP 6, Vol. I, Mine Warfare Principles
2. ATP 6, Vol. II, MCM Operations Planning and Evaluation

3. ATP 24, Vol. I, MCM Tactics and Execution
4. ATP 24, Vol. II, Mining and Minelaying Planning and Evaluation Tactics and Execution
5. AAP 8, Naval Control of Shipping Information on Ports, Authorities and NCS Publications
6. AEODP-1 series, Allied Explosive Ordnance Disposal Publication, Navy
7. AHP 1, Allied Navigation Information in Time of War "Q" System
8. AHP 1 NATO Supp 1, NATO Supplement to Allied "Q" Message System
9. AHP 7 Vol 1, 2, 3, 4, & 6, Dormant "Q" Message Publication ("Z, B, J, C, K" Zone): Listing of Allied force Q-routes, each volume for a different geographic area.
10. AHP 7 US Supp Vol 1, Dormant "Q" Message Publication, Q-Routes of USN Interest (Eastern Pacific): Listing of U.S. Q-Routes for west coast and Hawaii. East coast volume has not been published. Those routes were last listed in an unofficial supplement published by COMINWARCOM and titled US Supp to AHP 7 Vol 3.
11. AMP 3, Vol. 1, NATO MCM Vehicles and Equipment
12. AMP 3, Vol. 2, NATO Mine Delivery Systems
13. AMP 4, Degaussing & Acoustic Ranging Information Concerning NATO Minesweepers and Minehunters
14. AMP 7, Helicopter Mine Countermeasures Manual
15. AMP 11, Vol. 3, Mine Warfare Pilot (Denmark); Vol 5 Pt 2, Mine Warfare Pilot (Western Baltic); Vol 8, Mine Warfare Pilot (Turkey); Vol 12 Pt D, Mine Warfare Pilot (North & Eastern Coast of Scotland & England); Vol 13 Pt 1, Mine Warfare Pilot (Norfolk, VA Approaches)
16. AMP 13, Vol. 1, Intro. & Definition of Terms for NATO Sea Mines; Vol. 2, Characteristics of NATO Sea Mines; Vol. 3, Characteristics of NATO Exercise and Training Mines
17. AMP 14, Protection of Vessels from Electromagnetic Mines (or Electromagnetic Silencing)
18. APP 4, Vol. 1, Allied Maritime Structured Messages; Vol. 2, Allied Maritime Formatted Messages
19. ATP 1, Vol. I, Allied Maritime Tactical Instructions and Procedures: Chapter on mine warfare includes general protection procedures
20. ATP 1, Vol II., Allied Maritime Tactical Signal and Maneuvering Book: Source for several messages required of MCM forces; see MW section.
21. ATP 2, Vol. 1, Allied Naval Control of Shipping Manual; Vol. 2, Allied Naval Control of Shipping, Guide to Masters; Supp 1, Allied Naval Control of Shipping Manual, Merchant Ship Reporting and Control (MERCOS) System
22. AXP 5 MW SUPP, Mine Warfare Supplement to NATO Experimental Tactics & Amplifying Tactical Instructions

E.6 COMMERCIAL PUBLICATIONS

1. "Damn the Torpedoes": A Short History of U.S. Naval Mine Countermeasures, 1777-1991: Tamara Moser Melia, Naval Historical Center. Excellent and current history of naval mine warfare operations written by U.S. naval historian with cooperation of MCM forces.
2. "Weapons That Wait": Mine Warfare in the U.S. Navy: Gregory K. Hartmann, Naval Institute Press. (Older but still valuable history of mine warfare.)

E.7 INTELLIGENCE PUBLICATIONS

1. ONI TA #015-yr, MCM Systems Threat Assessment
2. ONI TA #019-yr, Mine Systems Threat Assessment
3. DST 1260H-061-yr, Naval Weapons Systems, European Communist Countries
4. DST 1260S-110-yr, Mine Warfare Capabilities: Selected Eastern European Countries

5. DST 1260S-120-yr, Naval Mines and MCM (Selected Free World & Third World Countries)
6. DST 1260H-071-yr, Naval Mine Technical Characteristics Handbook
7. ONI 2660H-002-yr, Naval Mine Recognition Guide
8. COMINWARCOM Shipboard Intelligence Officer Handbook (CMWC ships/staff only)
9. COMINWARCOM INST C3820.1 Pre-deployment Intelligence Support Collection and Reporting

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