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NWP 3-15
MCWP 3-31.2 ERR 12-04

NAVAL MINE WARFARE

MARCH 2004

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URGENT CHANGE/ERRATUM RECORD		
NUMBER	DATE	ENTERED BY
Erratum 12-04	Dec 2004	K. McClenning

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Naval Mine Warfare

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PREFACE

NWP 3-15, NAVAL MINE WARFARE, provides an overview of modern mine warfare operations. It establishes the organization, deployment, command and control, and logistics requirements of mine warfare forces. NWP 3-15 is designed to be used in conjunction with NTTP 3-15.21, Surface Mine Countermeasures Operations; NTTP 3-15.22, Airborne Mine Countermeasures Operations; and NTTP 3-15.23, Underwater Mine Countermeasures.

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

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WARNINGS, CAUTIONS, AND NOTES

The following definitions apply to “WARNINGs,” “CAUTIONs,” and “Notes” found throughout the manual.

WARNING

An operating procedure, practice, or condition that may result in injury or death if not clearly observed or followed.

CAUTION

An operating procedure, practice, or condition that may result in damage to equipment is not carefully observed or followed.

Note

An operating procedure, practice, or condition that is essential to emphasize.

WORDING

The concept of word usage and intended meaning which has been adhered to in preparing this publication is as follows:

“Shall” has been used only when application of a procedure is mandatory.

“Should” has been used only when application of a procedure is recommended.

“May” and “need not” have been used only when application of a procedure is optional.

“Will” has been used only to indicate futurity, never to indicate any degree of requirement for application of a procedure.

CHAPTER 1

General Concepts

1.1 INTRODUCTION

NWP 3-15 presents a broad command overview of mine warfare (MIW) from the operational level of war and establishes a link to other documents critical to understanding operational planning and execution. Its ultimate purpose is to serve in a supporting role toward keeping MIW 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, particularly in joint littoral warfare, mines are certain to play a major role. It is imperative to reduce loss of life and warships and to enhance the smooth integration, coordination, and effectiveness of MIW to support overall military and political objectives.

Since the invention of the Bushnell Keg in 1776, MIW has been an important element of naval warfare. Sea mines and mine countermeasures (MCM) played a significant role in every major armed conflict, and nearly every regional conflict involving the United States, since the Revolutionary War. Further, MIW has been increasingly important and effective since World War I. Mines on the world arms markets are inexpensive, easy to procure, reliable, effective, and difficult for intelligence agencies to track. More than 59 of the world's navies have minelaying capability. A considerable number of countries, many of which are known mine exporters, actively engage in development and manufacture of new models. Although most of those stockpiled are relatively old, they remain lethal and can often be upgraded. Thus, this weapon system has an extremely favorable investment return (cost of munition vs. extent of damage ratio) for those who use them.

Despite the logic and wisdom of keeping MIW balanced with the other warfighting specialties, the U.S. Navy has traditionally devoted proportionally fewer resources to that discipline. As a result, despite our emergence as the world's premier maritime power, development of MCM capabilities lags.

Santayana's dictum, "Those who cannot remember the past are condemned to repeat it," definitely applies to MIW. North Arabian Gulf operations of the U.S. Navy in Desert Storm contain some harsh experiences, including mission-abort mine strikes sustained by two warships and the decision not to land Marines in Kuwait. Despite initial MCM setbacks, Coalition Forces successfully countered nearly 1,300 Iraqi sea mines and emerged victorious in the MCM segment of Desert Storm.

The success of the MCM campaign in the North Arabian Gulf was due, in part, to the unparalleled material and logistics support from the Department of the Navy's shore establishment, the resourcefulness of the sailors executing the mission, and the cooperation of allied nations in the coalition effort. As the clearance campaign progressed, the Naval Component Command leadership came to understand, appreciate, and support the complex warfighting characteristics of MCM.

1.2 KEY DEFINITIONS

Mine warfare terminology appears in many other U.S. military publications, but carries different or more precise definitions when applied specifically to MIW operations. Additionally, many definitions used by allied MIW forces differ from those used by U.S. forces. Allied or coalition force operations can be far more difficult when the forces and commanders are unable to communicate freely because of terminological inconsistencies. Therefore, it is imperative for commanders to become familiar with the various terms employed when discussing and planning MIW operations.

1.2.1 Mine Warfare

Mine warfare 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. MIW encompasses all aspects of designing, producing, and emplacing mines, as well as the parallel efforts of developing, producing, and operating all forms of MCM equipment to combat an adversary's mining campaign.

1.2.2 Mining

Mining is one of the two distinct subdivisions of MIW. This warfighting discipline is used to support the broad tasks of establishing and maintaining control of essential sea areas. Mining embraces all methods whereby naval mines are used to inflict damage on adversary shipping to hinder, disrupt, and deny adversary sea operations. Mines may be employed either offensively or defensively to restrict the movement of surface ships and submarines. They can be used alone to deny free access to ports, harbors, and rivers, as well as movement through sea line of communications (SLOC). They can also be used as a force multiplier to augment other military assets that will reduce the adversary surface and submarine threat. Such a campaign is intended to inflict damage on adversary ships that challenge the minefield, thereby having an adverse effect on their defensive, offensive, and logistics efforts. It can also force the adversary to conduct a concerted MCM effort that exceeds the magnitude of the mining operation itself. Adversary ships detained at their base or impeded in transit may be rendered as ineffective for the immediate war effort as if they were otherwise sunk or destroyed. Further, delays in shipping may be as costly to the adversary as actual losses. The threat posed may be real or perceived, but mining has a significant psychological impact on the adversary by forcing him to combat an unknown force.

1.2.3 Mine Countermeasures

The other distinct subdivision of mine warfare is mine countermeasures and includes all offensive and defensive measures for countering a naval mine threat, including the prevention of adversary minelaying. MCM is considered to be any action that is taken to counter the effectiveness of sea mines or reduce the probability of damage to surface ships or submarines.

1.3 MINE WARFARE FORCE ORGANIZATION

Commander, U.S. Atlantic Fleet (COMLANTFLT) is the administrative and operational commander for the MIW forces. When other fleet commanders require MCM support, COMLANTFLT directs Commander, Mine Warfare Command (COMINEWARCOM) to provide forces as necessary. COMLANTFLT, Commander, U.S. Pacific Fleet (COMPACFLT), and Commander, U.S. Naval Forces, Europe (COMUSNAVEUR) each have operational control over mobile mine assembly group (MOMAG) units and the mine stocks located in their areas of responsibility.

COMINEWARCOM is responsible to COMLANTFLT 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 theaters of war (MTOW). COMINEWARCOM is also assigned as technical adviser to COMLANTFLT, COMPACFLT, COMUSNAVEUR, USNAVFORKOR, COMUSNAVCENT, and Supreme Allied Commander Atlantic (SACLANT). In addition, COMINEWARCOM provides technical advice to North Atlantic Treaty Organization (NATO) and allied countries, when directed.

COMINEWARCOM, under COMNAVSURFLANT, has operational control over all MCM 1 and Mine Hunter Coastal (MHC 51) ships. As necessary for intermediate or advanced training, and for participation in exercises or actual combat operations, the MCM squadrons are assigned operational control of MCM and MHC ships. For deployment purposes, a mine countermeasures squadron (MCMRON) may have operational control over one of two helicopter MCMHM squadrons, Naval Special Clearance Team One (NSCT1), or explosive ordnance disposal (EOD) MCM DETs.

1.3.1 Mining

Mining is typically directed by higher authority and is often conducted by forces external to the battle group (BG) or amphibious ready group (ARG). At the operational and tactical levels, the strike warfare commander maintains the expertise to coordinate and execute these missions. The Commander, Mobile Mine Assembly Group (COMOMAG), under the guidance of COMINEWARCOM, conducts preliminary maritime minefield planning and prepares minefield planning folders (MFPFs) as requested by naval component commanders. As the Assistant Chief of Staff for Mining at COMINEWARCOM, COMOMAG also advises naval component commanders on the requirements for prepositioned mine stocks to execute approved MFPFs and recommends redistribution of those stocks as necessary when new plans are developed or variations in the stockpile occur.

Tactical minefield planners are those personnel on numbered fleet, BG, and air wing staffs who may tailor plans derived from a MFPF to fit the specific mission or may generate a new plan where no appropriate one is available. These personnel are not dedicated planners but attended necessary courses at the Mine Warfare Training Center (MWTC) and perform planning as a collateral duty.

COMOMAG is responsible for maintaining mine material readiness and, when directed by the appropriate war plan execution authority, assembling service mines. COMOMAG is under the operational and administrative control of COMINEWARCOM but also reports for additional duty to COMLANTFLT, COMPACFLT, and COMUSNAVEUR.

In performance of this mission, COMOMAG maintains permanently staffed mobile mine assembly units (MOMAU) and DETs 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 units afloat or other mine sites when necessary to support mining operations. COMOMAG has operational and administrative control of continental United States (CONUS) units and detachments.

A minelaying mission is assigned to several types of Navy aircraft and submarines. Some Air Force bombers have a similar capability.

1.3.2 Mine Countermeasures

The COMINEWARCOM staff conducts planning and analysis for force deployment, MCM operations, and MIW employment. Staff intelligence specialists monitor collection and analysis on MIW capabilities throughout the world. Staff members responsible for requirements coordinate with type and combatant 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 to mainstream MIW forces into fleet operations and increase efficiency of those forces.

COMNAVSURFLANT is the type commander for surface MCM (SMCM) units, performing all type commander duties, except for scheduling. The COMINEWARCOM Operations Officer maintains scheduling authority.

There are three MCM squadron staffs under the operational control of COMINEWARCOM. They maintain operational control (OPCON) of all surface units assigned to them. Commander, MCM Squadron (COMCMRON) One is responsible for planning and executing MCM exercises and operations, as directed, serving as the Mine Warfare Commander. Their focus is on MCM planning for the Pacific Theater, particularly in support of Seventh Fleet, although operational assignment may be to any theater. As necessary for intermediate or advanced training and for participation in exercises or actual operations, the MCM squadrons are assigned OPCON of MCM 1 Class and MHC 51 Class ships. For deployment purposes, a COMCMRON may have operational control over airborne mine countermeasure (AMCM) and underwater mine countermeasure (UMCM) assets.

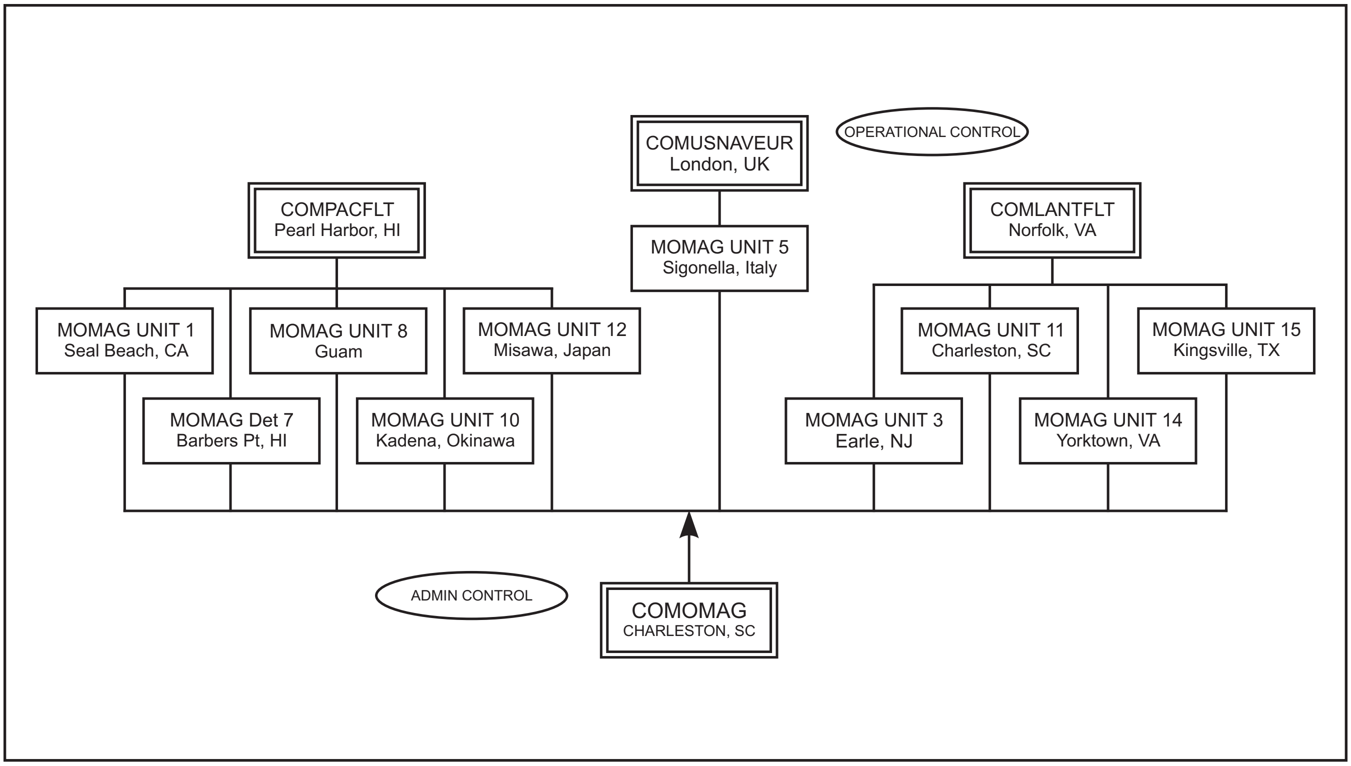


Figure 1-1. Mine Storage and Preparation Organization

Administrative control (ADCON) of Helicopter Mine Countermeasures Squadrons HM-14 and HM-15 is assigned to COMHELTACWINGLANT. ADCON of EOD MCM DETs is assigned to the parent EOD mobile unit (EODMU) under Commander, Explosive Ordnance Group One or Two, respectively.

COMCMRON TWO has the same responsibilities as COMCMRON ONE, with a focus on the Atlantic and Mediterranean theaters.

COMCMRON THREE has the same responsibilities as COMCMRON ONE, with a focus on the Middle East theater and the Third Fleet area of responsibility (AOR).

COMINEWARCOM, under COMNAVSURFLANT, has operational control over all MHC and MCM ships.

MCM assets that have completed all basic phase training requirements may be assigned to Commander Second Fleet (COMSECONDFLT) or Commander Third Fleet (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.

UMCM is a critical element of the modern MCM triad. EOD MCM divers are specially trained and equipped with nonmagnetic, low-acoustic signature equipment that permits them to approach influence mines safely and perform identification, neutralization, or render-safe and recovery operations. OPCON is assigned to COMINEWARCOM for various EOD and MMS DETs.

NSCT1 is responsible for conducting MCM in the VSW (40- to 10-ft depth contour, behind breaking surf) region in support of amphibious operations. They are OPCON to COMINEWARCOM and ADCON to COMEODGRU ONE. When an amphibious task force (ATF) is formed, NSCT1 is assigned to the supporting MCMRON. They provide a cadre of sea-air-land (SEAL) personnel, EOD divers, and U.S. Marines Corps reconnaissance specialists to conduct low-visibility mine exploration, reconnaissance, and neutralization missions. They perform this mission in conjunction with EX 8 (Mk 8) Mod 0 MMS.

The Commanders, Maritime Defense Zones (MDZ) Atlantic and Pacific are responsible for MIW planning within the MDZ. MDZ 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 will delegate control of mining or MCM forces as necessary (and if available) to support the MDZ commanders.

1.3.3 Naval Reserve Forces

The Naval Reserve Force (NRF) has 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, and as the MCM 1 Class ships replaced the mine sweeper ocean (MSO), nine of those vessels have remained in the active force. Currently, five of fourteen MCM 1 Class ships and ten of twelve MHC 51 Class ships are assigned to the NRF.

The NRF also plays a role in AMCM and EOD MCM. HM-14 and HM-15 each have a reserve component of pilots and maintenance personnel. NRF EOD forces are composed of four reserve units: EODMU TEN and EODMU TWELVE under COMEODGRU TWO; EODMU SEVEN and EODMU SEVENTEEN under COMEODGRU ONE. Each reserve unit trains and provides administrative support for three different types of detachments. Ordnance clearance detachments (OCDs) are fully qualified in diving and demolition procedures and are trained to locate, identify, and dispose of sea mines. Area search detachments (ASDs) use side-scan sonar systems to locate minelike objects. Mobile communications detachments (MCDs) provide fully transportable communications capability in support of fleet operations and exercises.

Naval Reserve units also are used to augment the command and control structure for MIW. Also, NRF mine division staffs have supported MCMRON staffs. As the armed forces have been reduced in size, so has the NRF staff structure.

1.4 RULES OF ENGAGEMENT AND LAWS OF ARMED CONFLICT

1.4.1 Mining Objectives

Mining supports the broad task of establishing and maintaining control of essential operational areas. In the event of war, the ability of the U.S. Navy to carry out its primary mission of maintaining control of the seas will be seriously threatened by enemy subsurface, surface, and air forces. U.S. mining may be required to assist in reducing that submarine and surface threat. In addition, offensive measures may be required against merchant ships and may include the restriction of certain passages to all shipping. For these reasons, mining complements and comprises an essential part of other warfare areas, particularly antisubmarine and antisurface warfare operations.

Sea mines, or the implicit threat that attends their possible presence, may deny the enemy the free and safe use of sea areas vital to their operations, or conversely, sea mines may be used to protect friendly harbors, channels, and shores against amphibious assault. Delays and interruptions in shipping of war-sustaining materiel may deprive the enemy of critical offensive and defensive capabilities. History has shown that enemy ships confined to their bases or deterred in transit by mining operations become ineffective in their contribution to the immediate war effort and delays in shipping may be as costly as actual losses.

1.4.2 United States Mining Policy

In the event of war, U.S. policy will be to conduct offensive, defensive, and protective mining as necessary. The purpose is to reduce the enemy submarine and surface combatant threat by destruction and disruption of their operations, to interdict the enemy sea lines of communications (SLOCs) and designated ports in order to neutralize or destroy combatant and merchant ships, and to defend U.S. and allied shipping. More specifically, naval mines may be used in conjunction with other warfare forces to aid in the Navy's sea control mission by:

1. Denying enemy use of designated ocean areas, ports, or waterways for diplomatic, economic, or military purposes

2. Influencing enemy maneuver and direction or otherwise restricting his movements to buttress the operational effectiveness of friendly forces

3. Protecting ports, coastal lines of passage, Q-routes, and designated operating areas

4. Destroying enemy ships and submarines directly

5. Establishing blockades to provide political leverage in a limited war situation

6. Denying the enemy the ability to carry out amphibious operations.

1.4.2.1 Implementation of Policy

Mining policy is carried out by use of aircraft, submarine, and surface mining forces. In order that mining may be conducted when and where desired, plans are prepared in advance for those areas in which a potential mining requirement exists, and appropriate assets should be made available. Mobile mine assembly units (MOMAUs) are capable of rapid augmentation by regular and reserve forces and can additionally perform stockpile maintenance.

1.4.3 International Law Relative to Mining

1.4.3.1 Hague Convention VIII of 1907 (36 Stat. 2332; TS 541)

Naval mines are lawful weapons, but their potential for indiscriminate effects has led to specific regulation under international law. International agreements affecting the use of naval mines are primarily intended to protect neutral parties, shipping, and innocent civilians. The most important international agreement in regard to naval mines is the Hague Convention VIII of 1907, which came into force with respect to the United States on January 26, 1910. The following paragraphs summarize its major provisions:

1. It is forbidden to lay unanchored contact mines, unless they are so constructed as to become harmless 1 hour, at most, after those who laid them have lost control over them.

2. It is forbidden to lay anchored contact mines that do not become harmless as soon as they have broken their moorings.

3. It is forbidden to use torpedoes that do not become harmless when they have missed their mark.

4. It is forbidden to lay armed (or automatically arming) contact mines near coasts and ports of the enemy with the sole object of intercepting commercial navigation.

5. When anchored and armed (or automatically arming) contact mines are used, every possible precaution must be taken for the security of peaceful navigation. Provisions should be enacted to ensure that the mines become harmless after a limited time has elapsed. When the mines are no longer under observation and military exigencies permit, the danger zone must be circumscribed through a notice to mariners and through diplomatic channels.

6. Neutral powers must observe the same rules and take the same precautions as are imposed on belligerents, and they must issue an advance notice to mariners.

7. At the close of the conflict, the nations who laid the mines must do their utmost to remove them, will reveal to other parties the locations of mines in its waters, and will proceed without delay to remove mines from its own waters.

8. While the provisions of the Convention are stated to be applicable only between the subscribing powers, the nearly universal acceptance of these as general principles by the community of nations has given them vitality under customary international law.

1.4.3.2 Other International Agreements

Other international agreements also impose restrictions that may affect the emplacement of naval mines. Primarily, the 1982 United Nations Convention on the Law of the Sea (21 ILM 1261, 1833 UNTS 3397) provides that the high seas are open to vessels of all nations and recognizes the right of freedom of navigation on the high seas. The Convention guarantees to all ships the right of innocent passage through territorial waters of littoral states so long as the passage is not prejudicial to the peace, good order, or security of the coastal state. Although the United States has not ratified the treaty, the United States' position is that all states are bound by these provisions because they have become part of customary international law. The Seabed Arms Control Treaty (23 UST 701, TIAS 7337) prohibits emplacing or planting on the seabed, beyond a 12-mile coastal zone, any nuclear weapon or other weapon of mass destruction. However, the U.S. interpretation is that this does not include non-nuclear sea mines. The Charter of the United Nations (59 Stat. 1031; TS 993, Bevans 1153) provides that members of the United Nations will refrain from the threat or use of force against the territorial integrity or political independence of any state except in individual or collective self-defense. The threat or use of force in self-defense must be necessary and proportionate to the threat posed.

1.4.4 Legal Interpretations

The Office of the Judge Advocate General of the Navy has provided guidance that is, in part, included in the following sections.

1.4.4.1 Peacetime Mining Operations

Armed or controlled mines may be emplaced in a nation's own internal waters at any time with or without notification. A nation may also mine its own archipelagic waters and territorial sea during peacetime when deemed necessary for national security purposes. If armed mines are emplaced in archipelagic waters or the territorial sea, appropriate international notification of the existence and location of such mines is required. Emplacement of controlled mines in a nation's own archipelagic waters or territorial sea is not subject to such notification or removal requirements. Because the right of innocent passage can be suspended only temporarily, armed mines must be removed or rendered harmless as soon as the security threat that prompted their emplacement has terminated. Armed mines may not be emplaced in international straits or archipelagic sea lanes during peacetime.

Armed mines may not be emplaced on the high seas prior to the outbreak of armed conflict, except under the most demanding requirements of individual or collective self-defense. Should armed mines be emplaced in international waters under such circumstances, prior notification of their location must be provided. In addition, an on-scene presence must be maintained in the area sufficient to ensure that appropriate warning is provided to ships approaching the danger area. All armed mines must be expeditiously removed or rendered harmless when the imminent danger that prompted their emplacement has passed.

1.4.4.2 Mining During Armed Conflict

Naval mines may be lawfully employed by parties to an armed conflict subject to the following restrictions:

1. International notification of the location of emplaced mines must be made as soon as military exigencies permit.

2. Mines may not be emplaced by belligerents in neutral waters.

3. Anchored mines must become harmless as soon as they have broken their moorings.

4. Unanchored mines not otherwise affixed or imbedded in the bottom must become harmless within an hour after loss of control over them.

5. The location of minefields must be carefully recorded to ensure accurate notification and facilitate subsequent removal and/or deactivation.

6. Naval mines may be employed to channelize neutral shipping, but not in a manner to deny transit passage of international straits or sea lanes passage of archipelagic waters by such shipping.

7. Naval mines may not be emplaced off the coasts and ports of the enemy with the sole objective of intercepting commercial shipping, but may otherwise be employed in the strategic blockade of enemy ports, coasts, and waterways.

8. Mining of areas of indefinite extent in international waters is prohibited. Reasonably limited barred areas may be established by naval mines, provided neutral shipping retains an alternate route around or through such an area with reasonable assurance of safety.

1.4.4.3 Minelaying by Neutrals

Neutrals have the right, for their own protection and after proper notification, to lay mines in their territorial seas during armed conflict or in time of peace when their security is threatened. Neutrals may not emplace mines on the high seas.

1.4.4.4 Use of Mines in a Blockade — A Legally Acceptable Procedure

The use of mines to enforce a naval blockade is now accepted by the international community. This is a change from traditional practice, which previously required an on-scene naval presence to enforce the blockade. Current warfare techniques that involve the use of radar, sonar, aircraft, and intelligence gathered by satellite appear to clearly provide for an effective blockade capability without the need to keep naval forces in the vicinity for the purpose of intercepting would-be blockade runners.

1.5 MINE WARFARE RELATIONSHIPS WITH OTHER WARFARE SPECIALTIES

1.5.1 Mine Warfare Commander

The following are mine warfare commander (MWC) roles:

1. Act as the single point of contact for MIW.

2. Provide recommendations to the composite warfare commander (CWC) and other warfare commanders and staffs.

3. Provide guidance on how MIW operations fit into theater operations of the fleet commander.

The MWC 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 supporting mining and MCM assets.

3. Evaluate implications of adversary MIW and recommend appropriate MCM response.

4. Coordinate with antisubmarine warfare commander (ASWC) on all defensive minefield planning matters.

5. Coordinate the employment of tactical air assets in mining with strike warfare commander (STWC).

6. Ensure that mining operations are conducted in accordance with international law.

7. Designate mine danger areas (MDA).

8. Maintain the status of all force MIW capabilities.

9. Coordinate environmental support for MIW operations.

The MWC maintains an operational tasking (OPTASK) message MIW supplement to communicate general procedures and instructions to other forces inside and outside the CWC organization as necessary.

1.5.2 Strike Warfare

Strike warfare (STW) aircraft are a key element in many mining plans. The MWC provides recommendations to the CWC for employment of strike assets to conduct mining in support of CWC objectives. If approved, the STWC and strike operations department on board an aircraft carrier (CV) carry out the minelaying planning and execution.

STW assets are also employed in conducting offensive MCM. Reconnaissance conducted by tactical aircraft may identify movement of such assets to indicate that mining is imminent. The MWC monitors intelligence data and provides offensive MCM targeting recommendations to the STWC and CWC early in the conflict.

1.5.3 Special Operations

Special operations forces are involved in both offensive and defensive MCM. Offensively, these forces may be assigned to cripple or destroy mine storage sites and mine stocks. Their ability to conduct limited objective raids with accuracy may be preferred in certain scenarios over tactical air strikes or Tomahawk land-attack missile (TLAM) strikes. In the defensive MCM role, naval special warfare (NSW) forces may conduct hydrographic reconnaissance in advance of an amphibious landing to determine whether a mine threat is present. This involves close coordination with AMCM, SMCM, and UMCM forces to develop synchronized tactics.

1.5.4 Surface Warfare

MCM forces interact with surface warfare (SUW) forces in several ways. A surface combatant may serve as the flagship for the MCM commander (MCMC) and provide support to the MCM triad. SUW forces can provide force protection for MCM forces, as well as some logistic support. They also may be tasked to provide SUW helicopters to support EOD forces or to conduct spotting for drifting mines cut by mechanical sweeping. MCM forces conduct reconnaissance for SUW operating areas when mining is suspected and, if necessary, clear areas to conduct patrols or fire support operations.

1.5.5 Antisubmarine Warfare

Antisubmarine warfare (ASW) forces may emplace protective minefields with air assets as barriers to control the submarine threat. ASW forces will support the MCM force by maintaining reconnaissance in their area of operations to detect minelaying assets or the existence of minefields. Some ASW sonars can also be employed for detection and avoidance. They permit the ASW ship to operate with increased safety in waters where the threat has not been determined, allowing the ship to detect and avoid moored mines.

1.5.6 Antiair Warfare

Actions between MIW and air warfare (AW) forces are limited to the force protection role that antiair warfare (AAW) ships and aircraft might perform. MCM forces are not equipped for substantial self-defense. If a hostile air threat exists, it may be necessary for AAW forces to create a sanctuary for the mission to continue. Given the small size of the MCM force, the loss of a single ship or helicopter can compromise the mission.

1.5.7 Amphibious Warfare

MCM forces operate in close combat support of amphibious operations against hostile objectives. The attempt to project power ashore against an armed threat is one of the most dangerous of military undertakings. Mines and obstacles increase this danger. The mine is an inexpensive, easily obtained weapon that can be employed against such an endeavor. Their presence, without a sufficient capability to counter them, can result in significant losses to the landing force or cancellation of the landing. Further details regarding evolving amphibious warfare (AMW) concepts relative to operational maneuver from the sea and ship-to-objective maneuver can be found in paragraph 3.7.

The supported and supporting commanders should provide detailed requirements for amphibious operations to the MCMC as early as possible to facilitate planning. Considerations include location and size of the amphibious objective area (AOA), may also be referred to as the littoral penetration area (LPA) for purposes of this NWP) in comparison to available MCM assets, slow SMCM transit times to AOA, rate of MCM operations required to meet established deadlines, and requirements to protect the MCM effort. Adversary observation of clearance operations, to include those of NSCT1, may compromise tactical surprise.

Large-deck, aviation-capable amphibious ships may be assigned to embark and support MCM forces as a contingency. This generally requires Marine elements to be displaced, requiring early liaison and planning to ensure potential amphibious operations are not adversely impacted. Marine amphibious ships may be used as support ships, embarking the MCMC, as well as AMCM and UMCM detachments, while providing logistic support to SMCM vessels. NSCT1 will require the use of a well deck ship to support its operations.

As an integral part of the amphibious breach, the commander, landing force (CLF) (also referred to as the supported commander) will embark assets to be used in MCM efforts from the high water mark (HWM) to inland objectives, which will include USMC breach forces and their equipment.

1.5.8 Maritime Interdiction Operations and Law Enforcement Operations

These operations may become targets of mining, and personnel must remain alert to the possibility. The use of passive MCM explained in paragraph 3.4.1 should be reviewed and employed where appropriate. When inspecting merchant ships, 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, maritime interception operations (MIOs) or law enforcement operations (LEOs) forces should be supported by MCM forces to establish safe operating areas, anchorages, and transit lanes.

1.5.9 Salvage Forces

Salvage forces not engaged in salvage operations may be called on to support MCM forces by providing an operating platform for EOD MCM divers. Any such vessels with an installed recompression chamber will be considered for support of EOD divers requiring emergency services.

1.5.10 Fleet Exercises

MCM forces are integrated with BG training exercises whenever possible. For in-port exercises, participation may be limited to MCM squadron staff members, either on-scene or from a remote location. During fleet exercises, MCM forces may also participate by transiting to the operating area (OPAREA) or by establishing a scripted geographic area near the SMCM homeport of Ingleside, Texas. The staff can conduct exercises there and transmit information with coordinates converted to match the geography of the exercise area. Since MCM activity frequently occurs beyond the sight of the BG, this participation saves fuel and transit time without sacrificing the benefits of their interaction.

1.6 MINE WARFARE AND JOINT ACTIONS

1.6.1 Army-Navy

Although the Marines share significant responsibility, particularly during an amphibious breach, the U.S. Army is responsible for conducting a large portion of minefield planning and breaching operations ashore during large land campaigns. The Navy responsibility ends at the landward limit of the craft landing zone (CLZ) along seashores, but extends inland where waters are navigable from the sea. Where navigation is no longer possible by seagoing vessels, Navy responsibility normally ends. The joint force commander focuses on capability (vice responsibility). If Navy assets are capable of conducting MCM in a waterway where Army craft need to navigate, it is likely that the Navy will be directed to clear those mines.

The Army has a tremendous amount of material that must be moved to support overseas campaigns such as Operation Desert Storm. The majority of this material will be moved by sealift ships, which may be brought under contract by Military Sealift Command (MSC). This same theme applies to the overseas movement of SMCM craft. To support the rapid buildup of forces required in an overseas conflict, the loading, transit, and unloading of these ships must follow a constrained schedule. A mining threat in CONUS, at choke points along SLOCs, or at ports of debarkation can delay or completely halt the movement of material. U.S. Navy MCM forces (and MCM forces from NATO or allied nations) will be tasked by the joint force commander with clearing and maintaining channels and anchorages to permit the free flow of traffic. EOD MCM forces may also be tasked to clear and assist in maintaining safe harbors to off-load shipping.

1.6.2 Air Force-Navy

The U.S. Air Force plays two important roles in supporting MIW forces (in addition to supporting offensive MCM). The first is the laying of mines. USAF bomber aircraft can deliver mines at long distances from CONUS or other bases, playing a critical role in accomplishing mining plans directed by joint commands. The second is the Air Mobility Command's (AMC) deployment of AMCM and UMCM 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.

1.6.3 Marine Corps-Navy

In support of amphibious operations in a mined environment, USMC breaching assets will be carried toward shore by Navy displacement craft and landing craft air cushion (LCAC). Explosive mine clearance systems or methods will be required for "brute force" clearance of the surf zone (SZ) to HWM. The clearance of assault lanes through the VSW zone (40- to 10-ft depth contour) will be executed by NSCT1.

Rapid deployment of USMC forces (other than those already embarked on amphibious shipping) is accomplished by airlift of personnel to a benign location where they can be united with equipment stored on maritime pre-positioning ships squadron (MPSRON) ships. In the same manner as MSC shipping carrying Army material or SMCM craft, 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 logistics over-the-shore (LOTS).

1.6.4 Coast Guard-Navy

During peacetime, the Coast Guard is part of the Department of Transportation, yet maintains a significant relationship with the Navy's MDZ organization. The Commanders, MDZ Atlantic and Pacific are Coast Guard flag officers, and there are Coast Guard officers on many Navy staffs to maintain the relationship. These officers should be graduates of MIW training courses. As the MDZ mission expands into deployable port control and coastal shipping management control, planning with MCM commands will increase.

Coast Guard assets are frequently included in exercises where mining and MCM are involved. Liaison with the local Coast Guard port authorities is necessary to transport exercise mines at their 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 COMINEWARCOM to facilitate cooperation. 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. These billets may be restored in the event of an operational emergency.

In wartime, when the Coast Guard operates under the Department of the Navy, Coast Guard assets will likely support route survey and MCM forces conducting CONUS operations.

1.7 RULES OF ENGAGEMENT

Rules of engagement (ROE) are directives issued by competent military authority that delineate the circumstances and limitations under which United States forces will initiate and/or continue combat engagement with other forces encountered. They are generally mission-oriented and action-specific and are published by the Theater Commander based on guidance provided by the President or Secretary of Defense through the Chairman of the Joint Chiefs of Staff (CJCS). 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 additional guidance. Combatant commander pre- and post-hostility ROE and OPLAN ROE should address any authority to emplace mines. Following the release of these elements, ROE should address their use by U.S. forces and the prevention, denial, or countering of them by the adversary.

1.7.1 Reconnaissance

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

1.7.2 NATO and Allied Rules of Engagement

When control of a U.S. mining or MCM force or asset is assigned to a NATO commander, those assets must conform to NATO ROE. There may be occasions when U.S. forces will operate with or in support of NATO or allied 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 President or the Secretary of Defense. 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 conflict between intended operations and ROE. The most important aspect of coalition operations is that the U.S. and allied commanders understand each other's ROE.

1.7.3 Rules of Engagement Relative to Warfare Specialty 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 command and control (C2), 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/supported units advised of any revisions. It may be necessary to review ROE when new forces are assigned and when missions change.

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 the adversary while allowing little or no chance for retaliatory action. Mines lie in wait for their target, allowing adversary shipping to be attacked without 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, the smallest minelayer may destroy the most powerful vessels. Minefields also allow the miner to establish preemptive defenses in which the aggressor assumes responsibility for casualties.

The mine offers the advantage of surprise, with detonation often being the first indication of its presence. Even if not placed covertly, mines offer the advantage of concealment because (if properly planted) they present no visible danger. Since mines operate continuously from arming until detonated, countered, or expired, they present a continuous, maintenance-free threat.

Mines, when used in conjunction with other systems, can serve as a force multiplier or as an economy of force measure. As a force multiplier, mines emplaced in a SZ or on a beach to reinforce and protect existing obstacles (covered by observation and supporting fires) present a formidable combined arms threat. As an economy of force measure, a minefield may be used to sustain a variety of warfighting functions that would otherwise occupy patrol or other combat forces, thereby freeing those forces for other operations. Likewise, the use of sea mines can reduce the number of vessels required to enforce naval blockades.

Early offensive mining may disrupt adversary war plans more effectively than any other weapon. It offers numerous complementary actions, such as the overload and disruption of adversary transport and logistics systems caused by interruption of normal port activity. The funneling of supplies or the restriction of supplies in fewer ports makes those assets more susceptible to attack by other forces.

One of the most widely recognized advantages of naval mining, but perhaps the one most difficult to quantify, is its psychological effect. The adversary perception of the danger posed by a minefield has a large psychological impact on the forces that must transit through it. While this is a real and unique advantage, this perceived threat may vary from nation to nation and culture to culture.

The mine may be the only naval weapon that offers an apparent ability to shape the battlefield. An area that has been (or perceived to be) mined may be vigorously avoided by the adversary, thus restricting maneuver options.

Perhaps the greatest advantage of MIW is that mines may even be effective if their use is merely feigned or threatened.

2.1.2 Disadvantages

The primary weakness of naval mines is that they are passive weapons that await targets rather than seeking and attacking them. Many mines (unless proper precautions are adhered to) remain a constant threat to friendly as well as adversary ships. U.S. sea mines are stationary once planted, providing the adversary the opportunity to detect, avoid, and counter them. Exposure to seawater for long periods may cause the mine to become materially degraded through biological fouling or corrosion, while water temperature may adversely affect battery life. Another environmental disadvantage is that water depth restrictions govern where mines may be effectively laid.

2.2 THE MINEFIELD

2.2.1 The Minefield Compared to Other Weapons

In naval warfare, a minefield is defined as an area of water containing mines laid with or without a pattern. If the field is not declared or the minelaying operation goes unobserved, it may not achieve its desired effect until some time after the mining agents have departed. Although able to discriminate between target types, the mine is unable to determine the nationality of a target. Unless sterilizers or self-destruct features are incorporated, the mine continues to be effective until swept or otherwise neutralized.

Mining operations often seem inconsistent with the aggressive spirit of an offensive navy. Mines and their countermeasures, however, must be given the attention merited during wartime experience. When used, mines have inflicted disproportionate casualties compared to the minelaying effort. The collateral effects of mining operations, such as the diversion of shipping, the exposure of targets to other weapon systems, and the cost of MCM efforts, can have a major impact on war aims.

The design of a naval minefield depends on the field's purpose, expected adversary traffic, type and number of mines, geographical location, amount of countermeasures to which it will be subjected, and the mining platforms to be used. Clever minefield design enables mining forces to achieve their objectives without an excessive mining effort. MCM forces can frequently confront individual mines, but the utility of any MCM undertaking must always be judged on their ability to reduce entire minefields.

2.2.2 Endurance and Life of the Minefield

If a sinking or sterilizing mechanism does not arbitrarily limit the life of a naval mine, its life generally will be limited by failure of the firing mechanism, battery, or mooring. Some influence firing mechanisms impose a steady drain on batteries, which may make the mine useless before the mooring fails. Other types of influence mechanisms and most contact mechanisms have little or no steady power requirements and may last indefinitely. In sheltered waters, some mines can remain moored for several years. In areas subject to strong tidal streams or extreme sea conditions, the mooring life is greatly reduced. Shallow water and short moorings also tend to reduce endurance.

2.2.3 Adversary Minelaying Capability

Information in national and NATO intelligence publications includes details of the naval order of battle (OOB) of potentially hostile countries. The data includes number of assets, bases, and units capable of laying mines. By considering the range to the scene of operations, minelaying sortie speed, number of units available, and their mining capability, it is possible to roughly estimate the number of sea mines that can be potentially laid in a particular area.

The likely threat can be further defined by considering the difficulties facing the adversary. The limitations exerted on submarine and surface minelaying operations can be assessed and the effectiveness of these means estimated. The possibility of aerial mine placement can be similarly examined. The likelihood of such actions by merchant or fishing vessels should be considered. It may be possible to discount one or more methods, thereby eliminating certain mine types. For example, discounting the possibility of submarine or aerial minelaying will generally reduce the mine types that might otherwise be encountered.

Other factors that the adversary must consider and that thereby form part of the adversary assessment include:

1. Being too selective against a specific target may reduce the potential to hit other targets.

2. Complex mines are expensive and tend to be less reliable.

3. A minefield in open waters has less probability of success than one in confined waters.

4. It is difficult to lay mines in confined waters close to defended adversary territory, in shallow waters, or in tidal streams.

5. Mines that are difficult to sweep may later prove a problem to the miner when it becomes necessary to remove them.

2.2.4 Adversary Mining Objectives

1. Having determined the types of naval mines available and the likely means of laying them, the threat must be viewed in relationship to targets that the adversary is seeking to destroy.

2. Geography greatly dictates target movement. This in turn dictates where mining against those targets must be carried out, such as port exits, narrow channels, choke points, or specific areas of operations.

3. Environmental considerations, particularly water depth, will restrict the types of mines used.

4. The characteristics of the target and traffic flow dictate the choice of mines and mine settings.

5. The rationale for undertaking a mining campaign must be considered. Generally, mines cannot be controlled once emplaced, which can inhibit their use under certain military and political circumstances. It may be that the aim of the adversary is not to sink or damage targets, but to apply political pressure through the threat of sea mines. The possibility of the adversary observing the 1907 Hague Convention is an important consideration, as this can reduce the risk in international waters or in territorial waters of nonbelligerent states.

2.2.5 The Mine Threat in Peacetime

Mines may be used in peacetime by a rogue government or terrorist group. This threat is countered by maintaining MCM capability, perfecting the techniques for using MCM equipment, and conducting rigorous exercises.

A secondary peacetime task is the execution of Q-Route surveys with MCM sonar in order to establish the best routes for shipping in the face of a mine threat.

2.2.6 The Mine Threat During a Period of Tension

Mines may be used during periods of tension, and the possibility of covert or overt mining must be studied. The counter to this threat consists of maintaining on-scene MCM forces at a high degree of readiness, surveillance of likely mining areas, and updating route surveys.

2.2.7 The Mine Threat After Hostilities

Following hostilities, the threat of adversary and friendly mines still exists. Once the types, numbers, and locations are ascertained, the most effective system and method of clearance can be determined. In this type of operation the safety of MCM forces is the primary consideration. It is also necessary to maintain EOD capability to render-safe mines washed ashore, recovered by fishermen, or discovered during the continuing MCM endeavor.

2.3 MINE CLASSIFICATION

Naval mines are typically classified in one of four ways:

1. Final position in the water

2. Method of actuation

3. Intended target

4. Method of delivery.

2.3.1 Final Position in the Water

When classified according to the position they assume in the water after placement, mines fall into three primary categories:

1. Bottom or ground mines

2. Moored mines

3. Moving mines.

2.3.1.1 Bottom or Ground Mines

Bottom mines (also called ground mines) are nonbuoyant weapons. When planted, the mine case is in contact with the seabed and is held in place by its own weight. In areas with a soft bottom they may be completely or partially embedded. Such mines are referred to as buried mines. A mine that is resting on the bottom (unburied or partially buried) may also be referred to as a proud mine.

The nonbuoyant case of a bottom mine allows for the use of a much larger explosive charge than those that are buoyant. The larger explosive charge provides a larger damage distance, enabling a single mine to cover a larger volume of water. However, they must be planted in water depths where the target 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. If bottom mines are intended for use against a surface ship, they are most effective in shallow waters (<200 ft). If planted in deeper waters, a vessel may pass over it without actuating the firing mechanisms or, if the firing mechanism is actuated, the 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 similar once they have reached their final plant position:

1. A moving bottom mine is one that is designed to move itself along the bottom after it has been planted, but before it arms.

2. A self-propelled mine is fitted with propulsion equipment, such as a torpedo, that is used to propel it to an intended final 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 location.

2.3.1.2 Moored Mines

Moored mines have a buoyant case set at a certain depth beneath the surface. The mine is held in place above the seabed by means of a cable or chain that is attached to an anchor. They are frequently fitted with a self-destruct device that will cause them to flood and sink if separated from the anchor. Mines that separate from their anchors and rise to the surface are known as floaters. These may continue to float until they are struck and detonated, or they may deteriorate from their exposure to the seawater.

Moored mines are designed for deep water, for use against both submarines and surface ships. The length and weight of the mooring cable and the mine case crush-depth limit the maximum water depth in which they may be laid. The explosive charge and firing mechanism are housed in the positive-buoyant case. Since the case is buoyant, the amount of the explosive charge is less than what is generally found in a typical bottom mine, thus reducing damage radius.

A major disadvantage of moored mines is that the mooring cable can be cut with mechanical sweep apparatus. When this occurs, the case floats to the surface and must be avoided or destroyed. Another disadvantage is that they can be affected by current and tidal variations that cause the case to dip below its intended depth, thereby reducing its effectiveness against a surface target.

Despite their susceptibility to mechanical sweeping, moored mines continue to play an important role. They can be moored so close to the surface that the smallest craft entering the field will be at risk. Additionally, mooring at different depths will add a vertical dimension to a minefield, creating a hazard to both ships and submarines.

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

1. Homing or 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 proximity to) a target. It does not incorporate a homing device to guide it to the target, but contains logic circuitry that enables it to calculate an estimated target location.

2.3.1.3 Moving Mines

Moving mines are classified in seven categories. Characteristics are shown in Figure 2-1.

1. Drifting mines:

   a. This is a mine that is buoyant or neutrally buoyant, but does not have an anchor or any other device to maintain it in a fixed position. It is free to move under the influence of wind, tide, or current. It may float at the water's surface or may be kept at a set depth beneath the surface by a depth-controlling hydrostatic device. It may be attached to a small piece of flotsam or other innocent-looking object, or even to another drifting mine. Two or more may be tethered together to increase the probability of striking a ship.

   b. Although banned from international waters by the 1907 Hague Treaty, these mines have been used on occasion. A drifting mine is classified differently from a moored mine that has become a floater, as a floater was designed to be anchored, while a drifter was designed to float freely with the tides and currents.

   c. The principal advantage of drifting mines is that their use is independent of bottom depth. The major drawback is that they scatter and may imperil friendly shipping. Consequently, drifters are usually fitted with devices designed to sink them after a short life span. As such, the most useful application has been in tactical situations in which they are placed in the path of an adversary to cause a delay or diversion.

2. Oscillating mines:

   a. This is a drifting mine that regulates its depth by means of a hydrostatic control mechanism.

   b. The hydrostatic control mechanism causes it to oscillate at or near a preset water depth, which permits the mining of waters that are too deep for bottom or moored mines.

3. Creeping mines:

   a. This is a modified version of a drifting mine with a buoyant case and attached weight (usually a chain). The weight is heavy enough to hold the mine near the bottom, yet not heavy enough to hold it in place.

   b. They are known as creeping mines because they move along the bottom with tidal streams or currents.

Mine Characteristics	Water Depth In Meters (Feet)				
	Surf Zone 0–3 (0–10)	**Very Shallow Water (VSW) 3–12 (10–40)**	**Shallow Water 12–24 (40–80)**	**Intermediate Water 24–304 (80–1,000)**	**Deep Water 304+ (1,000+)**
Mine Type	1. Ground 2. Antitank 3. Antiperson	1. Ground 2. Moored 3. Drifting	1. Ground 2. Moored 3. Propelled 4. Drifting 5. Rising	1. Ground 2. Moored 3. Rising 4. Drifting	1. Moored 2. Rising 3. Drifting
Size	Very Small	40–200 kg 90–440 lb	40–1,200 kg 90–2,650 lb	220–1,200 kg 485–2,650 lb	220–1,100 kg 485–2,425 lb
Expected Sensor Type	1. Contact 2. Trip Wire 3. Magnetic 4. Tilt Rod 5. Pressure Plate	1. Magnetic 2. Acoustic/Seismic 3. Pressure 4. Contact	1. Magnetic 2. Acoustic/Seismic 3. Pressure 4. Contact	1. Magnetic 2. Active/Passive 3. Acoustic 4. Contact 5. Underwater Electric Potential (UEP)	1. Active/Passive 2. Acoustic 3. Contact
Multiple Influence	Not Likely	Likely	Likely	Likely	Likely
Delivery	1. Surface 2. Helicopter 3. Fixed Wing Air	1. Surface 2. Helicopter 3. Fixed Wing Air	1. Surface 2. Submarine 3. Fixed Wing Air	1. Surface 2. Submarine 3. Fixed Wing Air	1. Surface 2. Submarine 3. Fixed Wing Air
Counter-Countermeasures Features	1. Shape 2. Burial 3. Case Materials 4. Large Numbers of Mines	1. Shape 2. Logic 3. Case Materials 4. Delay Arming 5. Ship Counts 6. Burial 7. Variety of Types and Settings In Same Minefield	1. Logic 2. Case Materials 3. Bottom Sitting 4. Delay Arming 5. Ship Counts 6. Burial 7. Variety of Types and Settings In Same Minefield	1. Logic 2. Bottom Sitting 3. Delay Arming 4. Ship Counts 5. Burial	1. Logic 2. Delay Arming 3. Ship Counts
Purpose or Target	1. Personnel 2. Tanks 3. AAAV 4. LCAC 5. Conventional 6. Landing Craft	Same as SZ (less Tanks)	1. LCAC 2. AAAV 3. Conventional 4. Landing Craft 5. Sweep Gear 6. MCM Craft	1. Sweepers 2. Landing Craft 3. Transports 4. Combatants 5. LHD 6. LHA	1. Aircraft Carriers 2. Combatants 3. LHD 4. LHA

Figure 2-1. Mine Types by Depth of Water

4. Mobile mines:

    a. Mobile mines are munitions with propulsion equipment similar to that of a torpedo.

    b. The mines sink at the end of a prescribed course and become ground mines.

5. Homing mines:

    a. Propelled ordnance with guidance equipment that homes onto a target.

    b. It rests on the seabed or is anchored until actuated by a ship's influence.

6. Rising mines:

    a. Having positive buoyancy, it is released from an anchor by a ship's influence and rises to a predetermined depth.

    b. It may fire by contact, hydrostatic pressure, or magnetic field.

7. Bouquet mines:

    a. A number of buoyant mine cases attached to the same anchor.

    b. When the mooring of one mine case is severed, another rises to take its place.

2.3.2 Methods of Actuation

Naval mines are actuated by three primary methods:

1. Contact

2. Influence

3. Command-control.

2.3.2.1 Contact Mines

Contact mines are the oldest and perhaps the most commonly known naval mine. A contact mechanism initiates the firing sequence and actuates the explosive charge. For detonation, the target must touch the mine case or a contact-responsive mechanism attached to the case. Typical contact firing mechanisms include the following:

1. Inertial switch:

    a. Inertial switch mechanisms consist of a freely suspended contact positioned between a number of stationary electrical contacts.

    b. When the mine case is tilted or jarred by contact, the suspended contact will engage one of the stationary contacts and energize the firing circuit.

2. Chemical horn:

    a. Chemical horn mechanisms contain a fragile vial used to separate an electrolyte from the battery electrodes.

    b. The vial ruptures when the mine case is hit, allowing the electrolyte to flow between the electrodes. This action energizes the battery and activates the firing circuit.

3. Switch horn:

    a. Switch horn mechanisms consist of a spike that is connected to one terminal of a firing circuit.

    b. 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:

    a. Galvanic action mechanisms use seawater as the electrolyte. A copper antenna or copper horn is attached to the mine case and connected to a firing mechanism.

    b. When the horn or antenna comes into contact with the steel hull of a ship, a current is generated that actuates a relay and the firing circuit.

    c. The antennae generally take the form of wires suspended above the mine by a float.

5. Snagline:

    a. A snagline mechanism is a contact mine with one of the horns or switches attached to a buoyant line.

    b. The line may be caught and pulled by the hull or propellers of a ship.

2.3.2.2 Influence Mines

Influence mines are fired by the effect of a target-created influence in the vicinity of the mine, or by radiation emanating from the mine.

The sensitivity of an influence mine determines the strength of the influence field needed to actuate it. The higher the sensitivity, the less influence required. The sensitivity of most influence mines can be adjusted to suit their purpose. Adjustment can rarely be optimized, so that when choosing mines for a particular field, several types may have to be considered. Influence mines are generally not deployed with only a single influence sensor. These sensors can be very vulnerable to natural phenomena and to MCM. They usually use two or even three sensors, with a frequently found combination being magnetic-acoustic. Both influences have to be satisfied before the mine is actuated.

The change in magnitude of the field and rate of change of the field required for firing is referred to as mine actuation level (MAL).

With influence mines, the firing mechanism is actuated by the change in the physical environment caused by a target's presence. A craft generates a variety of influence signatures, such as magnetic, acoustic, and pressure. Influence mechanisms are designed to sense these signatures. One or more detectors 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 analyzes the signal to determine whether it was generated by a valid target (i.e., an adversary vessel of a given size). If it is determined that a valid target is present, the firing mechanism triggers a mine actuation.

Combination influence mines consist of acoustic, magnetic, and pressure-firing mechanisms assembled together, each responsive to its own influence type. Each sensing mechanism must receive the appropriate signal in a specified period of time for detonation to occur. Systems with a combination of influences are available in most firing devices. These 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. Combination influence sensors are much more difficult to sweep than single influence sensors.

2.3.2.2.1 Magnetic

Magnetic sensors respond to a change (or rate of change) in magnetic field. They may be based on magnetic dip needle, induction coil, Hall effect, or magneto-resistance fluxgate. Sensitive magnetic mines may be used against SMCM or degaussed ships.

Magnetic firing systems respond to either the vertical or horizontal components of the magnetic field or the total magnetic field. There are two main categories: those that depend on the amplitude of the magnetic field and those that are actuated by a certain rate of change in the field.

Magnetic mines can be made sensitive to either the vertical or horizontal components of the craft's field by using a search coil. The coil is a high magnetic permeability core, wound with many thousand turns of wire. When the magnetic field changes, current is induced in the turns of the coil. This current operates a relay or other device. The greater the rates of change in the field, the greater the current induced.

The useful sensitivity of a magnetic mine sensor is limited by natural phenomena, such as geomagnetic noise, lightning discharges, and magnetic sun storms. Increased sensitivity requires improved signal processing, enabling valid targets to be distinguished from natural sources.

A magnetic influence mechanism is designed to sense a change in the Earth's magnetic field caused by a craft. The two types of mechanisms are magnetic dip needle and magnetic inductance.

1. Magnetic dip needle:

   a. A magnetic dip needle mechanism contains a horizontally pivoted, delicately balanced magnetic needle designed to pivot far enough on its axis to close a firing circuit.

   b. 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.

   c. The needle pivots in response to the change in the total vertical magnetic field caused by the presence of a ship.

2. Magnetic inductance:

   a. There are three types of magnetic inductance mechanisms:

      (1) Search coil

      (2) Total field magnetometer

      (3) Thin film magnetometer.

   b. Although the detection methods differ, each of these inductance mechanisms are capable of generating an electrical impulse sufficient to actuate a sea mine's firing circuit.

   c. The electrical impulse is generated in response to a designated rate of change in the magnetic field intensity caused by a passing ship.

2.3.2.2.2 Acoustic

Acoustic influence mechanisms consist of passive microphones and associated circuitry for detecting underwater noises, and active transponders that transmit signals and receive echoes from a previously acquired target. Passive mechanisms consist of hydrophones that are responsive to the characteristic frequency, intensity, and duration of noises generated by a ship's propeller, engine, machinery, or hull.

A craft produces characteristic sounds that can be exploited by the mine designer. Many earlier mine circuits contained a vibrator or hydrophone and were designed to respond to a particular frequency or combination of frequencies. Countermining protection was added to prevent the mine from being actuated by a sudden noise peak, such as that caused by a nearby explosion. Some modern sensors require not only a defined noise level but also a rate-of-change requirement. Mines of this type can avoid being swept by explosives. It is possible for the designer to select any frequency range for a mine from virtually the entire spectrum created by the ship. For convenience, the sound spectrum is divided into low frequency (LF) (below 30 Hz), audio frequency (AF) (30 to 15,000 Hz), and high frequency (HF) (15,000 Hz and above).

1. LF Mines. The lowest frequency that can be effectively used is about 2 Hz, intended for use in the open sea. The LF band has two major advantages to mine designers.

   a. It is difficult to produce low frequencies in a sweep without the gear being cumbersome and severely restricted in the range of frequencies produced.

   b. Frequencies are generated by sources in the target that do not respond to silencing techniques.

2. AF Mines. The AF band offers a great range of sensitivity. AF sensors can be directional, but they are susceptible to transmission anomalies that can cause the mine to miss valid targets.

3. HF Mines. These sensors can be designed to be directional. It is possible to design a mine that responds only to HF noise originating from within a cone above it, so that it actuates when the ship is directly above. The HF waves can also be generated in the mine, and the echo received from the hull of the ship is used to actuate the mine (active acoustic mine).

4. Multiple Frequency Mines. A mine can be designed so that sound must be received at two or more frequencies before it actuates. The mine will actuate only if the sound pressure level at each of the frequencies is consistent with the sound spectrum of a ship.

Acoustic mines are also categorized as either active or passive:

1. Active acoustic:

   a. An active acoustic mine is actuated when an acoustic signal emitted by the mine is reflected by the hull of a ship.

   b. Some employ a combination of passive and active sensors.

2. Passive acoustic:

   a. These mechanisms respond to a change (or rate of change) in acoustic sound pressure levels caused by noises resonating from the ship's hull, machinery, propellers, etc.

   b. Improved acoustic circuits may use a directionally discriminating transducer, resulting in improved firing range and discrimination against acoustic sweeps.

   c. Application of spectral analysis for discrimination is possible.

2.3.2.2.3 Seismic

This is a version of a passive acoustic naval mine that uses geophone elements to detect acoustic energy emanating from a ship and transmitted through the ocean bottom, rather than from the water shaking or vibration through the mine case.

2.3.2.2.4 Pressure

Sensors detect the low pressure zone created beneath a moving ship's hull. This system may be affected by surface wave action. As a result, it is used primarily in sheltered waters and only in combination with another influence mechanism. The advantage of this system is that it is impossible to simulate the pressure signature of a target ship without actually towing a decoy vessel, making it very difficult to sweep. The firing system may be improved by application of a linear sensor and a data processing unit for small target selection, swell discrimination, and better target location.

The hydrostatic pressure change caused by a passing craft is slight. The pressure mechanism must be capable of detecting this small deviation, while ignoring larger changes caused by wave action.

1. Swell. Sea swell may produce pressure fluctuations that can cause an actuation without an actual target. To counter this, pressure mines commonly require a magnetic or acoustic look to confirm that a valid target is present.

2. Effect of Mine Burial. The response of a pressure mine buried in the seabed depends on the design. In some cases, pressure changes in the sea communicate relatively easily through sediment. Do not assume that burial diminishes danger.

2.3.2.2.5 Underwater Electric Potential

Underwater electric potential (UEP) influence mechanisms make use of electric current flow that occurs when dissimilar metals 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 from different metals. This electric current flows through the water around the hull and is measured and sensed by properly designed mine mechanisms.

2.3.2.3 Command-Control Detonated

These are mines that can be command detonated by the user. A control station generally directs the firing mechanisms of these mines ashore, although it is possible to locate this station afloat. They receive their firing signals through wired control cables running from the land-based control centers to the mines. They are fired by individuals in the station who track targets until they are within the damage radius of the mines. However, a monitoring device affixed within a mine case may also achieve detection and localization of targets. These mines are traditionally used as defensive weapons to protect harbor approaches, but they can also be used offensively. In some designs, the actuation control may be switched to an automatic mode, in which case each weapon becomes an influence mine. Examples of command-control mines follow.

2.3.2.3.1 Cable

Cable-controlled mines allow the user to make the mine safe, live, or to fire it at a particular moment. They may contain detection mechanisms that signal ship presence, or may be operated in conjunction with a separate means of detection. Mining of protective harbor approaches or in proximity to an anchorage is the most useful cable application.

2.3.2.3.2 Cableless Remote Controlled

Control may be achieved by several means, including shore station transmissions via extreme low frequency (ELF) and transmissions via explosive or acoustic communications link from shore, surface ship, submarine, or aircraft. Depending on the degree of control available, reliability of the control method, and resistance to countermeasures and detection, they can be used for defensive or offensive purposes.

2.3.3 Intended Target

When classified according to the intended target, mines fall into eight primary categories: general purpose ground mine, deep water mine, anti-invasion mine, antisurface-effect vehicle mine, anti-SMCM mine, antisweeper mine, antiminehunter, and antihovercraft or antihelicopter mine.

1. General purpose ground mines are mines that are capable of being targeted against surface or submerged threats from a position on the seabed.

2. Deep water mines are used primarily against submarines in water depths greater than 300 m (1,000 ft).

3. Anti-invasion mines are used in SZ and VSW against landing craft, breaching platforms, and amphibious assault vehicles.

4. Antisurface-effect vehicle mines are used against high-speed surface effect vehicles, typically in shallow or very shallow water.

5. Anti-SMCM mines target MCM ships. Types include shallow water moored, snagline, highly sensitive magnetic (designed for degaussed ships), and medium-actuation level acoustic mines.

6. Antisweeper mines are aimed at SMCMs towing a sweep. Types include moored mines fitted with grapnel devices, medium-actuation level magnetic mines that will detonate within the damage area of the ship, and coarse acoustic mines for the sweeper towing an acoustic sweep abeam.

7. Antiminehunter mines are mines that are designed and laid with the objective of sinking or damaging minehunters. The sonar beam can trigger actuation.

8. Antihovercraft or antihelicopter mines have target detection and firing systems that are particularly discriminating because of unique craft signatures. They are designed to cause plume and fragmentation damage.

2.3.4 Method of Delivery

Mines classified according to method of delivery fall into three categories: aircraft-, submarine-, and surface-laid.

2.3.4.1 Aircraft-Laid

Aircraft are the preferred means for most offensive minelaying because they can penetrate areas denied to surface ships and submarines. Air-delivered sea mines are dropped in the same manner as bombs, and most aircraft equipped to carry bombs can carry a similar load of mines. These mines are specially crafted for air delivery, and they are designed so that they will not be damaged upon water entry.

There are a number of other advantages associated with aerial mining. When compared to the other delivery platforms, aircraft have a faster reaction time and can respond quickly to a mining mission. They are the only delivery platform that can replenish an existing field without being endangered from previously laid naval mines. They can be used to mine adversary inland waterways and shallow bodies of water, including rivers and harbors that cannot be reached by submarines or surface craft.

There are two major disadvantages to aerial mining. Weapon loads are relatively small unless large, cargo aircraft are used for delivery. Accuracy may also be sacrificed when aircraft, vice surface ships, are employed.

2.3.4.2 Submarine-Laid

Submarine-delivered mines are normally used in covert offensive operations. They are specially configured to be launched from torpedo tubes or mine belts. Submarines are effective because they can penetrate areas that are well protected by air and/or surface craft. Submarine delivery is the preferred method when secrecy is paramount.

When required by operation order (OPORD) or specified by the combatant commander, capable SSNs can be made available and loaded with mines. This requirement must be anticipated well in advance. A disadvantage is that there are limited numbers of SSNs available, and they are frequently dedicated to other missions. They also have a limited mine-carrying capacity and a relatively slow reaction time. Further, in order for an SSN to conduct a mining mission, it must be recalled to a port where it can off-load torpedoes and load mines.

2.3.4.3 Surface-Laid

U.S. mines would require extensive engineering modifications to be emplaced through surface means. This method of delivery requires control of the sea area and is therefore considered to be a suitable delivery method for defensive fields only.

Surface ships offer two major advantages. They are able to carry a much larger payload per sortie than aircraft or submarine, and they deliver with much greater accuracy than aircraft or submarine.

Outweighing these advantages, however, is vulnerability to attack. A surface minelayer can only be effective if the areas being mined and the surrounding air space are under friendly control. In addition, their reaction time is slower than air-delivered mines because of their transit speed. They must move to a location where they can load mines and then transit to the delivery location.

2.4 MINE COUNTER-COUNTERMEASURES FEATURES

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

The various types of MCCM devices available include the following:

1. Those that force the MCM equipment to replicate a ship
2. Those that attack SMCM assets
3. Those that make MCM physically more difficult (e.g., obstructors, pass-through devices, and ship counts)
4. Those that render the mine insensitive at predetermined times.

Some of the more important MCCM accessories and concepts are identified in the following paragraphs.

2.4.1 Combination Influences

Combination influences prevent the exploitation of any vulnerability that exists within a single-influence mine.

2.4.2 Delay Arming

The arming delay consists of a timing mechanism, usually a clock, that keeps the arming circuits open for a preset time after emplacement. The delay can vary from a few hours to more than a year, and during this time, sweeping is ineffective because the mine cannot be actuated. When the arming delay lapses, the mine is armed.

2.4.3 Ship Counter

A ship counter can be used on influence mines to delay detonation until the firing mechanism is satisfied a predetermined number of times. Hence, 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 activated to enumerate a ship count. When it has been actuated a preset number of times, the firing circuit is closed and the mine is said to be "poised."

2.4.4 Probability Actuation Circuit

The probability actuation circuit (PAC) can be used instead of a ship counter. It allows the mine to be active for only a specific number of seconds out of any given time period. When it is not active, valid ship or sweep signatures will not be registered, and it will not actuate.

2.4.5 Intermittent Arming

An intermittent arming mechanism is used to periodically arm and disarm the mine.

2.4.6 Delayed Rising

Delayed rising mechanisms are devices used with moored mines that enable the release and rising of the mine to be delayed. They are used in moored mines for the same purpose as delayed arming in bottom influence mines. Release may occur after a preset time or as the result of an influence from a passing ship or sweep. The depth at which such mines can be laid is normally limited by the crush-depth of the case.

2.4.7 Interlook Dormant Period

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 a different level of influence intensity. The interlook dormant period (ILDP) is a specified period of time between influence looks during which time the weapon becomes inactive or dormant.

2.4.8 Intercount Dormant Period

The intercount dormant period (ICDP) is a specified period of time between ship counts in which an influence mine becomes inactive or dormant. This feature is used so that a single pass of a sweeper is unable to satisfy more than one ship count.

2.4.9 Live Period

This is a time interval during which a specified event, usually a second look, must occur to satisfy the firing logic of the influence mine.

2.4.10 Sterilizers

A device called a sterilizer can be installed to render the mine inoperative on expiration of a specific period. It may take the form of a device to disable the batteries, fire the mine, or flood the case.

2.4.11 Anti-Sweep Wire Devices

Anti-sweep wire devices can be included in mine moorings to combat mechanical sweeping.

2.4.11.1 Chain Moorings

Chain moorings are lengths of chain fitted to moored mines that cannot be cut by wire sweeps. Because of the weight of such moorings, they usually extend only the first few fathoms below the mine case and are not likely to be used in deep water.

2.4.11.2 Sprocket

The sprocket is a device that allows the sweep wire to pass through the mine moorings without cutting the cable.

2.4.11.3 Grapnel

Mine moorings can be fitted with a grapple designed to grasp the sweep wire during the process of cutting the mooring, damaging a portion of the sweep gear, or endangering the sweeper when it attempts to recover the gear.

2.4.11.4 Cutters

Static or explosive cutters can be fitted to cut the sweep wire.

2.4.11.5 Sensitive Tubing

The upper end of the mine mooring may be fitted with tubing designed to actuate the mine when the sweep wire causes a sudden pressure change.

2.4.11.6 Cut-Resistant Mooring

A material such as fire hose, rubber-covered manila line, or piano wire may not be cut cleanly by either explosive or mechanical cutter. This may cause the mine to become ensnared in the sweep wire and endanger the ship during recovery operations.

2.4.11.7 Mooring Level Safety Cut-Out Switch

The mooring level safety cut-out switch normally renders-safe a moored mine upon breaking adrift or being swept. In order to leave the mine fully armed while drifting and liable to detonation during recovery, a bypass can be placed in the circuit. The Hague Convention forbids the use of the drifting mine, except for short-term use. This has not prevented some nations from using them.

2.4.11.8 Antiwatching Device

This device can be placed in a moored mine causing it to sink should it float on or near the surface. This prevents the mine, or minefield, from being exposed.

2.4.11.9 Antirecovery Switch

A hydrostatic switch is often incorporated in mine design to prevent actuation for a certain period after placement. Additional contacts can be incorporated in the switch to fire the mine or keep it armed when it is lifted above this depth.

2.4.12 Obstructors

Floats or empty mine cases, supporting either heavy chains or cables with cutters attached, can present a substantial obstacle to a standard wire sweep. They can also be designed to explode, severing the sweep wire.

2.4.13 Antiminehunter Devices

The following means of preventing detection by minehunting sonars may be encountered:

1. Anechoic coating and camouflage include anything done to a mine case to make it more difficult to locate and identify.

   a. Coatings applied to the exterior of a metallic case to reduce its acoustic reflection.

   b. Nonmetallic cases:

      (1) To reduce sonar reflectivity, modern mines are being manufactured from an increasing variety of composite materials.

(2) Many materials do not generate an acoustic return when prosecuted by minehunting sonar, making them more difficult to detect.

c. Irregularly shaped cases that do not reflect the type of sonar image considered to be minelike.

(1) Mine shapes have few limitations.

(2) Mine shapes have been designed to reduce sonar signature, mask its presence, blend with the background, and promote growth of organic sea life.

2. Nonsympathetic detonation:

a. Sensitivity settings can be incorporated into influence mines to ensure that they are not affected by sympathetic detonation (when a ship or a sweep actuates one mine, causing other mines in the field to detonate).

b. The minimum spacing between any two mines must be specified in advance.

3. Dummy mines or sonar decoys:

a. Minelike objects or sonar decoys can be placed in a field to complicate hunting.

b. Any object that produces such an image on sonar could be classified as a dummy mine.

c. Each must be classified, or marked and avoided, when they are identified.

2.4.14 Antisweeper

Mines can be planted in such a way as to target surface minesweepers. These may be moored contact mines set just below the surface or bottom influence devices that have extremely sensitive actuating mechanisms.

2.4.15 Antirecovery, Self-Destruct, and Antistripping Features

Mines may be equipped with various features to prevent adversary exploitation. These may include hydrostatic switches that detonate 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 its components. These features represent a significant threat to UMCM divers conducting any render-safe or recovery operations.

2.4.15.1 Prevention of Stripping Equipment

Prevention of stripping equipment (PSE) is essentially a booby trap, contrived to fire when an attempt is made to open any access.

2.5 MINE DAMAGE TO SHIPS

There are three types of ship damage that can be inflicted by a mine detonation:

1. Hull rupture caused by the pressure wave

2. Internal damage to equipment caused by vibration and flooding

3. Structural damage caused by the whipping motion of the bubble pulse.

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

1. Magnitude of explosive force
2. Shock resistance of a particular target.

The magnitude of the explosive force that the target is exposed to depends 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).

Resistance to an underwater explosion is dependent on the ship type, construction, age, history, and the state of machinery maintenance. The amount of damage also depends upon whether the mine was in contact with the ship when it detonated. Contact detonations result in an inefficient concentration of the shock wave energy, whereas detonations not resulting from contact usually result in a full shock wave and bubble pulse cycle.

2.5.1 Vulnerability

Target vulnerability is based on the target actuating the mine and the mine explosion damaging the target. Targets (such as transit ships, MCM ships, and MCM gear) can actuate a mine by passing within its influence range. The detonation can damage the target if it is within the damage contour. The calculation of vulnerability is a three-part process that entails calculating the probability of actuation as a function of lateral range, damage contour, and the probability of damage as a function of lateral range.

2.5.1.1 Damage Contour

Damage contours are calculated to depict the range at which a platform (e.g., MCM surface craft) will sustain a given level of damage from a mine detonation. The methodology used to develop damage contours provides a low fidelity estimate and is predicated principally on mine warhead size and theoretical platform damage criteria. More detailed, higher fidelity calculations can be derived based on precise structural properties of the platform and the propagation of shock waves through the platform. This more precise estimate is only sought if there is a specific requirement and if ample time is available.

Each target and warhead has a damage contour that represents the range, as a function of ship-charge geometry, at which a fixed level of damage is expected to occur from that warhead. Damage contours for surface ships are two-dimensional. Categories of damage contours as a function of damage criteria or warhead size are often presented.

The level of damage depends upon the distance from the mine to the target, mine warhead size, and the damage criteria. The damage criteria depends upon the amount of damage expected (i.e., sinking or destroying the target [mission abort], reduced capability [mission degradation], or minor damage that has little impact upon operability).

The damage contour measure of performance is based on the warhead size of the mine, the damage criteria, range from the keel of the ship to the mine, and the water depth of the mine. The standard damage level is based on shock factor and equates to mission abort. The shock factors for classes of ships are classified and can be found in several official documents. A radius sometimes represents the damage contour.

2.5.2 Damage Area

The damage area of an MCM ship is an area such that a mine exploding anywhere outside of the area will not do sufficient damage to significantly interfere with MCM operations.

2.5.3 Contact Mine Damage

When a mine explodes in contact with the hull of a ship, 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, 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 a severe blast, causing further damage.

If a hole opens into an air-filled space within the ship, most of the gas will vent into the ship and expand along 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, or bulkheads. In a submerged submarine, the internal pressure will increase as explosive gases enter through the rupture. Seawater flooding immediately follows.

2.5.4 Noncontact Mine Damage

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

2.5.4.1 Initial Shock Wave

The most dangerous element in underwater explosions is a high-pressure pulse called the initial shock wave. Although other phenomena increase ship damage, the initial shock wave produces the most violent results. Approximately 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 vessel. 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, which will increase the ship's vulnerability to other effects of the explosion, such as hull whipping. Some injuries may be caused by the initial shock wave, but most will result from other effects of the explosion.

2.5.4.2 Hull Whipping

After the initial shock wave, the next destructive effect of an influence mine is gas bubble expansion and the resulting water displacement. This process is known as 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 likely be damaged. Hull plating may not rupture, but the ship will likely suffer a "mobility kill" due to damage to engineering and combat systems equipment.

2.5.4.3 Gas Bubble Behavior

The high-temperature gases generated by an explosion expand rapidly, regardless of hydrostatic pressure (hydrostatic pressure is about 45 psi at 100-ft 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. Given the violent nature of the explosion, bubble expansion occurs so rapidly that it extends 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 approximately ten times the hydrostatic pressure. At this point, the gas bubble reaches the first minimum and contraction abruptly ceases, causing another shock wave. The elapsed time depends upon the depth and weight of the explosive, but for MIW considerations, it is less than one second. The internal pressure built during the collapse causes another expansion to the second maximum. The process continues for up to ten 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 lb of TNT in 40 ft of water will cause an explosion that has only one expansion. Bubble gases will vent into the atmosphere upon reaching the first maximum, with water rushing in to fill the void. In another example, 300 lb of TNT in 300 ft of water will cause a gas bubble that expands and collapses four or five times before venting to the surface.

2.5.4.4 Energy Transmission

As stated earlier, the initial shock wave contains 50 to 55 percent of the energy from an explosion. The generated gas bubble contains the remaining energy. The first expansion expends 5 to 10 percent (depending on depth), while the second shock wave carries off approximately 20 percent. Successive contractions send off smaller shock waves. By the end of the second contraction, about 85 percent of the energy is dispersed. 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 shallow water and the vicinity of boundaries (such as the bottom or a ship hull), a more dramatic energy conversion takes place. The bubble expansion violently displaces water, which pushes movable objects before it. There is a reversal of water flow when the bubble collapses, which carries movable objects back toward the center.

2.5.4.5 Secondary Shock Wave

Gas bubble pressure at the first minimum is approximately 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 ten 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.

2.5.4.6 Bubble Migration

The bubble pulse tends to migrate toward a negative pressure zone, such as that generated by the hull of a surface vessel traveling through the water.

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

If 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 occurs on the boundary side. However, water on the side away from the boundary will return to the vicinity of the boundary on successive collapses, causing additional vibrations to ship hull plating.

2.5.4.7 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) to potentially cause damage to ships, landing craft, or even aircraft in its vicinity.

2.6 U.S. NAVY AND ALLIED MINES

2.6.1 U.S. Navy Service Mines and Mine Characteristics

The U.S. mine inventory consists of air- and submarine-delivered, influence-actuated mines. The smallest mine is in the 500-lb category and the largest is 2,000 lb. There are no drifting mines in the inventory, nor are there contact or controlled mines. The U.S. mining program is designed to support offensive, defensive, and protective mining operations. If the United States required a defensive minelaying capability, new sea mines (or extensive engineering modifications) would be required.

2.6.1.1 Mine Mk 56 (IOC 1966)

The Mine Mk 56 is the oldest service sea mine in the U.S. inventory and is equipped with flight features for aerial delivery. It is a 2000-lb, aircraft-delivered, moored influence device that consists of an anchor, a buoyant case (containing 360 lb of HBX-3), and flight gear. It was designed for antisubmarine use and can be moored at various depths to create a vertical wall against submarine intrusion.

Featuring a nonmagnetic, stainless steel case and a cast steel anchor that is equipped with flight features for aerial delivery, 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, sterilization and 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 case rises towards 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. The burning propellant creates bubbles around the case, freeing it from the sediment. As it rises, a hydrostatic sensor is used to ensure that the mine case is moored at the correct depth. Should the mooring mechanism allow it to rise to a depth that is too shallow the case will scuttle itself, reducing the possibility of compromise and eliminating it as a hazard to navigation. This scuttling feature is also used if the cable breaks or if the mine is set to sterilize (rather than self-destruct) when it reaches the end of its preset, armed life.

2.6.1.2 QUICKSTRIKE Mines Mk 62 and Mk 63 (IOC 1985)

These are aircraft-laid bottom mines that provide a fast response-to-readiness capability. They are conversions of general purpose bomb bodies Mk 82 (500-lb) and Mk 83 (1,000-lb), respectively. The explosive weight of the Mk 62 is 196 lb (H-6) and the Mk 63 contains 453 lb (H-6).

Designed for use against both submarines and surface targets, they are capable of having various arming-delay, sterilization, self-destruct, and other operational settings emplaced. The firing mechanism, target detecting device (TDD) Mk 57 uses magnetic and seismic influences for target detection and validation. It can be set to respond to various levels of magnetic-only influences or a combined magnetic and seismic influence of the proper magnitude.

2.6.1.3 QUICKSTRIKE Mk 65 (IOC 1985)

The Mk 65 is a 2,000-lb aircraft-laid bottom weapon. Unlike the other QUICKSTRIKE mines, it is not a converted bomb. Instead, it is designed specifically to be a naval mine, and consists of a distinctly different, thin-walled mine case. The Mk 65 also has a specially designed arming device and nose fairing, and a tail section that is adaptable to a parachute option.

Designed for use against both submarines and surface targets, 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.

2.6.1.4 Mine Mk 67 (SLMM) (IOC 1987)

The Mk 67, more commonly referred to as the Submarine-Launched Mobile Mine (SLMM), is a 2,000-lb, submarine-laid bottom mine designed to target both surface ships and submarines. It may be covertly propelled to a predetermined location and can be placed in areas that are not normally accessible to other sea mines.

Consisting of a modified Mk 37 torpedo with an attached mine section, this system delivers the mine section to its intended location. The mine section contains the main explosive charge, blast initiator, arming device, target detection device, and the associated battery.

The Mk 67 can be set to respond to magnetic-only influences or combination magnetic-seismic influences. There are multiple sensitivity settings available for both the magnetic and seismic sensors, and numerous arming-delay, sterilization, and self-destruct settings.

2.6.2 Exercise and Training Mines

Exercise and training (ET) mines are reusable configurations designed for exercises. They use an inert-loaded or empty mine case that, in most cases, makes them resemble their service mine counterparts. Small explosive devices and/or pyrotechnics are contained in some ET shapes to provide realism in delivery and firing simulation and to aid in recovery operations. Specific descriptions of some common exercise and training mines follow.

2.6.2.1 Actuation Mines

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

Actuation mines consist of an inert-loaded case containing serviceable detection, firing, and safety devices. The bottom mine has an externally attached float that contains a pyrotechnic smoke signal and approximately 120 ft of nylon line for recovery. Upon actuation, it releases the smoke signal. At a preset time, the float is released, which enables recovery teams to locate and recover the mine. Actuation mines use a sonar transmitter (pinger) to aid in location and recovery.

These mines are painted orange and white to help distinguish the training mines from live ordnance and to enhance visibility during recovery.

2.6.2.2 Versatile Exercise Mine System

The Versatile Exercise Mine System (VEMS) is a microprocessor-controlled exercise mine. It is capable of emulating certain foreign sea mines or acting as a sensor data collection device. The mine is capable of recording the acoustic, seismic, pressure, and three-axis magnetic data produced during platform or system operation. In the emulation mode, VEMS replicates the foreign threat mine producing looks and fires in accordance with the influences being monitored. The recorded emulation parameters and sensor information can be used to evaluate MCM operations and tactics. Data from the mine can be gathered while it is in the water through the acoustic link, or when the mine is recovered and downloaded. The mine comes in two shapes and has an optional anechoic jacket to represent cloaked sonar targets for minehunting. VEMS features a remote, self-recovering system (initiated through the acoustic link), enabling recovery without diver assistance.

2.6.2.3 Laying Mines

Laying mines are used for emplacement training by delivery vehicles (aircraft and submarines). The shapes consist of inert-loaded cases (with weights in place of internal components) to provide a weight and center of gravity equivalent to service mine components. Complete and operable flight gear is employed with sea mines dropped by aircraft. Other components that operate with arming wires are also provided (minus explosives) and a sonar transmitter to aid in location for recovery. The case is painted orange with white stripes.

2.6.2.4 Diver Evaluation Unit

EOD mobile units are equipped with a diver evaluation unit (DEU) that although not a naval mine, simulates the sensor package of such a mine. The diver uses the unit to measure its reaction to his magnetic and acoustic signature. It is used for individual training and unit exercises and can also be employed in larger scale exercises to provide an effective training resource.

2.6.3 Mine Storage, Preparation, and Transportation

The U.S. Navy maintains service mines at prepositioned locations in CONUS and overseas, as well as on some aircraft carriers and ammunition ships. Those naval mines located on units afloat can be made available for delivery within 24 hours, but their type and number are limited. Those located at land-based storage facilities must be assembled and transported to the delivery platform. The time required to build these mines varies by type, but most can be prepared in less than 48 hours.

When land-based sea mines are needed for a mining mission, they must be transported to the delivery vehicle. This may be accomplished by truck, rail, cargo aircraft, or ammunition ship. The method will depend upon the number of mines that must be moved, the availability of transportation, point of origin, and destination.

2.6.4 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 a maritime area by surface ships or submarines. It 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 U.S. maintains a set of preplanned strategic minefields that are contained in minefield planning folders. These are designed by the COMINEWARCOM staff, as directed by the fleet commanders, and are promulgated in accordance with a distribution list provided in MFPF. The approved MFPFs are developed according to situations that may arise. They are reviewed and updated at regular intervals to ensure that they support the fleet commanders' OPLANs. However, when a minefield is actually being considered for execution, the preplanned fields may not be sufficient to support the desired objective, or there may not be a plan prepared for that area. In that case, the current plan will need to be updated or a new one developed. This process can be accomplished by COMOMAG, acting as the COMINEWARCOM ACOS for maritime mining requirements (if time permits), or it can be accomplished by mine planners assigned to the BG or air wing.

MFPF 00 serves as an index to all MFPFs, providing information about the uniform minefield planning system, how to use each folder, types of mines in the inventory, types of authorized delivery platforms, and the number of mines each can carry.

Individual MFPFs contain:

1. Recommended minefields identified by latitude and longitude

2. Recommended number and types of mines to be used in the minefield

3. List of priority targets for that minefield

4. Recommended mine settings for the priority targets identified by the commander

5. Options for different levels of threat

6. Recommended delivery platforms

7. Intelligence assessment of the adversary and the area to be mined.

During the minefield planning process, there are a number of factors that must be determined and evaluated. For example, the number and type(s) of mines planned for delivery to a specific minefield are dependent upon several variables, including the minefield's purpose and whether it is expected to be countered. Target types and environmental considerations also play a major role in the process. The operational commander or other higher authority must provide some of the required estimates to the minefield planner, while others are standard items that must be determined and evaluated by the planner.

2.6.4.1 Types of Mining Operations

Offensive mining is generally intended to destroy or disable adversary naval or merchant shipping, exposing minefields to concentrated MCM efforts. Therefore, the field will generally be planned using sophisticated mines with counter- countermeasure features. 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 field must be considered when selecting a means of delivery.

2.6.4.2 Types of Minefields

There are many different types of minefields, each having an impact on location, mine types, settings, and field sustainability. The following are examples of minefield types:

1. A closure field is planned to prevent all adversary movement and should present a threat severe enough to prevent adversary challenges. It may be sustained or unsustained, countered or uncountered. The planner attempts to achieve target damage whenever a naval mine actuates.

2. An attrition field is planned to cause enough damage to hinder adversary movements through the field. These may or may not be sustained.

3. A nuisance field is planned to force the adversary into taking countermeasures that delay his efforts, as well as influencing his operational maneuver. A nuisance field has an adverse effect on adversary movement until it is determined that the actual threat posed is relatively low. With this field, the planner is more concerned with obtaining actuations than actual damage.

4. An antisubmarine field is planned to specifically target submarines. It may be designed to target other ships as well.

5. A dummy field contains no live sea mines and presents only a psychological threat. Thus, it will adversely influence seaward operational maneuver. This may be very effective against an adversary without an MCM capability, or it may sufficiently delay traffic while the adversary conducts MCM before determining that the field is illusory.

2.6.4.3 Countermeasures

Expected countermeasures also affect the planning process:

1. A countered field is one in which the adversary is expected to employ MCM, and the planner must determine likely procedures. The use of mixed mines of varying ship counts and delay arms, as well as other counter-countermeasure features, are required to buttress the field's strength.

2. An uncountered field would be one in which the adversary is not expected to employ MCM. These fields would generally require a smaller number of less sophisticated mines that have few, if any, counter-countermeasure features.

2.6.4.4 Intelligence

Available intelligence plays a major role in the minefield planning process. It can be used to determine the primary and secondary targets and their expected transit patterns. The number and types of targets will affect which sea mines are used, as well as their settings. Available data regarding adversary defenses will also have an impact on the method of delivery, types of mines to be used, and field locale.

2.6.4.5 Measure of Effectiveness

A desired measure of effectiveness (MOE) must be designated for the minefield so that the planner has a quantifiable threat value to develop his scheme. The following five MOE are available for use.

1. Simple initial threat (SIT) is the most widely used effectiveness measure because it is easy to understand and plan. This is the probability of hitting the very first target that challenges the field. However, when this MOE is used, it does not provide any threat information for subsequent targets. It is very useful for fields where no MCM or infrequent ship transits are expected and is the only 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 ship of a given type in a sequence of transits. For example, if five targets are expected, this method can be used to determine what the threat would be for each in the sequence. It represents an extension of SIT.

3. Sustained threat is commonly used for countered minefields and provides an effectiveness measure to expected targets over a period of time.

4. Expected casualties is a measure that is useful to indicate the strength of a minefield. It is used to provide the average number of casualties expected to occur for a given number of transits.

5. Casualty distribution is the most useful effectiveness measure for minefields being planned against multiple targets. 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 process in which they will determine the field's specific location, delivery vehicles to be used, types and numbers of mines required, and mine settings. During this phase, planners must be aware of quantities and types of sea mines available, as well as delivery platforms at hand. When developing the situation, the actual site of the minefield or its segments must be determined. This is accomplished by surveying possible locations and determining which will best achieve the objective within given constraints. On-site environmental conditions will have an influence on mine types and quantities to be used. These conditions have far-reaching implications and are discussed later in this chapter.

Using all available publications and 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 for each. Some of the settings available are arming- or rising-delay, ship count, sterilization or self-destruct times, ILDP, and ICDP.

While a course of action (COA) for the desired objective is developing, logistics support must be examined. The required types and numbers of mines must be available within the time constraints required for emplacing the field, along with an ample number of delivery vehicles. If these assets are not available in the required numbers, it may be necessary to lower the desired threat level or revise the plan so they are delivered on time. The threat level is determined through discussions with the operational commander, who has the ultimate responsibility for the mine plan.

Mine and delivery vehicle availability are 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 acceptable risk to the aircraft. Availability and storage location of mines will also affect the plan, and because of availability, a less-effective mine may be used. Thus, during the initial minefield and mission analysis a best estimate of the situation is derived and applied. During the final mission planning, last-minute alterations may have to be made to accommodate a fluid situation.

2.6.5 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 of COMOMAG or the MIW staff at the BG or air wings.

2.6.5.1 Uncountered Minefield Planning Model

The Uncountered Minefield Planning Model (UMPM) program is available to the COMOMAG staff. It aids in the development of sophisticated COAs for an uncountered scenario. The model can be used either to determine how many naval mines are required for a specific situation, or to evaluate a possible plan to determine what a field's MOE would be. The program accesses a database containing damage and actuation information for a wide variety of mines and settings against various target types. This data for a specific mine versus target can be entered if it is not contained within the database.

2.6.5.1.1 Planning Mode

The planning mode of this model calculates only the number of mines required for a single mine type and sensitivity setting. Entered parameters are mine type, sensitivity setting, target, number of targets, their speed and navigational error, minefield width, water depth, desired damage level, and desired MOE. The planner will evaluate how different mines or different sensitivity settings will respond to a given circumstance. This can be done by successive iterations of the program, entering different variables for each iteration.

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 various MOE. For example, if the model is used to determine how many mines are required to achieve a 75-percent SIT for a given event, it would also determine what the sustained threat, expected casualties, threat profile, and casualty distribution are for that scenario.

2.6.5.1.2 Evaluation Mode

The evaluation mode of this model calculates only the number of mines required for a single mine type and sensitivity setting. In most cases, multiple mine types and multiple settings within a single minefield are used and the evaluation mode of the program can determine effectiveness. The data is basically the same as that required in the planning mode, except the number of mines must be calculated for each mine and setting combination to be evaluated, and the desired effectiveness is not entered. The resulting product will be the level of threat that the minefield provides.

2.7 U.S. AND ALLIED MINELAYING ASSETS

Mines reach their maximum effectiveness only when they are accurately positioned in time to be armed and ready for the transit of the first target ship. This requirement places the burden on operational forces to employ delivery vehicles with acceptable capabilities. As previously stated, mines may be delivered by aircraft, submarine, or surface craft. Selection depends on the various environmental and operational factors associated with each situation. The factors to be considered include:

1. Type of minefield (defensive, offensive, or protective)

2. Number and type of mines to be delivered

3. Number of sorties required

4. Defensive capabilities in area, attrition rate expected for delivery vehicles, and the need for standoff delivery systems

5. Environmental characteristics, such as water depth and bottom composition

6. Required accuracy in delivery

7. The logistics for coordinating stockpiled mines and delivery system.

2.7.1 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 sea mines of the same weight class. There are some constraints and limitations imposed by matching 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 can be corrected with existing adapters and modification kits, but the performance limitations imposed on high-speed aircraft are also factors. Range, weather conditions, auxiliary equipment, and armament must be considered, as each can affect the maximum permissible load aboard the aircraft. The tactical manual of the individual aircraft is the final authority on mine carriage.

2.7.1.1 Advantages of Air Delivery

There are a number of advantages associated with aerial delivery:

1. Aircraft can penetrate areas denied to submarines by hydrography or to surface ships because of adversary defenses and can replenish existing fields without danger from previously laid sea mines.

2. Aircraft have a faster reaction time than surface ships or submarines. When properly alerted, aircraft can respond quickly and cycle faster when multiple strikes or sorties are required. They can also get to the minefield quickly, especially from a forward-deployed CV.

3. Aircraft are generally more readily available and can typically complete their mining mission quickly, thus becoming readily available for other missions.

4. Aircraft can carry a wide variety of naval mines.

5. Aircraft have a virtually unlimited approach direction.

2.7.1.2 Disadvantages of Air Delivery

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 payload-per-sortie is relatively small except for large, cargo aircraft. However, this disadvantage can be overcome by their ability to rapidly execute multiple sorties.

2. Minelaying accuracy of aircraft is lower than for a surface ship but is adequate for offensive mining.

3. Many aircraft types can be restricted by weather conditions.

4. The range of aircraft is more restricted than that of surface ships or submarines.

2.7.1.3 Helicopter Delivery

It is possible to deliver sea mines by helicopter, but such use is inefficient due to limited range and carrying capacity. However, helicopters may have a role in replenishing defensive and protective minefields or in placing small barrier fields in rapid response situations.

2.7.2 Submarine Delivery

Submarines are most effective in areas that are too well protected for surface or aircraft delivery. Normally, they will be used in offensive fields, but may be used to lay defensive fields as well. This can take place day or night; surfaced or submerged. The availability of the SLMM enhances the submarine capability.

2.7.2.1 Advantages of Submarine Delivery

The advantages of submarine delivered mines are:

1. The secrecy with which a submarine can deliver naval mines over great distances to adversary ports or operating areas provides an overwhelming tactical advantage.

2. Mission radius.

2.7.2.2 Disadvantages of Submarine Delivery

The disadvantages of submarine delivered mines are:

1. SSNs cannot carry large payloads (must unload one torpedo for every two sea mines).

2. SSNs have a slow reaction time. If not preloaded with mines for a contingency, they must return to a port where torpedoes can be off-loaded and naval mines loaded.

3. Transit speed is slow when compared to aircraft delivery.

4. There are limited submarines available, and they have other competing missions.

5. The variety of mine types available is limited, and they must be configured to fit a torpedo tube.

2.7.3 Surface Delivery

This is the preferred method for protective and defensive minefields where transit distances are limited and the area to be mined is benign. Any surface ship can be configured to lay sea mines by hoisting or rolling them over the side or by using temporarily installed mine rails or tracks. Although minelaying ships of various types appeared on the Navy roster for about 60 years, there are no active surface ships in service today. However, should an operational requirement develop, this capability could be provided by crafting appendages and then engineering them to fit available ships. Suitable conversion of cargo ships is also an option. Some allies do have a surface minelaying capability.

2.7.3.1 Advantages of Surface Delivery

1. Able to carry a larger payload than aircraft or submarine minelayers

2. Surface assets have the ability to position mines more accurately than the other delivery assets.

2.7.3.2 Disadvantages of Surface Delivery

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

2. Surface minelaying is not covert.

3. They are vulnerable to attack, so they are not effective offensively.

4. Surface ships are unable to replenish existing minefields.

2.8 IMPACT OF ENVIRONMENT ON MINING

The environment plays a significant role in mining, with location being the first planning consideration. While sites (e.g., choke points, harbors, and ports) where traffic is physically constrained may appear preferable, critical environmental factors may override their use. These additional factors include water depth, prevailing sea state, sea ice, tides, currents, seawater temperature, and bottom conditions. Magnetic, acoustic, and pressure environments must also be considered. Figure 2-2 provides a matrix of environmental considerations for mining.

ENVIRONMENT		EFFECTS ON MINEFIELD			
FACTORS	DEPEND ON	GROUND MINE MECHANICS			MOORED CONTACT OR INFLUENCE
		ACOUSTIC	MAGNETIC	PRESSURE	
BACK-GROUND NOISE	1. Marine life 2. Swell 3. Waves 4. Tide 5. Rain	1. Field effectiveness reduced 2. Adjust sensitivity settings	Little/none	Little/none	Same as ground mine
MAGNETIC FIELD	Magnetic storms causing short periods of fluctuations	Little/none	1. Comparatively insignificant 2. Destructors (DSTs) may actuate	Little/none	Same as ground mine
MINE BURIAL	1. Bottom material 2. Current 3. Mine mass 4. Water depth 5. Layer		Little effect	Signal attenuation: 1. Shallow: Adjust sensitivity 2. Deep: Do not use	Burial greater than one meter may impede operation of rising-delay mechanism
BOTTOM PRESSURE	1. Waves 2. Swell	Little/none	Little/none	1. Stresses sensor 2. Reduces sensitivity 3. Aids MCM	Little/none
CURRENTS AND TIDES		1. Mine burial 2. Mine rolling	1. Mine burial 2. Mine rolling	1. Mine burial 2. Mine rolling	1. Dip depth of mine below surface 2. Mine walking
FOULING	1. Current 2. Temperature	Signal attenuation	Little/none	Unlikely to be affected	1. Greater dip 2. Mooring switches fouled 3. Bioluminescence
LUCIDITY OF WATER	1. Water movement 2. Bottom sediment	Visual detection by diver, television, helicopter, and surface craft			Detection enhanced in shallow clear water

Figure 2-2. Environmental Considerations in Mining

2.8.1 Water Depth

The primary concern is to choose waters where the mines will be most effective. A mine's probability of detection, damage radius, and physical integrity are affected by depth. If placed in water too deep, targets may pass without actuating the mine. If detonation occurs, damage may be negated. Additionally, if the water is too shallow, explosive power may be lost through surface venting.

2.8.2 Winds

Winds can have a direct impact on the sea state and swells, while also affecting the accuracy of air-delivered mines.

2.8.3 Seas and Swells

Dependent on wave height and water depth, a pressure sensor can be affected by the pressure signature of a wave. Under the right sea state conditions, an otherwise unsweepable pressure mine may become vulnerable because the prevailing pressure environment satisfies the sensor. Planners 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.

2.8.4 Sea Ice

An awareness of ice conditions can allow the planner to evaluate the use of a particular sea mine. For example, ice coverage is better for pressure mines, while increased ambient background noise may decrease 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 capricious behavior of naval mines under an ice cover and the difficulty of penetrating that cover.

2.8.5 Tides

Relatively shallow waters where moored mines might be used may be subject to large tidal variations. This can significantly alter the depth at which a mine moors. Selection of mooring depth is determined by total water depth, tidal ranges, and currents. If these factors are not considered, a large percentage of the mines may scuttle or (for certain periods) may be too deep to be effective.

2.8.6 Currents

Relatively high surface currents may affect the response of certain influence mines by changing the magnitude of acoustic and pressure influences generated by passing ships. They may also affect ground mines, especially on hard bottoms, by causing a rolling motion that results in false actuations. Where bottom currents and hard bottom conditions are known to exist, minefield activation delays may be needed for mines to settle. Currents can also cause problems for moored mines, causing the case to dip below its planned depth. Current and the length of cable between the case and the anchor determine the amount of dip.

2.8.7 Seawater Temperature

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

2.8.8 Water Clarity

Transparency varies between operational areas and is dependent upon the amount, absorption, and scattering of light by particles suspended in the water. In very clear water, mines will be visible and may be countered or avoided.

2.8.9 Marine Life

Fouling caused by marine life can degrade performance of acoustic sensors and can produce an increase in ambient background noise. It can also increase the amount that a moored mine case will dip.

2.8.10 Bottom Conditions

2.8.10.1 Topography

Slopes may allow a bottom mine to roll out of position and may cause a moored mine anchor to slide to the bottom of that slope. A rough or cluttered bottom may increase sonar reverberation, decreasing the effectiveness of hunting. A rough bottom can also reduce mine rolling.

2.8.10.2 Bottom Type

The nature of the bottom affects the degree to which a sea mine will bury itself. In general, a soft bottom, conducive to burial, is desirable for several reasons. A fully or partially buried mine is more difficult to locate by hunting. Some degree of burial will lessen the likelihood of movement (and any false actuation) in the presence of strong bottom currents. Burial has little or no effect on the sensitivity of a mine actuated by magnetic influence. However, acoustic and pressure influences may be compromised by burial. Rising-delay 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 sea mine first strikes the bottom. The amount of burial is dependent upon impact angle, impact speed, bottom composition, and the weight of the weapon. Grain size will also contribute to the amount of burial.

2. Scouring occurs as a result of bottom sediment being removed from around the 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 it settles into the cavity and is covered.

3. Sand-ridge migration is another form of burial that is induced by strong currents as sea mines migrate with the sand in the direction of that current.

2.8.11 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 operations are classified as either offensive or defensive.

3.1.1 Offensive Mine Countermeasures

Offensive MCM consists of any actions implemented to prevent the laying of mines, eliminating the requirement for a defensive MCM operation. The effective execution of offensive countermeasures can eliminate or substantially reduce the degree of risk that must be borne by operating forces, warships, submarines, and merchant shipping, as well as MIW platforms, systems, and personnel.

3.1.2 Defensive Mine Countermeasures

Defensive MCM operations are classified as either passive or active. Passive MCM are dynamic measures that tend to prevent engagement of the mine and target. Active MCM is reactive in nature and involves directly assailing mines. Figure 3-1 illustrates the relationships within this warfare specialty.

3.2 GENERAL WARFIGHTING CONSIDERATIONS

3.2.1 Composite Warfare Doctrine

This doctrine provides a set of operational principles applied through a basic organizational structure and is documented in NWP 10-1, Composite Warfare Commander's Manual. The essence of the doctrine is to provide a timely and controlled response to any threat detected by the battle group (BG). Heavy emphasis is placed on:

1. Assignment of surveillance responsibilities
2. Delegation of the reaction authority.

These assignments are made at each level of command consistent with the ROE.

The OTC can control the forces in two ways:

1. Centralized Control. Used for peacetime when restrictive ROE apply and in periods of tension when permissive ROE are in effect. The OTC retains all or most authority for defending the force and makes direct target assignments.
2. Decentralized Control. Best suited for dispersed formations or in a multithreat environment during hostilities when wartime ROE apply. The OTC, as the Composite Warfare Commander, delegates some or all authority to take action to defend the force. The OTC will thereafter become involved:
   a. If disagreement with actions planned or taken exists
   b. By making direct target assignments to ensure proper threat engagement
   c. To prevent meeting engagements between friendly forces.

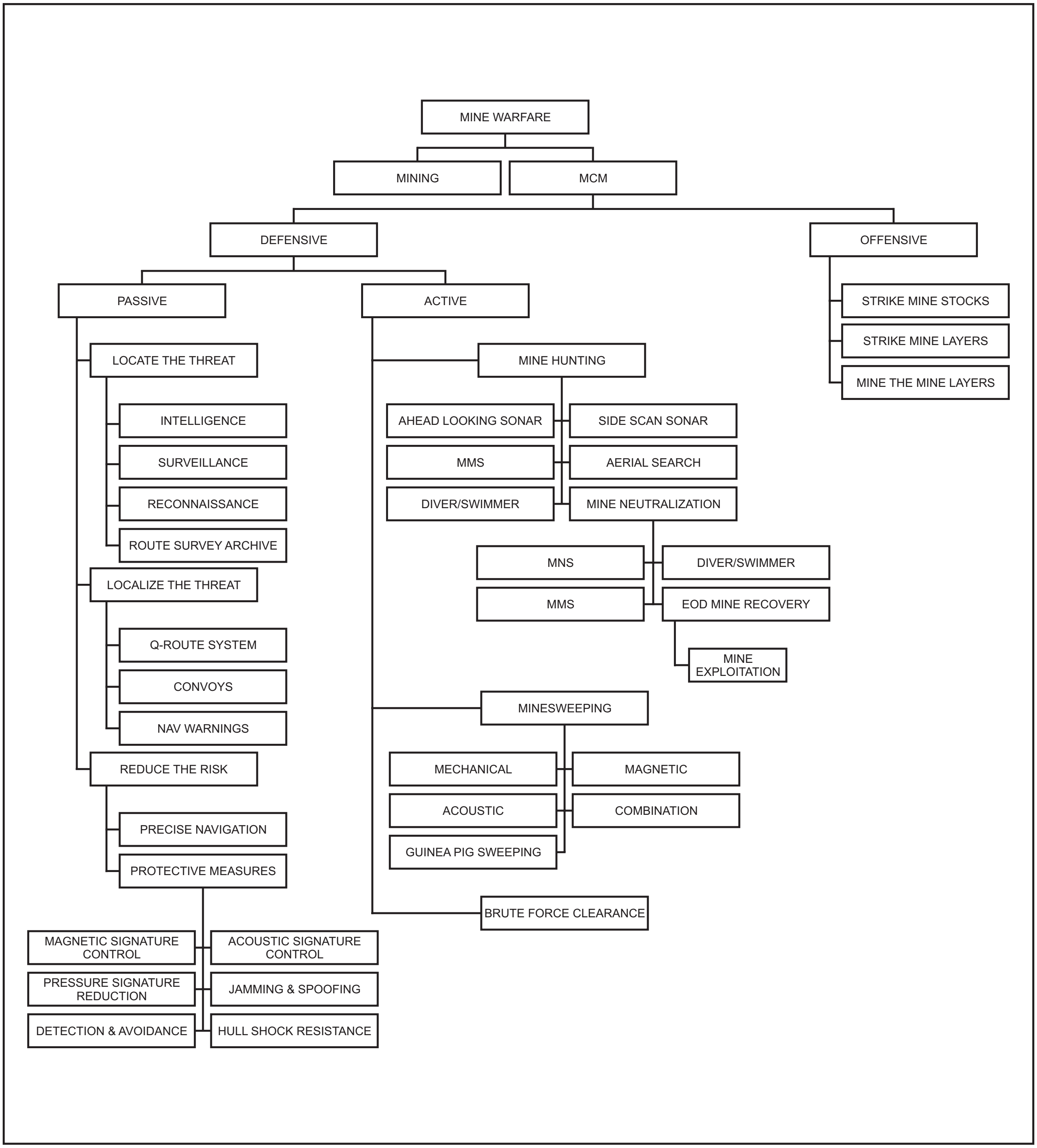


Figure 3-1. MCM Family Tree

The execution of MIW operations is extremely complex. The warfare area will be represented by a MWC. In this role, the MWC:

1. Acts as the single point of contact for MIW

2. Provides recommendations to the CWC and other warfare commanders

3. Provides guidance on how MIW operations fit into theater operations of the Fleet Commander.

The Navy-wide OPTASK for MIW expands on these basic tasks and provides detailed guidance for their application within the composite warfare doctrine. When an MCM squadron commander is assigned he should be designated the MCMC with charge of the entire MCM triad.

In addition to the basic duties listed above, the OPTASK directs the MWC to:

1. Make recommendations to assist in establishing the force disposition in the presence of a mine threat

2. Coordinate requests for all nonorganic mining and MCM support

3. Evaluate the implications of adversary MIW operations and recommend an appropriate MCM approach

4. Coordinate with the ASWC on all defensive minefield planning matters

5. Coordinate the employment of TACAIR in mining with the STWC

6. Ensure that mining operations are conducted in accordance with international law

7. Designate MDA

8. Maintain readiness status of MIW forces

9. Coordinate procurement of oceanographic support for mining operations.

The MCMC is charged with outlining BG MCM requirements, in advance of anticipated operations. The information is sent to the MCMC via the CWC and includes:

1. Geographic area

2. Oceanographic data

3. MCM support requested

4. Mine threat expected

5. Characteristics of the group involved

6. Estimated threat to the MCM force and available force protection assets.

CWC doctrine was developed to meet the threat of a command, control, and communications (C3) disruption that would lead to the inability to receive weapons employment guidance from superiors.

3.2.1.1 Standard Composite Warfare Commander Doctrine

The source document for afloat C3 is the NWP 10-1. It contains the standardized doctrine that:

1. Describes afloat C3

2. Establishes the relationships among different command levels

3. Provides guidelines for specifying the authority and types of activity to be performed or accomplished at each command level

4. Describes the function, authority, and activities of support organizations.

3.2.1.1.1 Command Structure Provisions

The command structure established by the CWC doctrine provides for:

1. Overall C2 vested in the OTC and CWC

2. Warfare commanders who exercise tactical control over forces consistent with the authority delegated by the OTC and CWC

3. Warfare coordinators who perform aircraft and sensor management functions

4. Supporting CWCs that may be established in special circumstances.

3.2.1.1.2 Designated Subordinates

CWC designated subordinates are:

1. Warfare commanders responsible for the conduct of AAW, SUW, and ASW. They are responsible for collecting, evaluating, and disseminating tactical information, and may, at the discretion of the OTC or CWC, be delegated authority to respond to threats with assigned forces.

2. Supporting coordinators who are responsible for assisting in the management of specified assets and sensors to support the warfare commanders and the CWC.

3. Warfare commanders and supporting coordinators differ in one very important respect. Warfare commanders have tactical control of resources assigned and may autonomously initiate action as authorized by the OTC or CWC. The supporting coordinators execute policy but do not have authority to initiate action.

3.2.1.1.3 Command Responsibilities

The OTC or CWC directs the efforts of the force in the manner best suited to the tactical situation. Factors that determine the amount of delegation of authority and control include mission, force composition, threat, proximity of warfare commanders to the CWC, and the ROE.

The OTC has overall responsibility for successfully accomplishing the mission. His offensive objectives cannot be delegated, but some responsibilities for certain defensive aspects may be. The CWC concept allows the OTC to decentralize close control of power projection and strategic sea control operations while delegating authority to counter threats. The OTC maintains tactical control.

The primary duties and responsibilities of each warfare commander include:

1. Planning force protection

2. Exercising tactical control of assigned forces

3. Collecting and disseminating pertinent tactical information and intelligence

4. Coordinating warfare plans and actions with the CWC and other warfare commanders and coordinators.

3.2.2 Protection of Mine Countermeasures Forces

The loss of MCM platforms may well be a decisive turning point in a campaign. Hence, it is imperative that force protection assets be assigned to shield the force from submarines, aircraft, and surface combatants. Artillery and other indirect or direct fire weapons will be factors in the littorals.

3.2.2.1 Surface Threat

The principal surface threat to MCM forces includes ship- or shore-launched missiles and shore-based fires.

The threat includes fast patrol boats armed with guns, rocket launchers, and torpedoes, as well as small suicide craft that may carry large amounts of explosives in an attempt to destroy SMCM assets.

3.2.2.2 Air Threat

The air threat may vary from sophisticated attack and fighter aircraft with a missile launch capability, to strafing or bombing, to general aviation or micro-light aircraft employed by terrorists.

3.2.2.3 Subsurface Threat

This threat ranges from submarines with missile and torpedo launch capability through smaller submersibles and swimmer delivery vehicles.

3.2.2.4 Mine Threat

Obviously, mines themselves pose a significant problem for the MCM forces. SMCM assets are in significant danger because they are actively seeking to locate, close with, and destroy mines.

3.2.2.4.1 Mine Threat Localization

The more that is known about the geographic location of the mine threat, the easier it is to plan, maneuver, and execute MCM. Methods to localize the threat and estimate its extent and significance include:

1. Minewatching. This includes surveillance of the area by observers, radar, and satellites.

2. Intelligence. Gathered to create an illustration of adversary intentions and minelaying operations.

3. Reconnaissance. Exploration of the minefield area to determine presence and density of mines by using satellites, aircraft with electro-optic detection systems, AMCM, SMCM, UMCM, surface ships, and remote-controlled systems.

3.2.2.5 Mine Countermeasures Forces Self-Protection and Self-Defense

The lack of organic defensive systems in MCM forces and the danger they are exposed to in executing their missions necessitates planning and prudence on the part of the MCM planner. It is the responsibility of the MCMC to initiate the application of self-protective measures. Measures that may affect other forces, or may conflict with other missions or objectives, must be coordinated with the OTC.

3.2.2.5.1 Self-Protection Measures for Sailing

The following measures are useful for MCM forces in preparation. Relevant publications are ACP-148 and ATP-1, Vol. I.

1. Execute magnetic material off-load bill.

2. When in waters that may be mined, reduce sailors below deck to man only essential stations.

3. Assume the highest sustainable damage control readiness status.

4. Implement quiet ship bill.

5. Endeavor to avoid waters that may be mined. If necessary to pass such an area, do so at high tide and in deepest possible water.

6. Be fully prepared to anchor; be aware of the change to magnetic and acoustic signatures that this engenders.

7. Prepare for leadthrough operations.

3.2.2.5.2 Protective Measures Against Moored Mines

When ships enter a moored minefield they should:

1. Follow the same path as the ship ahead.

2. Avoid all unnecessary alterations of course to present as small a target area as possible.

3. Post mine lookouts for shallow and drifting buoyant mines.

4. Request an AMCM precursor sweep.

3.2.2.5.3 Protective Measures Against Magnetic Mines

If magnetic mines are expected, the following steps are advised:

1. Maintain degaussing system configuration in accordance with latest threat specific guidance.

2. Take advantage of every opportunity to use a degaussing range to check the magnetic condition of the ship.

3.2.2.5.4 Protective Measures Against Acoustic Mines

To reduce the danger from acoustic mines, the following items should be considered:

1. Implement quiet ship bill.

2. Ships should proceed at their best noise-speed ratio. They should be noise-ranged frequently so that this speed is established and known.

3. The noise from the propellers should be kept as low as possible, as cavitation is a major source of noise.

4. Avoid violent engine speed changes, particularly reversing engines.

5. Operate only vital auxiliary machinery in dangerous waters.

3.2.2.5.5 Protective Measures Against Pressure Mines

Pressure mines react to the negative pressure caused by the movement of the ship through the water. Proceed slowly in deep water at high tide. Consider transiting in rough weather to mask pressure and acoustic signature of ship.

3.2.2.5.6 Protective Measures Against Drifting Mines

Ships should post mine lookouts. Charged fire hoses can be used to flush mines away from the hull. The water stream should not be sprayed directly on the mine case.

1. If a mine on the surface is being fired on, only as a last resort, do not approach within 200 m (220 yd). This should be avoided, as drifting mines with a pierced case may become neutrally buoyant and create an even greater hazard to shipping. If a closer approach is unavoidable, sailors located topside should take cover.

2. When a mine has been sunk, do not approach its former position. Mines sunk by gunfire may explode after disappearing below the surface or on hitting the bottom.

3.2.2.5.7 Protective Measures at Anchor or While Moored

The following self-protection measures should be conducted:

1. Do not move the ship.

2. Do not work anchors. If only one anchor is out, consideration should be given to lowering a second anchor underfoot to reduce the swing of the ship.

3. Stop all possible auxiliaries.

4. Do not use percussion tools such as pneumatic hammers.

5. All ships at anchor maintain an organized lookout for aircraft or surface vessels laying mines and report observations to the OTC. Lookouts should be briefed to report the position of any object dropped from an adversary aircraft or surface craft.

6. Degaussing should be used in accordance with instructions.

3.2.2.5.8 Airborne MCM Defensive Measures

AMCM helicopters have a minimal defensive capability. There are no antiair or antisurface weapon systems normally installed. Force protection measures to ensure their safety require significant coordination with other assets.

3.2.2.5.9 Surface MCM Countermeasures Defensive Measures

SMCM ships have virtually no means of defense. They have .50 caliber machine guns with a 1,825 m (2,000 yd) effective range and some small arms. In special situations, the ship may have additional weapons deployed for special situations (see Class Tactical Manual).

3.2.2.5.10 Underwater MCM Defensive Measures

The defensive capabilities of UMCM units are limited to small arms and extemporized explosive charges. VSW forces will require supporting, covering fires.

3.2.3 Protective Measures for All Ships

All ships, including SMCM, transiting a known or suspected minefield should take the appropriate measures:

1. Endeavor to pass through the mined area at high tide and in the deepest possible water (preferably >50 m (150 ft)) if no channel has been established.

2. Adopt a single column formation. Distance between units is left to the discretion of the OTC or Convoy Commander. As a general rule, distance should be 915 to 1,830 m (1,000 to 2,000 yd).

3. If a rendezvous with an MCM force is expected during darkness, the first unit of the column is to show three white lights, displayed vertically at her bow, for identification purposes.

4. Transiting units must be fully prepared to anchor.

5. Reduce speed (<6 knots is recommended).

6. Assume the highest damage control status.

7. Degaussing settings are to be checked prior to the transit and energized prior to entering the mined area.

8. Post mine lookouts.

9. All off-watch sailors should remain on weather decks.

10. Implement quiet ship bill and secure all unnecessary machinery.

11. Proceed along centerline of the channel, each unit navigating independently.

12. Only the lead unit adjusts speed to maintain distance.

13. The speed ordered should not be exceeded.

14. Maintain constant engine revolutions.

15. For ships configured with PRAIRIE MASKER, operate system in accordance with guidelines.

16. Turn off active cathodic protection system 24 hours before entering a suspected minefield.

17. Use short-range sonar to detect buoyant mines.

18. Use helicopters for visual search ahead of the ship for buoyant mines.

19. Move in direction of tidal stream if possible.

20. Avoid excessive rudder movement or violent alterations of course.

21. Reduce armament state of readiness if tactically feasible to avoid secondary detonation of fused ammunition.

22. Consider transiting in rough weather to mask pressure and acoustic signature of ship.

3.2.4 Use of Nonorganic Helicopters

Specific attention must be devoted to the safety of helicopters assisting in the effort. A helicopter element coordinator (HEC) organizes the use of nonorganic helicopter assets in MCM operations.

Water plume, fragmentation, and air shock can possibly inflict damage upon helicopters. Damage due to air shock is not significant in most cases. The casings of mines detonated underwater break up into large fragments, rapidly decreasing the possibility of damage with increasing water depth. At shallow depths, case fragments and bottom material will be hurled upward, increasing the effective damage within the plume radius.

3.2.5 Emission Control

Planning considerations for the imposition of acoustic and electromagnetic emission control (EMCON) are significant and contained in the appropriate ship class tactical manual.

3.3 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 adversary's capability to lay mines, thereby preventing the establishment of an operational minefield. Mining can also be used as a tactic to trap surface minelayers in port. Offensive MCM should be an integral component of any OPLAN and, to prevent mining, considered in the nascent planning stages.

3.3.1 Offensive Mine Countermeasures by Strike Assets

Offensive operations against adversary mine storage, handling, and laying capabilities need to be included in the campaign plan. In addition, during a period of impending hostilities, the MCMC should recommend that ROE allowing surveillance and interdiction of adversary minelaying be considered. This is usually executed by strike or special operations forces who have the capability to deliver and attack mine storage facilities, loading or transportation facilities, or minelaying assets. While MCM platforms have several techniques for countering mines once they are laid, they are not armed to conduct offensive MCM.

3.3.1.1 Intelligence

Intelligence is critical to offensive MCM. Strike planners need to know the storage location, types of mines, fortification of the storage facility, and defense systems. Among the peacetime requirements for intelligence collection is the number, type, and location of mine stocks throughout the world. Whenever there are indications of potential hostility with a particular country, monitoring 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 applied. When planning, intelligence gaps and collection requirements must be identified to increase knowledge of the adversary's MIW plans. Actually, overt surveillance of an adversary may act as a deterrent.

Once movement is detected, action 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. Delay may result in attacking after mine movement is complete. Complicating the problem is the likelihood that if hostile intent exists, the transfer of mines will be carried out surreptitiously, 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 adversary activity is detected, it is likely that mines will be deployed before any offensive countermeasures can be undertaken. In international waters, the ROE may permit a response without communication with higher authority, but in the territorial waters of another nation, delay can be expected in obtaining permission to strike, even if the capability is at hand.

To improve the chances of mounting a successful strike, the commander might seek advance approval for strikes where mine storage has been identified, but the ROE will not permit preemptive strike.

3.3.2 Mining as an Offensive Mine Countermeasures Tactic

Where a direct assault is not feasible, offensive mining may be used to prevent the effective employment of adversary assets.

Depending on the types of mines available to the adversary, delivery may be attempted by aircraft, surface vessels, or submarines. An offensive MCM effort against minelaying air assets is a more difficult task requiring the suppression of all adversary airfields and support facilities that might sustain minelaying aircraft or helicopters. Strike assets performing this mission face the same threat as if they were conducting direct strikes on the aircraft emplacing the mines.

Offensive mining against surface or submarine laying platforms is a somewhat less complicated task. Mines laid in 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.

3.4 DEFENSIVE MINE COUNTERMEASURES

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

3.4.1 Passive Mine Countermeasures

This chapter will address passive MCM as practiced by SMCM or an organized MCM planning staff. Chapter 8 describes those measures for non-MCM vessels.

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

3.4.1.1 Locating the Threat

Locating the mine threat requires some of the same actions as were necessary to support offensive MCM. First, a long-term intelligence collection effort to determine the extent of mine inventories, capabilities, and locations must be conducted.

This must be followed by increased surveillance in times of heightened tensions to determine and chart where and when mine emplacement is in progress. 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, plots the splash positions, which 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 long-range electronic systems that, if properly alerted, can track the minelayer from airfield or port of departure to arrival at the minefield. Long-range assets can then trigger tactical surveillance assets to pinpoint the minelaying operation. MCMC 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 type and extent of the field. If the first two steps have been successful, MCM assets may perform reconnaissance. When the first three steps fail, unprepared merchant or naval ships will likely perform an unwitting initial reconnaissance, and the mine sighting 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 stockpiles and minelayers under frequent surveillance.

Route survey databases should allow easy identification of areas that require investigation. The primary goal is to compile an archive of minelike contacts and other significant sonar contacts before any mining has taken place. This permits rapid exploratory operations along the route and classification of new contacts that might be mines by MCM assets. Contacts that correlate by position, as well as appearance, to those previously archived can be bypassed. Critical to the success is the availability of a precise navigation system that is common to all MCM assets. Without a common system, minor variations in position between different navigation systems will result in an inability to correlate sonar contacts to the data archive positions.

Route conditioning is the removal of objects from the seabed that produce minelike echoes and contacts on a minehunting sonar system. This process reduces operational timelines when MCM assets revisit the same area to conduct live operations. As part of route survey operations, channel conditioning may be performed. This 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 sonar contacts. Channel conditioning is not normally practiced by U.S. Navy MCM forces.

3.4.1.2 Localizing the Threat

Localizing the mine threat means reducing the area in which shipping may be exposed to mines, thereby reducing the area that MCM forces must cover to protect that shipping. This does 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 that will transit minable waters. These are preplanned channels for movement over bottom areas best suited for minehunting. Each is 1,000 yd 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 (see 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 .5 miles wide, the area is reduced to 5 square miles. Assuming that the 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 reseeding or delayed moored mines just before the convoy's transit. Even without MCM, the threat is reduced if all ships follow the same route because the traffic exposes itself to only a fraction of the mines present.

A navigation warning message system is used to provide information on suspected or confirmed minefields, cleared channels, or other important navigation information. The MCMC assists the OTC or area commander by maintaining a list of mine sightings, designating MDAs where necessary, and reporting the status of channels that MCM forces have been directed to clear.

3.4.1.3 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 duped into putting mines in the wrong location. Since the minelayer may no longer depend on navigation lights or local radio beacons, this tactic may not be as effective as it once was.

The availability of precise navigation has resulted in a significant reduction of risk for MCM forces. Those units using global positioning systems (GPS) 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 allow a unit to hunt or sweep a track and return to that track later with confidence that they remain in the area previously covered, and not to either side in uncleared waters. This risk reduction also extends to traffic ships using GPS. Such ships can transit without a leadthrough vessel when provided the proper coordinates.

An MCM ship is expected to maneuver in proximity to mines. Contact mines can be seen on sonar and avoided, but there are occasions when SMCM will maneuver within the sensing range of influence mines. Consequently, that ship

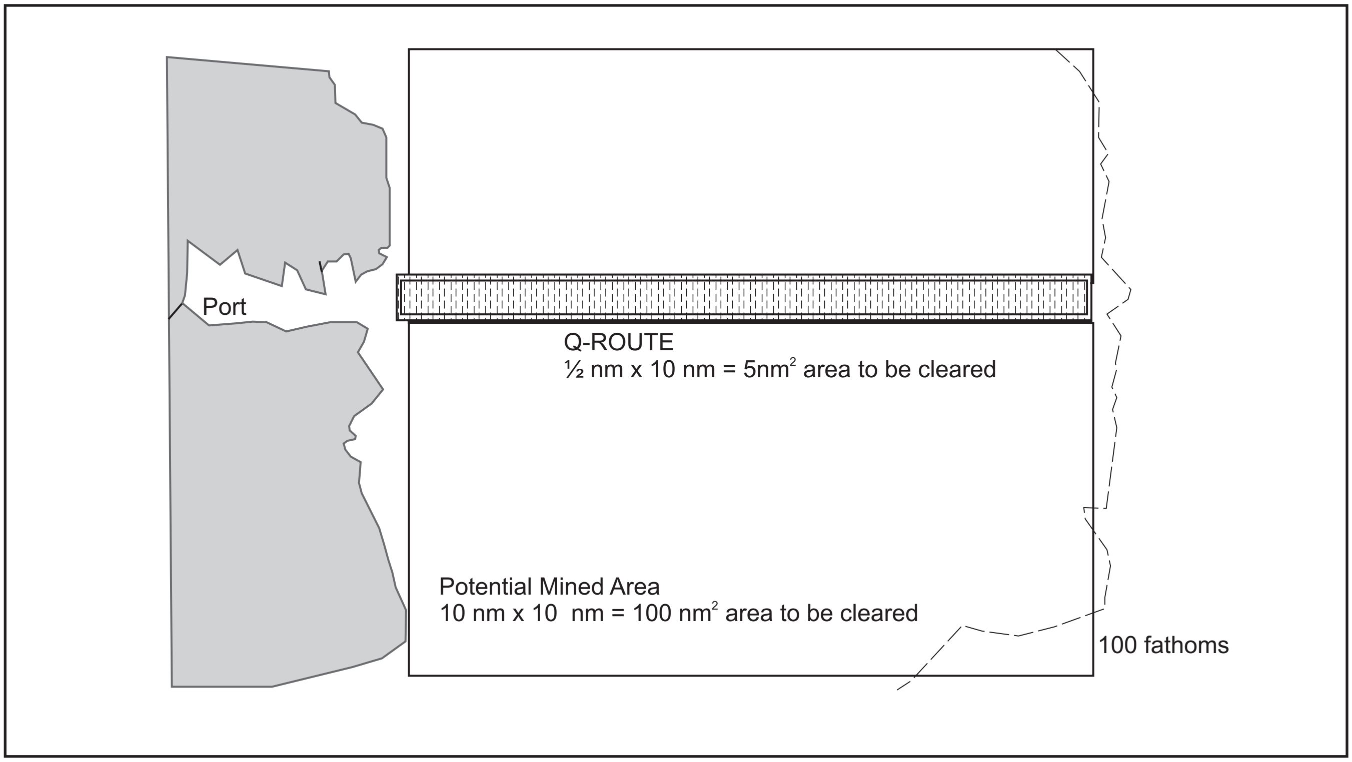


Figure 3-2. Localization of Threat by Q-Route

must have a magnetic and acoustic signature much smaller than the signature that most mines will be intended to target. The greatest danger is a shallow moored or a sensitive-set influence mine.

The Class Top Level Requirements Document and the OPNAV C8950.2 instruction set the magnetic silencing requirements for MCM ships. A dedicated effort must be maintained to minimize the ship's acoustic and magnetic signatures 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 Ingleside, Texas and San Diego, California. Other ranges that could be used are located in Japan, Italy, and the United Kingdom. British forces in the Persian Gulf during Operation Desert Storm used a portable degaussing check range.

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 detecting the ship. With this protection, SMCM may be able to successfully maneuver in a minefield for hunting or sweeping, or another craft may transit a channel with less risk.

Systems that are designed for detection of mines with the intention of avoidance rather than prosecution, are also classified as passive MCM. Detection and avoidance is less risky than active MCM. In the case of MCM forces, avoidance is usually a temporary measure, but for other combatants it is a valid tactic.

3.4.2 Active Mine Countermeasures

The two main subsets of active MCM are minehunting and minesweeping.

3.4.2.1 Minehunting

Minehunting is the process of searching the seabed and water column for mines. It is comprised of detection, classification, localization, reacquisition, identification, and neutralization.

Since no current single sensor or weapon system can carry out all functions, reacquisition will be required by another follow-on sensor. The AN/SQQ-32 detects a contact and classifies it as a minelike contact (MILC). The mine neutralization vehicle (MNV) or EOD diver then reacquires the MILC, visually verifies it as a mine or not, and neutralizes it as the situation dictates.

The hunting performance of the AN/SQQ-32 is not affected by the type or sensitivity settings of the firing mechanism, ship count settings, or arming delays. Even delayed moored mines can be detected by a bottom search. However, operations are influenced by the degree to which mines are buried, mine case construction and material, sea bottom clutter, and many other environmental factors.

3.4.2.1.1 Minehunting Process

The process includes the following:

1. Detection: Using sensor systems, objects possessing characteristics similar to moored or ground mines are located. These contacts are noted for further investigation.

2. Classification: The contacts are further investigated, usually with higher resolution sonar, and classified as MILCs or non-minelike based on detailed characteristics. If the contact cannot be classified as non-minelike with confidence, it will be called a MILC until identification proves otherwise. Some specific characteristics include size, shape, shadow, ringing, height above bottom (HAB), aspect change, and doublets. Equipment operators use all available features of the minehunting system to examine a contact, while maneuvering to view a different aspect of the object.

3. Localization: The MILC position is refined and plotted as precisely as possible (specifying navigation sensor, datum, and position in latitude-longitude) so that further prosecution can be carried out either immediately or at a later time. MCM forces use GPS as the standard reference system and an MDA is established around all MILCs. Its size is based on mine threat, ship vulnerability, location in volume, and current doctrine.

4. Reacquisition: MCM force tasked with verification or neutralization reacquires MILC with sensors, based on previous location data.

5. Identification: MCM EOD diver or remotely operated vehicle (ROV) using video camera and sonar investigates the MILC. Identification should be made using an optical system so that a positive ID of the mine can be made. It also prevents MCM forces from falsely assuming that a minefield exists.

6. Neutralization: The mine is either rendered inoperative or removed. Though not a step in minehunting, the prosecution of a contact is incomplete until details are reported to the MCMC using standard reporting formats.

Verification of mine neutralization is necessary since there is no positive evidence of success on the surface or on sonar. After a neutralization charge has been activated, a diver or ROV should reacquire and visually verify mine neutralization. This should be completed as quickly as possible, but the time element may vary according to the type of operation.

3.4.2.2 Types of Minehunting

There are two primary types of minehunting: acoustic and optical.

3.4.2.2.1 Acoustic Minehunting

Acoustic minehunting is the use of active sonars to find objects with minelike characteristics. SMCM and AMCM minehunting sonars use a video display of the acoustic signal only, and do not use audio, as is common in submarine warfare sonar. Acoustic minehunting is effective against mines with metallic cases or other cases that provide sufficient echo. Ground mines, partially buried in mud or sand, may be difficult to detect in marginal environmental conditions. Moored mines are detectable by the case, anchor, or the mooring cable. Both directional and side-scan sonars are utilized in MCM operations.

1. Directional sonar

   a. Can be manually steered to detect in any direction, independent from the course of the deploying unit

   b. Capable of detecting ahead of course, providing cleared water for movement in any direction

   c. Used primarily by SMCM.

2. Side-scan sonar

   a. Detects in swaths relative to the deploying unit's course

   b. Inherent gap, requiring more tracks for complete coverage (without down-looking array)

   c. Used primarily by AMCM assets.

3.4.2.2.2 Optical Minehunting

Optical minehunting is the use of visual, optical, or electro-optical systems to locate mines on the surface, in the volume, or on the seabed. The primary limiting factor with optical systems is water clarity. 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.

Other detection techniques provide additional details on visual search methods and equipment. Developmental programs are underway for dedicated mine detection systems that use laser optics and infrared frequencies, but none have been fielded.

3.4.2.3 U.S. Minehunting Systems

3.4.2.3.1 Airborne MCM Minehunting System

AN/AQS-14A sonar detecting set is a cable-towed side-scan sonar operated by the MH-53E AMCM helicopter. It has a video waterfall display for the onboard operator, and the sonar data is recorded on magnetic tape for post-mission analysis.

3.4.2.3.2 Surface MCM Minehunting Systems

3.4.2.3.2a AN/SQQ-32 Minehunting Sonar

AN/SQQ-32 minehunting sonar is a variable depth, directional sonar designed specifically for hunting. Capable of being operated in a hull-mounted position or while deployed by a cable through the ship's hull, while operating at variable depths, to exploit sound velocity convergence zones. This sonar is installed on all SMCM ships.

3.4.2.3.2b AN/SLQ-48 Mine Neutralization System

AN/SLQ-48 Mine Neutralization System (MNS) is capable of mine reacquisition, identification, and neutralization.

1. The mine neutralization vehicle (MNV) is a nonmagnetic, electro-hydraulic powered, remotely operated submersible, with two directional video cameras and a variable range, tiltable sonar head.

2. Monitor and control consoles are used to control and monitor MNV status.

3. Umbilical cable handling system (UCHS) tends the cable which provides vehicle power and data.

4. MCM 1, Vehicle handling system (VHS), boom and winch system is used to lift, launch, and recover MNV.

5. MHC 51, Multi-purpose crane (MPC), articulated hydraulic crane is used to lift, launch, and recover MNV.

3.4.2.3.3 Underwater MCM Minehunting Systems

3.4.2.3.3a Marine Mammal Systems

Mk 7 MMS is used to detect, locate, mark, and neutralize proud, partially buried, and buried mines. The Mk 7 Mod 1 is the only operational system with a capability to detect buried mines, however it has not been proven to be able to operate in other than a benign environment.

Mk 4 Mod 0 MMS is used to locate and neutralize close-tethered moored mines.

EX 8 MMS used by NSCT1 to locate, classify, mark, and neutralize mines in assault lanes.

3.4.2.3.3b AN/PQS-2A Sonar

AN/PQS-2A sonar is a hand-held model used by UMCM and is used for reacquiring contacts. It provides an audio tone to the diver through earphones that enables the diver to localize a contact within the sonar beam.

3.4.2.3.3c Mk 25 Ordnance Locator

The primary magnetic locating device is the Mk 25 ordnance locator used by UMCM to reacquire buried ferrous objects. It has a limited capability and a relatively short range and is therefore more of a localization device than a minehunting system.

3.4.2.4 Minehunting Procedure

The general MCM procedure is to hunt when conditions permit and sweep when hunting is not feasible. This is premised on the fact that hunting, in a favorable environment, is safer than minesweeping. When minehunting, the ship is detecting the mine prior to coming within range of the influence sensors. When sweeping, 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, hunting is the optimal technique.

There are two approaches to minehunting that can be followed. The first is to have the unit that makes the detection carry out the neutralization prior to proceeding to the next detection. This is a typical tasking for SMCM, since it has the option of employing the MNV or EOD divers. The second approach is to have one unit conduct the detection-to-localization process and another execute identification and neutralization. Owing to the use of the MCM triad’s components, this would be referred to as an integrated MCM operation. The MCMC determines which process to employ based upon available assets.

3.4.2.5 Mechanical Minesweeping

The AN/SLQ-38 (Oropesa) used aboard MCM 1 Class ships is a simple mechanical sweep that cuts the cables of moored mines, in the volume, but cannot sweep close-tethered mines.

The Mk-103 mechanical sweep is a modified Oropesa-style sweep used by AMCM. The depth is determined by selecting pendants that attach the sweep wire to the surface floats.

A/N 37-U controlled depth sweep (see Figure 3-3). This is an AMCM mechanical sweep system developed to provide increased depth capability. 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 have 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 surfaces, may be necessary as depth increases. No surface floats are required.

3.4.2.6 Influence Minesweeping

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

1. Sensor exploitation:

   a. Takes advantage of vulnerabilities in mine target discrimination capability 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.

   b. Determines the required sweep characteristics, mine exploitation, and analysis that must be performed.

2. Target ship emulation:

   a. Sweeps with an influence signature that emulates the target ship.

   b. Does not require knowledge of the mines present but does require knowledge of the specific signature of transiting ships and may require a more sophisticated sweep system.

3.4.2.6.1 Magnetic Minesweeping

In magnetic sweeping, whether single or combination influence (which includes a magnetic component), the magnetic field of the system must be slight enough to pass over the mine without satisfying the sensor. Also, the magnetic field generated must be far enough astern so that a magnetic mine is not actuated until the ship is at a safe distance. When a mine has a ship count setting, the magnetic field of some sweeps can be pulsed to simulate several passing ships. Otherwise the sweeper must make multiple runs on each track to account for all mines.

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

1. AN/SLQ-37 (V)3 influence sweep system:

   a. Effective SMCM sweep used against magnetic mines

   b. Powered by the marine minesweeping gas turbine generator (MMGTG)

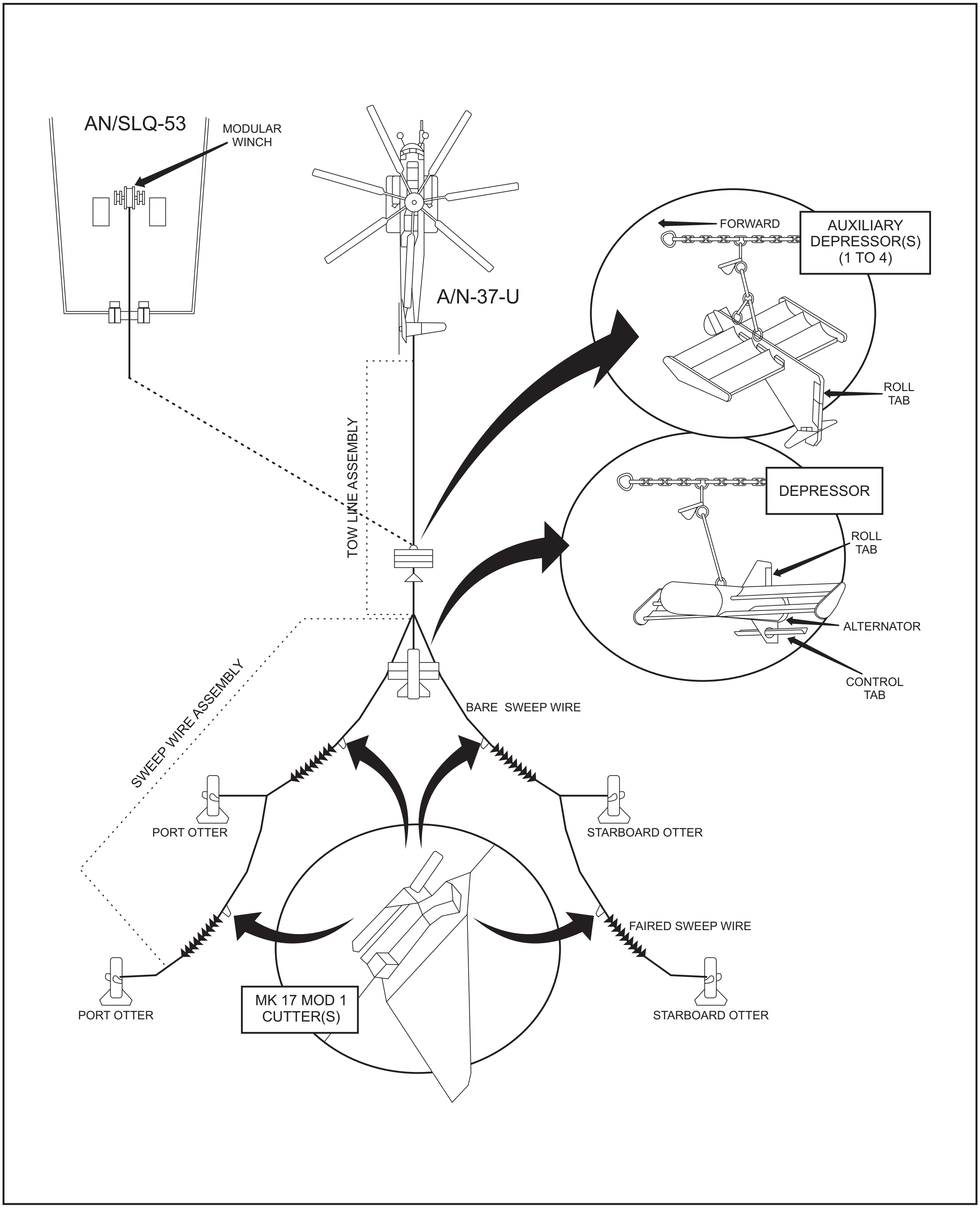


Figure 3-3. A/N 37-U Controlled Depth Sweep

c. Open loop electrode set to be electrically pulsed while being towed astern

d. Selectable pulse waveforms, providing some performance flexibility against newer mines with advanced logic

e. Capable of three configurations:

(1) Straight tail (streamed astern)

(2) Diverted tail (changes orientation of magnetic field)

(3) Closed loop (for low-conductivity environments).

2. AN/SPU-1/W magnetic orange pipe (MOP):

a. 9 m (30 ft) in length

b. 27 cm (10.75 in) in diameter

c. Composed of a buoyant steel pipe that is magnetized before being towed by AMCM

d. Effective only against sensitive mines in shallow water.

3. Mk 105 magnetic minesweeping system:

a. Hydrofoil sled towed by the MH-53E helicopter.

b. Mounted on the sled is a 2,000-amp gas turbine generator. The generator functions are controlled from the helicopter and constant or pulsed current modes are available.

c. 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 ft.

3.4.2.6.2 Acoustic Minesweeping

Influence sweeping that involves generating an acoustic signal to satisfy a passive acoustic mine sensor. It may also include systems to respond to active acoustic sensors.

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

Acoustic sweep systems are as follows:

1. The Mk 105/A Mk 2(g) is a simple, towed acoustic device. It is composed of a number of metal bars, stationary and motive, that resonate as they are towed.

2. The AN/SLQ-37 influence sweep system (acoustic components) is an older technology electromechanical system installed on the MCM 1. The automatic control unit (automatic) or power control unit (manual) on the ship provides power via the acoustic power cable (APC) to operate towed devices. Control options include steady state operation, modulated operation (a continuous operation with alternating high- and low-output levels), and pulsed operation (cycles of high-level output followed by an off period).

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 Mod 3 acoustic minesweeping device is the principal airborne acoustic sweep device. It can be streamed, towed, and recovered from the helicopter. The device produces acoustic energy as a result of cavitating water flow.

3.4.2.7 Mine Neutralization

Mine neutralization is the process of rendering a mine inoperative using an explosive charge. AMCM, SMCM, and UMCM use differing terminology and methods to describe and achieve this process. For example, EOD employs an overpressure charge (OP) to achieve this goal. NATO navies use countermining to describe this process. Following detonation, the mine case may continue to resemble a mine on sonar. If time permits, inspection should be conducted to verify neutralization. The major disadvantage to neutralization is that it leaves a mine case, with explosives, on the bottom, which may contribute to bottom clutter. Countermining or countercharging is mine disposal by using an explosive charge to cause sympathetic high-order detonation. The major advantage is that it does not leave a MILC to clutter the environment. A disadvantage is that it requires placement of a large explosive charge in proximity to the mine, which involves risk to the diver or ROV.

Relocation of a mine to an area where it presents no hazard is called removal. This method is used in locations where detonation could cause damage to pipelines, dwellings, docks, or other facilities. Recovery of a mine is conducted when exploitation or analysis is necessary to collect intelligence data on how the mine operates or to use it for laboratory analysis to develop tactics against it. The purpose may also be to determine what mine types are present and what settings are in use so that sweeping can be done more effectively.

A render-safe procedure (RSP) is performed to render a mine inoperative by interruption of internal functions or separation of essential components prior to or during recovery.

3.4.2.8 Mine Exploitation

For an influence minesweeping operation to be successful, the sweep characteristics must be matched to 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 MCMC.

Field exploitation requires that the mine be raised, towed, and beached at a safe location. Afterward, the mine may be shipped to the EOD Technology Division at Indian Head, Maryland, and Coastal Systems Station (CSS), Panama City, Florida, for technical analysis. If the mine is of an unknown type or new modification, a full exploitation and analysis to determine sweep tactics should be performed. After sufficient study has been conducted, mines of a type that have previously been exploited and analyzed may be disposed of by countercharging.

3.5 INTEGRATED MINE COUNTERMEASURES OPERATIONS

Force integration is the cornerstone of the MCM triad. MCM operations require a variety of assets to overcome the multitude of mines in use today. Employment of the triad involves the coordinated planning and deft blend of SMCM, AMCM, and UMCM. There are four basic principles applied to their use:

1. Determine the tactical objective

2. Assess the threat

3. Assess triad capabilities

4. Develop and implement a synchronized tactical plan.

The BG or commander, amphibious task force (CATF), with advice from the MCMC, will determine the MCM objective by considering minefield location, friendly mission, adversary situation, the necessity to transit the area, and the acceptable degree of risk. Assessment of the threat is a continuing process that must include the mines themselves, the challenges resulting from or compounded by the environment, and the danger from hostile forces. In assessing asset availability, capabilities, and employment the MCMC must evaluate the capability of each asset against mine types or combinations while evaluating logistic support requirements.

Asset strengths that are capitalized upon where possible include the following:

1. AMCM virtual invulnerability to mines
2. AMCM speed when hunting and sweeping
3. AMCM shallow water sweep ability
4. AMCM time to arrive on station
5. SMCM operational endurance
6. SMCM influence sweep versatility
7. SMCM deep hunt, neutralization, and sweep ability
8. UMCM identification and neutralization capability
9. UMCM MMS shallow water and buried mine capability
10. UMCM NSCT1 capability at 10–40 ft depth contours.

Asset weaknesses to be recognized and surmounted include the following:

1. AMCM daylight-only limits
2. AMCM inability to identify and neutralize
3. AMCM requirement for extensive logistical support
4. SMCM shallow water limits
5. SMCM vulnerability to mines
6. UMCM MMS requirement for extensive logistical support
7. Force protection for the MCM triad
8. Overt nature of MCM operations.

Having considered triad capabilities, the MCMC must now integrate those assets into a tactical plan that will exploit strengths and avoid 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 SMCM 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 BG and MCMC may also request the use of national sensor and satellite assets. These can monitor adversary activity from stockpile to the area of operations and localize MDAs to isolate specific threats.

3.6 COMBINED MINE COUNTERMEASURES OPERATIONS

Combined MCM operations are those conducted with U.S. and allied MCM forces. These multinational operations may involve forces accustomed to operating under different doctrine, different tactical procedures, and 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 that prevent free employment of some forces. An example might be the prohibition of force employment in the territorial waters of a foe using an integrated force that would include a neighboring nation's assets. The same tactical approach of considering all resource capabilities and limitations should be applied, although these limitations may serve to complicate planning.

3.6.1 NATO MCM Assets

Descriptions and details of NATO MCM assets are contained in the following publications: ATP-24, Vol. II; AMP-3, Vol. I; and AMP-3, Vol. II. Descriptions of NATO mines are contained in AMP-13, Vols. I, II, and III.

3.6.2 Non-NATO MCM Assets

Descriptions and details of non-NATO MCM assets are contained in Naval Mines and Mine Countermeasures Rest of the World (Less Eastern Europe) and Naval Mines and Countermeasures (CIS and Selected Eastern European Countries).

3.6.3 Additional Reference Sources

U.S. MIW personnel frequently participate in conferences, meetings, and formal data exchange agreements with other nations and can provide updates on allied MCM capabilities. Points of contact include COMINEWARCOM (Allied Tactics Division), NAVSEA/PEO MUW (Navy IPO representative), OPNAV (N752T), Naval Surface Warfae Center (NSWC) CSS Panama City (R33), and NSWC Carderock (Code 854). In addition, the three MCMRONs frequently conduct operations with MIW forces of other nations and are able to provide current assessments of their equipment and capabilities.

3.7 AMPHIBIOUS MINE COUNTERMEASURES OPERATIONS

The performance of forcible entry missions through the use of U.S. Navy amphibious ships continues to evolve as designed according to the fundamentals of operational maneuver from the sea (OMFTS) and ship-to-objective maneuver (STOM). It should be noted that the formulations contained in these volumes are now in the active process of transitioning from concept to actual doctrinal principle. They are discussed herein to provide the reader with an illustration of those fundamentals that amphibious warfare will eventually embrace. At the time of this writing these documents have presented bold and innovative concepts that are undergoing continual analysis, testing, and validation. In the main, they describe power projection as rapid maneuver from amphibious ships directly to objectives ashore, unimpeded by aspects of topography or hydrography. Consequently, naval forces must strive to discard hitherto accepted procedures such as operational pauses, phases, and reorganizations that erode momentum. Emerging technologies represented by the advanced amphibious assault vehicle (AAAV), MV-22 aircraft, GPS, intelligence assets, autonomous systems and standoff munitions for SZ breaching, and command and control systems will be central to this thesis. Characteristics of STOM may pertain as follows:

1. The littorals are vulnerable flanks through which the adversary may be attacked.

2. Landing force maneuver will begin upon crossing the line of departure (LD). The assembly area will be the amphibious ships and the attack position will be well offshore. The controlling focus will remain the operational objective.

3. Assault elements will depart the ships well familiar with the established plan and objectives and will proceed to the LD.

4. Movement parallel to the shore may occur. The sea will be regarded as maneuver space, but the presence of naval mines will be a militating factor.

5. Tactical commanders may vary their formation and approach axis, as required.

6. Tactical commanders, within their assigned area of responsibility, may penetrate the beach at a point felt to be most advantageous. The emphasis is on intelligence, deception, and flexibility. The goal is to find, or create, and then exploit gaps while pitting strength against weakness.

7. Rather than seizing and consolidating the beach itself, forces will slice rapidly inland to secure objectives. Adversary formations will only be confronted and actively engaged to achieve freedom of action and operational initiative.

8. Logistics will be, in the main, sea-based.

Irrespective of the operational art being applied, the introduction of naval and land mines into the tactical picture will heighten complexity in a profound way. Moreover, the endeavor to project combat power from the sea, in the face of a hostile force that is shielded by an obstacle system reinforced by mines and covering fires, is the most risky operation that a force can undertake. This chapter provides the organization, considerations, and command relations for planning and conducting the MCM that support such an amphibious operation.

A shrewdly integrated combination of mines, placed to reinforce and protect obstacles that will be covered by fire and observation, is an essential feature of any adversary effort to repulse an assault from the sea. Hence, the immediate goal of MCM forces is to prevent the inordinate delay of amphibious operations. This support of amphibious operations is frequently referred to as shallow water MCM (SWMCM), because the critical areas for the landing force are in the VSW and SZ. The SZ is that area from the 10-ft depth contour to the HWM. Here, any significant wave action and turbulence will prevent a swimmer from maintaining the physical control that attends the search for mines. Hence, SZ mines must be overcome through explosive means. Those that might be found include ground contact, ground influence, ground pressure plate, ground tilt rod, moored contact, moored influence, and anti-invasion. Additionally, the adversary will exploit existing and natural obstacles to establish a series of layered defensive belts, each to be penetrated in turn. Such an array is designed to eventually exhaust the will and resources of the breach force. Active reconnaissance and intelligence activity is essential in the effort to seek defensive gaps. However, when so confronted, the current tactic for conquering this daunting portion of the water column, as well as ashore, is the aforementioned "brute force" application of explosive charges or autonomous mine clearance systems and standoff munitions systems that are now under development.

The VSW zone is between the 10- and 40-ft depth contours. Mines found in this zone may include ground or moored contact, ground or moored single influence, ground multiple influence, and ground tilt rod. NSCT1 has been created specifically for duty in this region. They are composed of SEALs, EOD divers, and reconnaissance Marines (USMC) who work in dive teams employing MMSs.

The shallow water (SW) zone covers the 40- to 200-ft depth contours. Moored contact and ground or moored single and multiple influence mines will be found here.

To avoid disrupting the timing and choreography of an amphibious assault, final MCM must be performed just prior to or in conjunction with the attack to clear assault lanes. The transition across the water column up to the HWM must be synchronized and controlled so as to accommodate an uninterrupted sequence of events. Considerations include the following:

1. AMCM and SMCM. Not capable of undetected operations where radar systems or visual watch is maintained; not suited for near-shore effort.

2. AMCM. Limited to daylight operations and extremely vulnerable to hostile fire.

3. SMCM. Used to perform exploratory minehunting at night but detectable by radar and requires force protection.

4. C2. Importance of tactical hand off of responsibility from NSCT1 in their zone of action to those forces conducting SZ clearance cannot be overemphasized as this is the key to uninterrupted movement to penetration points.

5. Synchronization. An orchestrated scheme of maneuver, fire support plan, C4I plan, and dedicated force protection allocation are paramount.

It is important to note that, prior to the amphibious assault and breach, MCM advance force operations may be significant. However, also note that the requirements of STOM must be meshed with the reality of the MCM effort necessary to actually get ashore.

Until the arrival of the ATF, possibly for a period of several weeks, advance force operations will serve to deceive the adversary, identify his vulnerable points, shape the battlespace, and enable the ATF to arrive in the AOA-LPA safely. Reconnaissance efforts will determine specific mine locations with a priority aimed at finding gaps. This mission is of critical importance as D-day approaches, as the selection of littoral penetration zones (LPZs) and littoral penetration sites (LPSs) within the AOA-LPA, littoral penetration points (LPPs), and assault lanes are selected as a result of these surveys.

The various phases of MCM in support of amphibious operations are discussed in the following subparagraphs. A summary is given in Figure 3-4.

3.7.1 MCM Pre-Assault Phase

This phase encompasses all MCM advance force activities prior to the tactical execution of the assault and may last for days or weeks. The tenets of STOM require a modification of advance force operations to preserve the element of surprise but the reality of circumstances viewed in their totality may not permit this. Events include MCM planning and coordination, movement to objective area, conducting hydrographic and mine detection surveys of waters in the AOA-LPA, conducting clandestine exploration-reconnaissance of beach approaches, then marking and preparing minefields and obstacles for breaching or avoidance. As discussed, these operations may well reduce the tempo while increasing the pressures of the immediate pre-assault phase. Advance force exploratory and reconnaissance reports should be used to help define the threat, pinpoint adversary vulnerability, and to determine where active MCM

PHASE	DURATION	MCM OPERATIONS	FORCES
Pre-Assault	Days to Weeks	Minefield Locating and Marking, Approach Lane Identification	National RECCE Resources, Submarine, Aircraft, NSW
Assault	One Day or Less	Approach Lane Clearance, Very Shallow Water/Surf Zone/Breach Lane Clearance, Lane Marking, Fire Support Area, Inner Transport Area Clearance	SMCM; AMCM; UMCM; USMC Assault, Covering, and Breach Forces; Beach Group; Medium/Heavy-lift Helicopters; Fire Support Elements
Post-Assault	Days or Weeks	Approach/Departure Channel Clearance and Widening, Buoying, Outer Transport Area Clearing	SMCM, AMCM, and UMCM

Figure 3-4. MCM Operations in Support of Amphibious Operations

emphasis should be placed. Several potential penetration sites should be reconnoitered. Avoidance of adversary strengths should be the objective. The resultant data will be the basis for determining the scope of MCM operations required and selection of the best penetration site and penetration points. Unless deception is the actual intent, stealth must be maintained to prevent compromise of the impending assault.

During advance force operations, NSCT1 is the primary MCM capability at the 40- to 10-ft depth contours. SEALs, EOD divers, and reconnaissance Marines operating in conjunction with their EX 8 MMS will locate, classify, mark, and neutralize mines in the assault lanes. For further details on the detachment's capabilities refer to NTTP 3-15.23, Underwater MCM Operations.

If MCM assets are very limited, it may be necessary to conserve them until the assault phase. If total control of the AOA-LPA has been established and time is available, a high percentage clearance should be attempted. The final decision relative to the scope of MCM operations in the pre-assault phase will hinge on:

1. Perceived mine threat
2. Availability of MCM forces
3. The supported commander's (CLF) concept of operations and scheme of maneuver ashore
4. The supported commander's (CLF) fire support plan
5. Highest priority is neutralization or marking of mines located in assault lanes.

If a mine is found early in the exploratory phase, MCM forces proceed directly to a reconnaissance effort, in order to identify approach channels with the least risk.

CATF must consider adversary mining capability and tactics in selection of the penetration zone. MIW aspects that should be considered are:

1. Mine threat
2. Environmental conditions
3. Available MCM assets
4. MCM tactics
5. Sufficient time to execute the plan
6. The effect that mine casualties will have on the force.

3.7.2 MCM Assault Phase

The task of MCM in the assault phase is to slash through the MDA established during the pre-assault phase in the channels, areas, and boat lanes required for the immediate assault. In the final planning, adjustments may be made to the assault area design, taking into account the latest intelligence and exploratory MCM reports. Breakthrough operations such as this require the rapid, synchronized application of all available resources that are effective against the mines. Clearing and marking of mines and obstacles and the marking of areas and boat lanes must be accomplished prior to transit of the initial assault waves. Timing is crucial and MCM units must report any delays that will impede the assault.

The amphibious breach will be a deliberate one, characterized by thorough reconnaissance, detailed planning, and extensive preparation that includes rehearsal. It should not be considered to be an in-stride breach but should feature an uninterrupted transition across the water column. Fire support assets will suppress and obscure adversary activity on the objective. Timed and command detonated demolitions, emplaced by NSCT1, will be used in the 40- to10-ft region of the water column to clear assault lanes. Covering fires from a multitude of sources will protect the force. Explosive systems will be required to accomplish SZ clearance. Marine combat engineers with the breach force will clear mines ashore. AMCM, SMCM, and UMCM forces will later clear and widen approach lanes and seaward operating areas to ensure that the additional assault echelon (AE) assets and the assault follow-on echelon (AFOE) can land. Note that, as the principles of OMFTS and STOM transition from the conceptual toward established practice, the footprint of the AFOE will diminish until eventually logistics will be essentially sea-based.

The following summarizes the MCM tasks that may be ordered in the assault phase:

1. Breaching of assault lanes in VSW

2. Brute force application of explosive charges to clear SZ mines

3. Mine clearance of CLZs

4. Marking of lanes, channels, and operating areas

5. Guinea pig and check sweep operations

6. Deception operations

7. Support of UMCM

8. Use of SMCM and AMCM in deeper waters if practicable.

3.7.3 MCM Post-Assault Phase

During this period, MCM forces continue clearance operations to expand cleared offshore areas to support force buildup, arrival of the assault follow-on echelon, and general logistics off-loading. Rapid follow-on clearance (RFOC) under the auspices of Marine combat engineers will be conducted ashore.

Immediately following the initial assault, and with the beachhead secured, men and material must continue to come ashore to establish a rapid buildup of combat power. MCM forces must facilitate this by continuing mine clearance to expand the lanes and sea areas to support critical LOTS. They also must remain responsive to newly discovered mine threats that may endanger ship-to-shore movement.

The following summarizes the MCM tasks that may be required in the post-assault phase:

1. Continued exploratory, reconnaissance, and breakthrough operations to provide additional channels and to expand areas as required

2. Attrition operations in existing channels and operating areas

3. Leadthrough operations for high-value units

4. Further marking and widening of channels and areas

5. EOD neutralization of mines previously marked, continuation of mine exploitation, and other EOD tasking.

3.7.4 Mine Warfare Duties and Responsibilities in the Amphibious Task Force

3.7.4.1 Commander, Amphibious Task Force MIW Responsibilities

CATF, as the supporting commander, has overall responsibility for MCM within the sea areas within the AOA-LPA. Through his designated MCMC, he plans for all facets of MIW. CATF will delegate the conduct of MCM to the MCMC and has the responsibility to provide them logistics support and force protection.

3.7.4.2 MCM Commander Responsibilities

In support of littoral warfare, the mission of MCM forces is to detect, locate, identify, and either mark or clear mines in the areas designated by CATF as essential to the conduct of a successful assault. The MCMC has the preponderance of the organic and supporting forces required, thus his responsibilities include:

1. Planning, task organizing, and conducting MCM operations to clear or neutralize mines in the deep water, SW, VSW, and SZ approaches to the penetration points as well as the inner and outer transport areas, various operating areas, and fire support areas. SZ clearance operations are planned and coordinated with the supporting and supported commanders, CATF and CLF.

2. Arrange for force protection of the MCM force.

3. Coordinate RFOC effort.

3.7.5 Organization and Assumptions

In peacetime, COMINEWARCOM has operational control of MCM forces. When tasked, he will assign the necessary MCM force to the supported commander. The MCM force deploys with its own commander and planning staff. When the ATF is formed, they become a part of that task organization.

3.7.5.1 Command and Control

MCM is a supporting operation conducted by forces other than those organic to the ATF. The MCMC provides the expertise to CATF to develop the MCM plan. Then, in continued close coordination and integration with the ATF, the MCMC and his staff will establish the final plan and execute MCM operations in the AOA-LPA.

3.7.5.2 Assumptions

3.7.5.2.1 Controlled Environment

Maneuver warfare doctrine emphasizes the use of tempo, speed, and surprise to shatter adversary cohesion, organization, and command. Toward this end, undefended or lightly defended beaches will be selected for penetration areas, zones, sites, and points whenever feasible.

3.7.5.2.2 Air Superiority

U.S. forces will be required to establish air superiority in the AOA-LPA prior to MCM operations.

3.7.5.2.3 Transiting Within the Amphibious Objective Area

Assault waves transiting from ship to shore must navigate precisely. Accurate navigation, based on GPS, is the key element in rapid mine relocation and destruction, accurate lane marking, and the precise piloting of the assault craft.

3.7.6 Selection and Design of the Assault (or Penetration) Area

3.7.6.1 General

Sea, beach, and inland OPAREA in the AOA-LPA are selected to meet tactical requirements and facilitate control of the ship-to-shore movement. Selection of deep water AOA-LPA is highly desirable to reduce the mine threat. As previously stated, the ultimate objective will be to seek a region where a mine threat does not exist.

3.7.6.2 Areas and Channels in the Assault Area

The AOA, or LPA, is a geographic region, delineated in the initiating directive or OPTASK AMPHIB, for the purposes of C2, within which is located the objective(s) to be secured by the ATF. This area must be of ample size to ensure accomplishment of ATF taskings and must provide sufficient physical space for the conduct of necessary special operations missions. Sea operating areas are established to minimize the possibility of interference with amphibious operations by elements of the ATF. A notional view of an AOA-LPA is shown in Figure 3-5.

Sea areas are established by CATF and promulgated in the OPORD.

1. Screening areas are designated for aircraft, ships, and submarines providing antiair, antisurface, and antisubmarine protection to the ATF. These areas provide maximum protection to the forces operating in the AOA-LPA.

2. The AOA-LPA is that part of the objective area within which the amphibious force conducts the landing operations. It includes the beach, beach approaches, transport areas, fire support areas (FSAs), the airspace occupied by close air support assets, and the land included in the advance to the initial objective. CATF's mission determines the number of penetration zones and sites selected within the AOA-LPA.

3. The transport area is an area assigned for the purpose of debarking Marines and equipment. This area may be divided into an inner and outer area. A transport area supports one or more colored beaches, or LPSs, depending on the distance between beaches.

3.7.6.2.1 Sea Echelon Areas

The sea echelon area is located seaward of the transport area. The ATF operates in the sea echelon area for dispersion and mobility. Assault shipping is phased in and out of transport areas as the assault progresses.

3.7.6.2.2 Approach and Retirement Lanes

An approach lane extends from the transport area to the LD. It is the exact route displacement landing craft use to approach the LD from the transport area when static debarkation is employed. It may be identified by a marker ship, boat, or buoy. Adjacent approach lanes may be parallel or diverge seaward to provide for early dispersion of assault waves. A retirement lane serves the same purpose as the approach lane and is used for returning the displacement craft from the LD to the transport area.

3.7.6.3 Amphibious Objective Area Design Considerations in MCM Environments

Avoidance is the best form of MCM in an environment known to be mined. As such, reconnaissance becomes increasingly important. The preceding sections described the key water areas designed to facilitate and control the waterborne ship-to-shore movement. These areas must be cleared of mines or marked for avoidance. Recognizing the potency of the threat, planners should weigh the following considerations when planning and designing the AOA-LPA and, in particular, LPSs.

3.7.6.3.1 Time Constraints

MCM in support of amphibious operations is particularly time-sensitive. The ability to complete the necessary requirements to permit the breakthrough of assault shipping into the AOA-LPA and LPS is vital to the waterborne

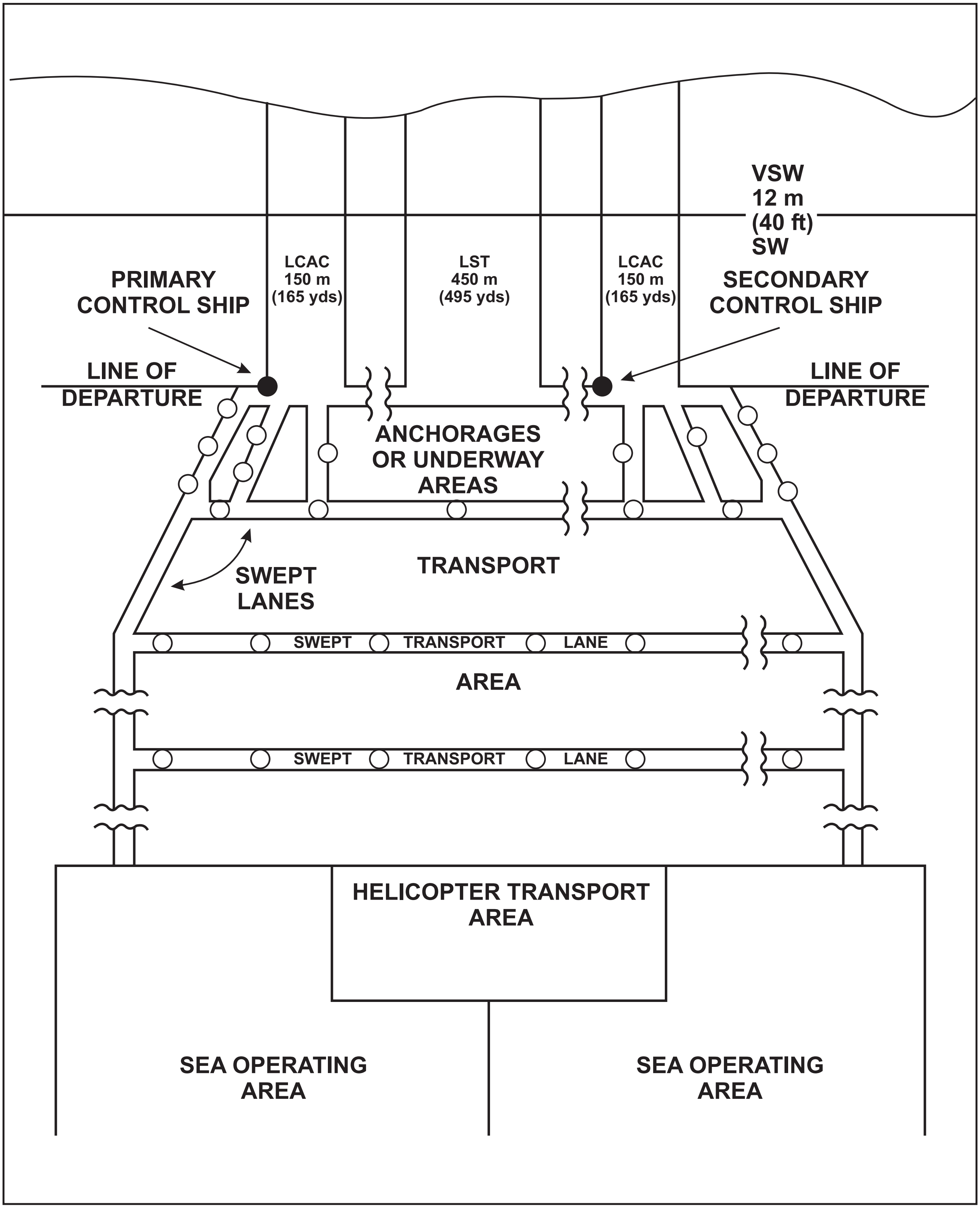


Figure 3-5. Notional AOA-LPA Configuration (Not to Scale)

ship-to-shore movement. The failure to address the threat will jeopardize D-day and H-hour. Minehunting and minesweeping are tedious and time-consuming endeavors. The difficulty increases as MCM efforts proceed from deep water into shallow water, VSW, SZ, and to the beach due to mine type, density, hydrography, and proximity to adversary fires. The vital portions of the AOA-LPA must be cleared and marked in concert with the commencement of the waterborne ship-to-shore movement. The time required to accomplish MCM is directly proportional to the number and size of lanes and penetration points to be cleared. Therefore, MCM efforts must commence sufficiently early during the advance force operations, preferably in a clandestine fashion.

3.7.6.3.2 Area Geometry

The design and size of the AOA-LPA and LPSs are greatly influenced by the ATF objective(s), disposition of the adversary forces, size of the landing force, scheme of the ship-to-shore movement, topography, and scheme of maneuver ashore. The geometric shape of the area to be cleared affects the efficiency and time required for MCM operations. Square and rectangular shapes are preferred over curved- and round-shaped lanes and areas. Square and rectangular shapes better facilitate the grid system layout of parallel, offset tracks for successive passes by MCM platforms as well as easing the marking and charting of mined and cleared areas.

3.7.6.3.3 Width of Areas

To facilitate MCM operations, the width of the lanes and areas must be kept to a minimum but be sufficient for the movement of assault shipping, boats and craft, and fire support ships. At H-hour or very shortly thereafter, the lanes must accommodate two-way traffic.

Ship-to-shore movement in a mined area requires approach-retirement lanes for vessels to transit between the ITA, the LD, as well as the SZ and CLZ. The nominal ship transit lanes should be 457 m (500 yd) wide, craft lanes 150 m (165 yd) wide, and assault lanes through the VSW and SZ to the penetration point may be 46 m (50 yd) to 150 m (165 yd) wide depending upon the circumstances at hand.

3.7.6.3.4 Uniformity of Depths

Selecting lanes where the depth of the water is relatively uniform and free from sharp peaks, valleys, and ridges facilitates dividing areas for MCM detection, identification, and clearance.

3.7.6.3.5 MCM Optimum Depths

Selecting landing beaches with a steep underwater gradient reduces the MCM effort particularly in the calculation of number of mine clearance systems required.

3.7.6.3.6 Mine Environment

The ATF can expect an increased mine density in shallow water approaches up to likely landing beaches and penetration points.

3.7.6.3.7 Precise Navigation

Precise navigation is imperative to secure mine protection for the assault force while transiting cleared lanes of minimal width. Further, mines and obstacles that cannot be cleared must be precisely marked for avoidance. The selection of navigation systems and establishment of the MCM navigation and reporting datum rests with the MCMC. Detailed discussion on MCM navigation is found in Chapter 7. Adversary situation permitting, visual marking systems should also be emplaced at lane and area boundaries.

3.7.6.3.8 Clandestine Operations

Early pre-assault MCM operations must be conducted clandestinely. Adversary detection or sightings of MCM activities will not only invite attack but will also forfeit the element of surprise.

3.7.6.4 Threat Assessment

3.7.6.4.1 General

Assessment of the mine threat must be continuous as information received from all sources is evaluated and processed. Rapid modification of basic plans may well be required to adjust to what is typically a fluid set of circumstances.

3.7.6.4.2 Sources of Information

Information on adversary mines can be obtained from allied, national, and local intelligence collection assets. As the concept of the amphibious operation is being developed, CATF should exploit products from all available intelligence assets. Sources include:

1. Intelligence publications:

   a. Adversary OOB in the AOA-LPA as well as his MIW doctrine and capability

   b. Hydrography of shallow water region and potential approaches to landing beaches.

2. Intelligence reports from fleet and national agencies.

3. Mine-watching and surveillance reports from NSW, reconnaissance teams, and friendly forces in the objective area.

4. Reports from MCM units.

5. Other intelligence sources include data or imagery collected by satellites, aircraft, and remotely operated vehicles. Aerial imagery may be particularly effective in clear SW.

3.7.6.5 Adversary Minefield Planning Considerations

3.7.6.5.1 Shallow Water MCM

A clever foe will create a barrier defense using a combination of mines, placed in depth, to reinforce and protect obstacles that will be covered by fire and observation. This theme will remain an essential feature of any adversary effort to repulse an armed assault from the sea. Thus, the focus of MCM is to underpin amphibious mobility by neutralizing those naval mines found in the beach approaches. This is frequently referred to as SWMCM because the continuum of critical areas for the landing force extends from the SW toward the VSW, into the SZ, and up to the HWM. MCM operations from seaward may begin in the deep waters of the AOA-LPA, but MCM forces can rapidly encounter shallow water as they progress toward the beach. SWMCM presents challenges that include greater mine density, more mine types (such as antiboat, antitank, and antipersonnel), as well as the integration of mines with obstacles buttressed by an observed supporting arms plan. Furthermore, AMCM and SMCM platforms decrease in effectiveness as they enter into SW and become ineffective and extremely vulnerable in the VSW and SZ.

1. Surf zone (SZ). Here, any significant wave action will prevent a diver from maintaining the physical control required in the search for mines. Mines that might be found here include ground contact, ground influence, ground pressure plate, ground tilt rod, moored contact, moored influence, and anti-invasion. Additionally, the enemy will reinforce and tie-in existing obstacles with these mines, which will vastly complicate matters. The approach for conquering this daunting portion of the water column is the aforementioned brute force tactic.

2. Very shallow water (VSW). Mines found in this zone may include ground or moored contact, ground or moored single influence, ground multiple influence, and ground tilt rod. NSCT1 has been created specifically for duty in this region.

3. Shallow water (SW). This zone covers the 40- to 200-ft area. Moored contact and ground or moored single and multiple influence mines will be found here.

At present, SWMCM capability is very limited. The primary means for conduct of the amphibious breach are NSCT1 followed by an application of explosive methods for the SZ. Amphibious planners must consider increased time for the pre-assault phase to accomplish clearance and/or locate and define lanes and areas that will reduce the MCM effort.

The magnitude of the task will be determined by:

1. Distance from the 12-m (40-ft) curve to the HWM

2. Number, length, and width of boat lanes

3. Mine and obstacle density and design

4. Mine size and type

5. Requirement to remain clandestine

6. Whether or not the beaches are defended

7. Accuracy of adversary observation and covering fires

8. Environmental conditions such as weather, bottom topography, water and air temperature, lighting conditions, and water conditions (sea state, current, and turbidity)

9. Beach gradient (determining beginning of the SZ and quantity of mine clearance munitions required).

3.7.6.5.2 Minefield Design

With the exception of remote controlled (command detonated) mines, a minefield denies area access to both friend and foe. Within the context of this chapter, the purpose of the adversary obstacle system is to slow, influence the movement of, or stop an amphibious force from reaching the shore while taking that force under intense fire. The density of the field tends to increase closer to shore. While mines are usually targeted against ships in deeper waters, in the VSW and SZ the field includes anticraft, antipersonnel, antitank, and tilt-rod actuated mines. Figure 3-6 portrays a potential shallow water profile.

3.7.6.5.3 Impact of Amphibious Traffic on Mine Placement

To support an extended or prolonged campaign, much of the landing force equipment and supplies must go over a beach acceptable to conventional displacement landing craft. The adversary will be able to concentrate his mining at these locations. Given the capability of the ATF to launch amphibious assaults from over-the-horizon (OTH) and with more penetration sites and points usable by LCAC, the adversary may not be able to mine all beaches. This could result in lower mine density or areas that are unmined. The situation also increases the difficulty of adversary mining in reaction to the appearance of an ATF.

3.7.6.5.3a Delayed Mining Operations

Installing an impenetrable anti-invasion defense or mining all potential assault beaches requires enormous resources and may be well beyond the means of an adversary. Also, mining one’s own waters has a number of disadvantages. The adversary may, therefore, delay mining operations until the location of the assault area has been deduced or confirmed.

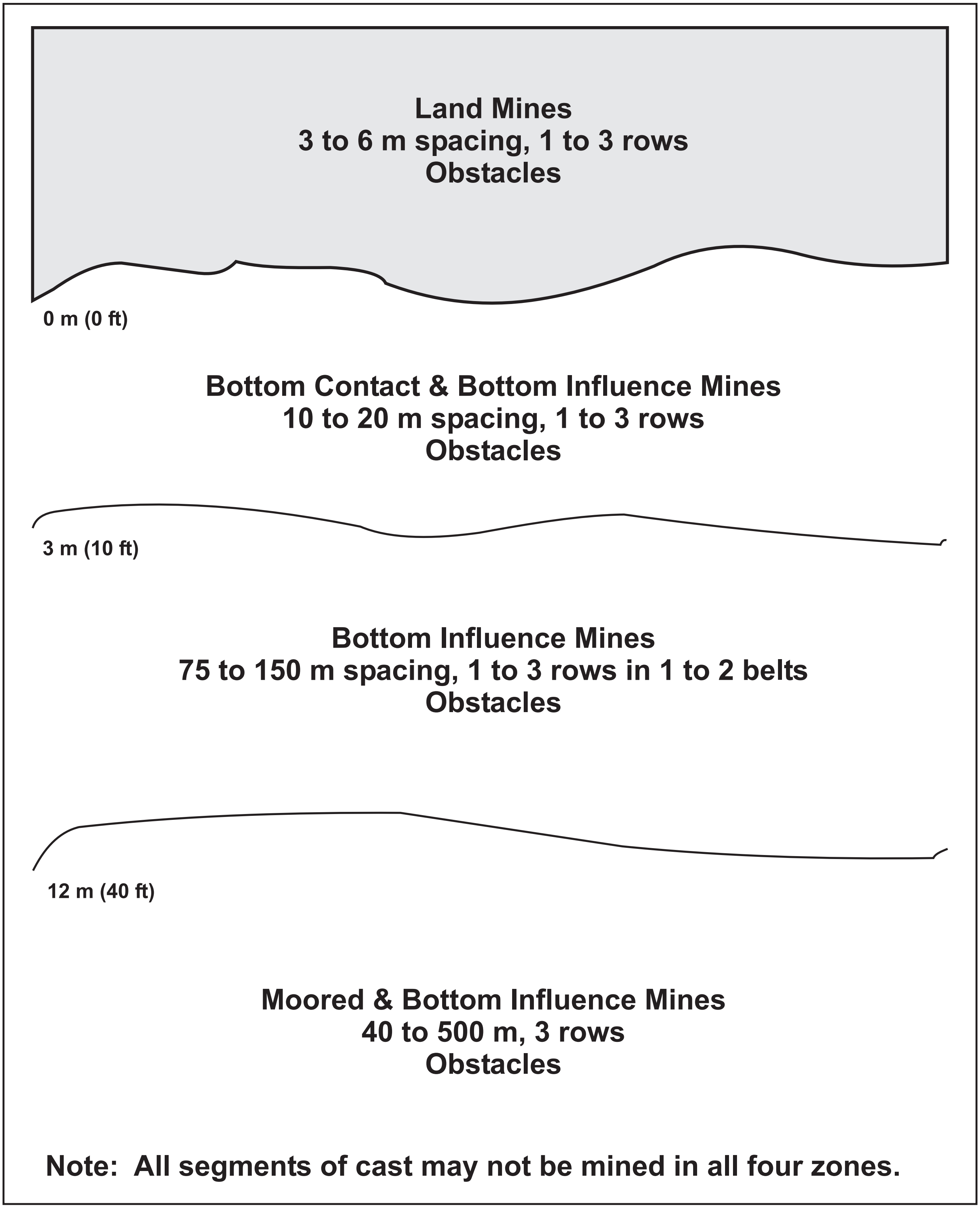


Figure 3-6. Shallow Water Minefield Profile

3.7.6.5.3b Coordination With Overall Threat

Virtually all adversary forces have minelaying potential, ranging from rudimentary to highly sophisticated. Therefore, it is important that mine threat assessments be coordinated and reconciled with the air, surface, and subsurface warfare threat assessments.

3.7.6.5.4 Vulnerability of Amphibious Craft to Mines

3.7.6.5.4a Landing Craft Air Cushion

At very low speed and off-cushion, LCACs are vulnerable to ground, antipersonnel, antitank, and moored or drifting mines or mines designed to target high-speed nondisplacement craft. When on-cushion and traveling at high speed, LCACs are somewhat less vulnerable to mines designed for displacement craft. Detailed, classified statistics on this subject have been compiled in a study by the NSWC CSS, Panama City, FL, and are available for fleet review.

3.7.6.5.4b Displacement Craft

Conventional landing craft such as the landing craft, utility (LCU), LCM 8, and amphibious assault vehicles (AAV or AAAV) are vulnerable to the full range of mines.

3.8 RIVERINE MINE COUNTERMEASURES OPERATIONS

Riverine MCM operations include all MCM activity 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 maneuver room in many riverine scenarios make most current MCM platforms and systems poorly suited for these operations.

Of the SMCM platforms and systems in current use, some could 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. Navigation drafts of 18 ft and 15 ft, respectively, prevent employment in the shallow river environment except where deep channels exist. Additionally, the MCM systems installed are all designed to operate in water greater than 30 ft deep, and the sonar requires a minimum water depth in the 50-ft range for deployment.

AMCM helicopters could be employed in riverine operations provided the surrounding geography affords maneuver space. Riverbanks shrouded with tall or overhanging trees could cause severe limitations. Vulnerability to adversary ground fire from concealed positions is a force protection issue that must be adequately addressed.

The AMCM shallow water sweep systems (SPU-1/W MOP and A Mk 2(g) Rattlebars) would be effective, but the AN/AQS-14A Sonar, Mk 104, and Mk 105 Sweep Systems would probably not be functional.

UMCM should be fully capable in riverine operations, although poor water clarity or swift currents might hamper divers. MMS systems would not be employable since they require a seawater environment.

Regardless of the platforms or systems being employed, force protection for those assets is required.

3.9 DEPLOYMENT OF MINE COUNTERMEASURES FORCES

Dedicated MCM forces consist of both domestic and forward-deployed naval forces (FDNF). OPLAN response calls for deployment of domestic MIW forces to supplement the FDNF in critical theaters of operation or as the initial response in other theaters in accordance with time-phased force and deployment data (TPFDD) flow. The proliferation and sophistication of the maritime mine threat dictates that MCM forces be assigned a high priority in the allocation of lift assets to ensure early arrival in theater. The most effective counter to a determined hostile maritime mine threat is deployment of the complete MCM triad, a combined employment of SMCM, AMCM, and UMCM assets under the operational control of a MCMC embarked on-board the MCS.

OPLAN activation results in the rapid mobilization of AMCM, UMCM, and battle staff functions followed by movement of SMCM forces. Generally, AMCM, initial UMCM units, and some MCM staff members quickly airlift into theater. SMCM units are limited in speed and endurance and the options available for their deployment are described below. The MCS deploys in accordance with TPFDD flow, or as directed by operational commanders.

When feasible, site surveys should be conducted in areas where there have been no recent MCM operations. The unique support requirements for MCM forces justify an advance party visit. They 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.

3.9.1 Surface Mine Countermeasures Forces

Surface MCM ships transit to the area of operations in three ways: self-transit, towing, or heavy-lift ship. Heavy-lift is the preferred means of transit to support theater OPLANs. Such a lift is conducted in accordance with commercial contract sponsorship of MSC. The heavy-lift option eliminates strain on SMCM propulsion systems and accelerates the actual transit. However, there are no government-owned heavy-lift transports in service, thus commercial vessels may not be available. There are only a limited number of these ships and they are currently under contract to foreign oil industries. Such circumstances place operational timelines in potential jeopardy. Another option under examination is the employment of lift-on/lift-off (LO/LO) craft that feature cranes for loading SMCM ships onto cradles.

Should SMCM be required to sail under their own power or by towing, they will require escort craft that are capable of providing underway replenishment and towing multiple MCM ships. Further, once in theater, maintenance and training requirements will cause added operational delay.

The following characteristics may be advantages or disadvantages, depending on the scenario and distance to be deployed:

1. Self-transit:

    a. Maximum sustained speed of advance (SOA) is 8 knots.

    b. Engine wear is a distinct possibility.

    c. Refueling required at 4 to 5 day intervals using astern rig.

    d. High sea states can significantly impede or prevent transit.

    e. Maintenance period is required on arrival for planned maintenance system (PMS) and voyage repairs.

    f. Full crew rides the ship.

    g. Escort required for extended transits to provide fuel and logistics support.

    h. If escorted by MCS the MCMC, AMCM, and EOD can also be embarked.

    i. Escort may carry spare parts, engines, and sweep gear.

    j. Transit time may not meet OPLAN requirements.

2. Towing:

    a. Dedicated towing platform(s) must be assigned.

    b. Tow speed may be less than self-transit speed.

c. High sea states may result in damage to the towing or towed vessels and significantly delay or prevent transit.

d. Maintenance period required upon arrival for extended transits.

e. Crew can ride the ships, but training en route is limited.

f. Tow ship may not be able to transport spare parts, engines, and sweep gear.

g. Ship's service diesel generators may sustain wear.

h. Does not cause wear on engines.

3. Heavy-lift ship:

a. Limited availability of these foreign-flagged vessels will entail detailed contract process and pronounced financial expense.

b. Certain heavy-lift ships cannot transit the Panama Canal.

c. Requires deep berth (60 ft) for load and off-load with calm weather or protected waterways.

d. Loading requires four days; off-load requires three days.

e. Typical transit speeds of 12–14 knots. No engine wear, but potential power train misalignment from docking.

f. Lift ship is not as susceptible to delay by harsh weather.

g. Lift ship can carry containers of spare parts, sweep equipment, C4I vans, etc.

h. Will require significant additional funding for MSC.

i. Minimum caretaker crew is embarked on heavy-lift ship. Remainder of crew requires airlift or sealift into theater.

Once in the area of operations, SMCM forces require unique support. SMCM hulls are constructed of wood with a glass-reinforced plastic (GRP) sheath (MCM 1 Class) or are solid GRP (MHC 51 Class). Mooring facilities should have Yokohama-style fenders to protect the hull from direct contact with the pier. The size and configuration of these ships may require modified brows when placed at commercial docking facilities. SMCM ships require frequent replenishment of supplies, often in smaller quantities than most ship chandlers are accustomed to administering. Crew support features include disbursing, ship's store, barber, and medical-dental facilities. A shore facility or host ship must provide these services in the absence of the MCS.

3.9.2 Airborne Mine Countermeasures Forces

The AMCM mission includes a quick response readiness posture, the ability to deploy worldwide via air or surface lift, and the ability to conduct operations from the MCS, land bases, aircraft carriers, and large deck amphibious ships.

Transit can occur via assisted self-lift, airlift, or surface lift. For short-range deployments, MH-53Es can fly cross-country accompanied by support personnel and with MCM equipment on board. Remaining support equipment and personnel can be carried by ground transportation or C-17, C-130, and C-141 airlift. Transportation of all support equipment and 90-day packup by ground requires 20 to 30 trailer trucks, depending on the sweep systems required.

For long-range deployments, AMCM can be transported by C-5A, C-17, or C-141 airlift. Approximately four C-5As and twelve C-141s are required to deploy a 7-aircraft squadron. The squadron has a computerized loadout support system program to prepare the load plan that interfaces with the Air Force computer-aided load manifesting program.

USS INCHON (MCS 12; formerly LPH 12) was decommissioned as a command and support ship for MCM triad operations. This means AMCM requires a large-deck aviation-capable ship, such as a CV, LHA, LHD, or LPD. Operation from a CV or CVN will displace air wing assets and requires significant modification of the normal flight operations routine. Operation from an amphibious platform in conjunction with Marine air assets creates a similar impact and requires significant coordination.

Employment of any amphibious ship as the primary platform for AMCM will result in the displacement of a significant portion of embarked Marine forces.

An LPD can accommodate only four aircraft, thereby limiting operations. It provides no maintenance support, such as an aircraft intermediate maintenance department (AIMD) or hangar deck maintenance area, and cannot accommodate utility aircraft. Embarkation on an LSD would prohibitively limit AMCM capabilities. All platforms require 3 to 5 days for embarkation to properly stow equipment.

The normal AMCM deployment package includes seven MH-53E helicopters, Mk 103/104/105 minesweeping systems, AN/AQS-14A sonar, AN/ALQ-141 countermeasure sets, ground support and maintenance equipment, a 90-day packup (205 m^3/7,240 ft^3, 2,650 kg/5,842 lb), rigid-hull inflatable boats (RHIB) for equipment launch and recovery, and approximately 450 people. Logistics support required for AMCM while deployed for operations is similar for shipboard or shore operations:

1. Normal aviation support facilities aboard ship or ashore are runways, parking apron, fuel trucks, etc..

2. Accommodation for 90-day packup; spare aircraft parts for 90 days (weigh 32,660 kg/72,000 lb and occupy 650 m^2/7,000 ft^2) requiring covered storage.

3. Office space of 383 m^2 (4,120 ft^2).

4. Berthing and messing for 450 personnel.

5. 83,280 L (22,000 gal) of JP-5 per day (if each aircraft flies a single mission), diesel fuel required for RHIBs.

6. Freshwater wash capabilities for aircraft and sweep systems.

7. Mk 105 sled launch and recovery requires crane, if ship has no well deck, or boat ramp located at a shore site.

8. RHIBs for sled operations require crane or davit for launch from trailers, or pier berthing and parking area for shore operations.

9. AMCM packup includes four mobile maintenance facilities (MMFs) erected to conduct equipment maintenance.

10. Ground support equipment, such as forklifts, mobile power units, hydraulic test stands, tow tractors, workstands, cranes, nitrogen cart, etc. If aboard ship, many of these items will be provided.

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

3.9.3 Underwater Mine Countermeasures Forces

3.9.3.1 Explosive Ordnance Disposal MCM

EOD forces are structured and trained to deploy and perform specialized missions relative to diving and demolition missions.

EOD MCM personnel can deploy on short notice for operations in conjunction with SMCM vessels, AMCM aircraft, or independently from shore-based and shipboard facilities. These detachments are designed for short notice deployments and except for water, food, fuel, and demolitions can operate for approximately 30 days without resupply. Details regarding specific embarkation requirements are found in Chapter 9.

3.9.3.2 Naval Special Clearance Team One

In the event of war this specially trained, manned, and equipped unit is capable of deploying by airlift on short notice, to participate in advance force operations in the amphibious area of interest.

3.9.3.3 Marine Mammal System

MMS are deployed to operate with UMCM as a part of the integrated triad along with SMCM and AMCM. They may work in conjunction with EOD DETs or NSCT1. Certain conditions must exist in the area of operations to support them. They require a safe base of operations on a friendly shore site 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 m. Water temperature must remain between 42 °F (6 °C) and 91 °F (33 °C) during the period the dolphins are in the area, although they can be acclimated to endure some extreme ranges. There must be no significant environmental pollution, and water salinity must be at least 20 parts per thousand. Prior to deployment, a site survey is necessary to determine the suitability of the area and available support. The survey takes from 1 to 3 days and includes water chemical sampling, facility inspection, evaluation of OPAREA features, and logistics support arrangements.

Mk 4 or Mk 7 can deploy on short notice with the ability to operate independently with only minimal support once at the forward station. This includes all major equipment required for navigation, local transportation, communication, and animal husbandry. Environmental conditions can limit the choices for designating MMS operating areas and bases.

NSCT1 features human divers and MMS trained to conduct hydrographic exploration and reconnaissance, as well as mine clearance in the VSW depth regime, where favorable environmental conditions exist, in support of amphibious operations. The detachment is a specialized unit composed of SEAL, EOD divers, and USMC reconnaissance specialists who employ as dive teams in conjunction with MMS (EX 8). The detachment is capable of detecting, classifying, identifying, and neutralizing mines while opening assault lanes for landing craft. They can deploy on short notice and are capable of operating from shore sites or at sea from appropriately configured amphibious ships.

3.9.4 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 MCM squadron staffs. The primary purpose of these officers is to maintain the communications flow between a task group and force commander or theater commander and the MCMC. They are instrumental in making the initial decisions on required forces and preparation for deployment of follow-on forces.

The MCMC and staff can be deployed by airlift independent of other forces or by sea embarked on the MCS. The staff may consist of between 15 to 20 people with administrative support equipment and supplies. They can be deployed on very short notice, but not until some support facilities are available in theater.

For effective planning and control, the MCMC requires a dedicated command center with C4I capabilities. MCM and MHC ships are not equipped to support a staff because of limited berthing, insufficient communications, and no spare space in the combat information center (CIC) for staff use. The MCS is the ship of choice. It is possible to be set up in an ashore command center. Minimum basic requirements are as follows:

1. Secure space for six to eight people (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. Power source for desktop computers

5. Messing and berthing.

If no established command center exists ashore, an alternative is to use the COMINEWARCOM deployable C4I van. This system is intended to be a self-contained command center that can be embarked on ship or set up ashore. It is equipped with all, necessary communications and tactical data systems to support the MCMC. Characteristics can be obtained by contacting COMINEWARCOM, N2 Department.

Although far less desirable, another option is to use a mobile inshore undersea warfare (MIUW) command van that can fulfill the minimum communications requirements.

3.9.5 MCM Command and Support Ship

The MCS is the critical link in the MCM C2 and logistics support chain. This was demonstrated in the Persian Gulf and during mine clearance operations in North Vietnamese waters. For both operations, amphibious ships of opportunity were configured to temporarily fill the MCS role. With the loss of USS INCHON (MCS 12), a large deck of opportunity is required.

The effort required to properly configure a substitute is extensive. It must support the entire MCM triad, each element of which has unique equipment and limited organic repair, maintenance, and supply capabilities. The MCS must provide:

1. Maintenance and repair services that include support for nonmagnetic engines and combat system equipment

2. Storage space for spare and repair parts including replacement MCM gear, ammunition and demolition explosives, gasoline, diving gear, and recompression chambers

3. Medical, dental, disbursing, and other personnel administrative support services.

In addition to serving as the support ship for the MCM elements, it must also support the MCMC and staff. This places a considerable demand on the administrative and communications capabilities of any ship.

3.9.5.1 Airborne MCM Support Ship

If operational exigencies arise that require afloat basing of AMCM, UMCM, and MCM command elements, several ship-classes might be used to provide support. Each has its merits, and each, its deficiencies. Consideration must be given to duration, MCM elements involved, MCM equipment required, and the availability of logistic and repair support (see Chapter 11). Note that embarkation of AMCM aboard amphibious shipping will engender displacement of USMC assets, which translates into diminished landing force combat power.

1. LHA and LHD. These are considered apt platforms for AMCM operations should the urgent need arise, as they have the required facilities necessary to support independent MCM operations. The aircraft and MCM equipment, as well as all support equipment and personnel, can be loaded aboard and the ship prepared for MCM operations upon arrival in the OPAREA. If still required in an amphibious role, careful coordination is required to prevent shipboard support facilities and deck space from becoming critically overloaded.

2. LPD. With an abridged support capability, the LPD has been used for small, short-duration AMCM deployments. Aircraft size and deck weight limitations severely restrict sustained, high-tempo operations as do deck and storage space constraints.

3.10 INFLUENCE OF THE ENVIRONMENT

In strategic, tactical, and technical planning for both mining and MCM, the environment plays the dominant role. The Mine Warfare Environmental Decision Aid Library (MEDAL) is the primary tactical planning and evaluation tool. This system provides access to the MIW environmental database that supports this planning function. Minelaying missions will be conducted only if environmental conditions are favorable for delivery and weapon effectiveness after placement. Mines and components (cases, sensors, and target signals) are all affected in significant ways by myriad environmental factors. The fundamental decisions in MCM to conduct exploratory and reconnaissance operations, as well as which MCM technique to employ, are found in a matrix summary of environmental factors affecting MCM provided in Figure 3-7. A detailed examination of environmental factors affecting mine countermeasures is found in Chapter 6.

3.11 MINE COUNTERMEASURES FORCE COMMAND AND CONTROL

3.11.1 Concept of Operations

Command and control of MCM requires meticulous planning and execution. The MCMC 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 execution.

Successful planning requires the following:

1. A MIW liaison officer may be designated for duty with the BG, even when no MCM force is present.

2. The MCMC must be included in communications at the same level as other warfare commanders.

3. The levels of command between the overall commander and the MCMC should be few. MCM forces should be in the same chain of command as the forces they support to avoid excessive delay and unnecessary message traffic.

4. The MCS ship should be under the tactical control of the MCMC to avoid conflict in tasking and assigned missions.

5. Protective forces for MCM assets should be under MCMC tactical control.

Every operational staff, whether it is a naval component commander, numbered fleet commander, or amphibious squadron commander, should have a billet with the responsibility for MIW. In some cases this may be a collateral duty for an officer who has had mine warfare exposure (often an attack or maritime patrol aviator who has some mining training). Because few of these officers have had sufficient experience or training in MCM to advise the commander effectively when a mine threat is encountered, it is essential that MIW training for these officers be given a high priority. Such courses are available at the MWTC.

When MCM assets are deployed to counter a threat, the BG should be augmented by one of the three tactical MCMRONs. The MCM squadron commander will assume the duties of MCMC.

The MCMRON may have officers on staff designated as liaison officers. Their mission is to advise the commander who requires on-scene assistance in coordinating the support of an MCM force. Prior to the MCMRON's arrival in theater, the liaison officer may be deployed as a quick response advance party and may be instrumental in determining what forces are required to counter a threat, while the rest of the 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 ATF. Thus they may participate as part of a demonstration force intended to mislead the adversary 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 situation 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-LPA, MCM forces conduct operations as a task group under OPCON of the advance force commander. The presence of a MIW officer on the advance force staff is critical to ensure close coordination with other advance components, such as intelligence, fire support, reconnaissance, air, and force protection. 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 until conclusion of the operation, close coordination is required between the MCMC and other ATF and landing force elements. If MCM is to continue after the termination of the amphibious operation and disestablishment of the ATF, OPCON may shift to the area commander.

3.11.2 Mine Countermeasures Staff Organization

There are many aspects of an MCM operation that are unique. 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. They can dispatch 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 mission, 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. MCMC (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 information technicians (one E5 and one E3).
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).

Category	Factors	Major Operation 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, 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, and logistical concerns.
Water Depth	Bathymetry, seasonal storms, river run-off.	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 condition, 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 riverine-originated currents.	Navigation and maneuver 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 compilation of conductivity for magnetic sweep; sonar depth and effectiveness.
Seabed 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 velocity profile, acoustic propagation/attenuation, acoustic scattering, and reverberation.	Sonar settings, ranges, and effectiveness, acoustic sweep path and sweep safety, number of MILCs, and sonar hunting efficiency.
Magnetic Environment	Electrical conductivity, 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.
Biologic Environment	Bio-fouling conditions, hazardous marine life.	Ability to detect and classify mines visually or with sonar; marine life presenting potential hazard to divers.

Figure 3-7. Environmental Considerations in Mine Countermeasures

3.11.3 The Mine Countermeasures Command Center

To perform his duties effectively, the MCMC requires facilities to set up a command center and establish a watch. The function of the command center is to manage MCM and mining operations while the MCMC is involved in planning. If minefield planning is assigned to another commander, the MCMC must still plot mine positions and record mine settings in case he is required to clear the minefield. The command center should include automated 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 and MILCs.

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. Global Command and Control System — Maritime (GCCS-M) with the MEDAL segment and databases are critical for maintaining the rapid flow of information.

If the MCS or other support ship is not available, and no established command center exists ashore, there are two options for establishing a temporary center. One is to use the COMINEWARCOM MIW C4I Mobile Integrated Command Facility (MICFAC), which is designed to meet all of the MCMC needs. The other option is to request the use of other Mobile Naval Command and Control assets that can fulfill the minimum communications requirements. These include: MIUW C2 vans, other MICFAC or mobile ashore support terminal (MAST) units, or reserve mobile ashore support terminal (RMAST) units.

The MCMC 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. As the Navy transitions to Netcentric Warfare, access to both SIPRNET and NIPRNET (either by satellite or if available, ashore through landline) is of paramount importance. The Officer in Tactical Command Information Exchange System (OTCIXS) and Common User Digital User Information Exchange System (CUDIXS) are required via UHF Satellite Communication (SATCOM), unless the information provided by these legacy circuits can be obtained by other means (e.g., SIPRNET or GATEGUARD).

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 UHFline of sight (LOS) voice and data, secure UHF SATCOM voice and data, and possibly VHF voice circuits. POTS with STU III or STE capability for clear/secure voice, fax, and data communications are also required.

3.11.4 Mine Warfare C4I Systems

The purpose of the MIW C4I system is to link MCM forces with the MCMC and integrate with all other expeditionary warfare elements using Navy standard C4I systems. To fulfill this mission, C4I and IT21 systems have been developed that provide MCM forces with the ability to communicate with each other and the MCMC by using computerized data links. This provides the MCMC and MCM forces with a common operational picture (COP) within the GCCS-M system, which is common to other warfare forces.

Computer-based tactical decision aids that are used by MCM forces for planning and analysis are incorporated into the MEDAL, which has been fielded as a segment of GCCS-M (available to all MCM planners).

The MIW C4I to support a deployed MCMC can be met by the integrated C4I system aboard the COMINEWARCOM MIW C4I MICFAC. The MICFAC system can also operate from a shore site. Use of MICFAC requires consideration for force protection, messing, billeting, and a source of diesel fuel for two generators.

Included within the MEDAL computer tactical decision aid are the following capabilities:

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 (future release)

7. Environmental database

8. Q-Route and route survey database

9. Mine technical data reference

10. Mining and MCM asset data reference (future release)

11. Digital chart reference

12. Message processing.

3.11.4.1 MCM Unit C4I (Communications Capability)

The MCM 1 was designed with a limited satellite transmit and receive capability. MHC 51 was designed as a coastal operations platform with no satellite transmission capability. Starting in 1995 the first phase of C4I improvement was made. This included the OE-82 UHF SATCOM antenna system, DAMA (through the AN/WSC-3 - TD1271, the Mini-DAMA AN/USC42(V 1 or 2), or the AN/WSC-3 - AN/USQ-145 (V 1, 2, 3 or 4) and GCCS-M AN/USQ-119B(V). These improvements provided simultaneous access to satellite SECVOX, CUDIXS, and OTCIXS. Phase 1 is now complete for all MCM and MHC craft. Phase 2 began in 2000. These IT21 upgrades first targeted for MCMs are composed of INMARSAT B (HSD), ADNS, "J98" (now referred to as GCCS-M/(NT), and CFCP). These new systems together supply a 64 kbps satellite communication "pipe," multiplexed to provide up to 4 POTS lines for secure or clear voice, fax, and data along with 32 kbps shared IP data for SIPRNET or NIPRNET access.

The MH-53E AMCM helicopter now has a unique data link which can downlink data to the AMCM mobile operations center (MOC). Both HM-14 and HM-15 each have a MOC to support this data link. This provides helicopter position data and AQS-14 snippets from up to six airborne units over an encrypted HF circuit. This data is processed and displayed by the MEDAL Tactical Decision Aid (TDA).

3.11.5 Mine Countermeasures Planning

To plan missions and provide tasking to MCM units, the MCMC is normally provided with an MCM operational directive (MCM OPDIR) with specific information by higher authority. Key elements of the MCM OPDIR are listed below:

1. BG mission priorities

2. Risk estimates relative to how mines will affect the mission as planned

3. Known or assumed intelligence on the following:

   a. Adversary mine inventory, location of stockpile, and laying doctrine

   b. Adversary MIW order of battle and locations

   c. Geography and political boundaries in the area

d. Minefield structure (density, spacing, patterns, mine types, etc.)

e. Defense of the minefield by non-naval assets such as artillery, aircraft, infantry, or armor.

4. Critical timing of events

5. Force protection

6. Supporting logistics arrangement

7. Tactical organization (who supports whom).

The MCMC will brief the BG on possible COAs to prevent, limit, or eliminate the impact of adversary mining on the mission objective and will recommend an MCM objective and risk directive for the operation to be planned. The BG must select the MCM objective, MOE, and risk directive prior to issuing an operational tasking directive based on these recommendations. The risk directive approved by higher authority has a major impact on the approach to MCM operations and the techniques selected by the MCMC. Each of these items will then determine the information contained in an MCM task order.

3.11.6 Mine Countermeasures Exercises

Exercises involving MCM forces are the primary opportunity to conduct integrated training with BG elements. 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 exercises with numbered fleet commanders. Participation in NATO or other allied exercises is coordinated through COMLANTFLT. Whenever possible, an integrated MCM task group with an MCM squadron commander will participate in major exercises. When participation by MCM forces in the exercise area is not feasible, they may participate in a separate operation area using scripted geography to duplicate the exercise scenario. Although the forces may be separated by thousands of miles, the MCMC can receive tasking from the BG, carry out planning, direct execution of the MCM effort, and report results just as if the two forces were operating together.

3.11.7 Mine Countermeasures Exercise Analysis

A number of agencies conduct MIW analysis to measure operational effectiveness and to identify equipment deficiencies for COMINEWARCOM. 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

Mine Countermeasures Forces

4.1 INTRODUCTION

This chapter describes resources of the U.S. Navy MCM triad (AMCM, SMCM, and UMCM). Fleet MCM forces are supported by the type commander and staff and a broad network of laboratories and field activities.

4.2 AIRBORNE MINE COUNTERMEASURES

This section describes the general capabilities of MCM helicopters and their systems. Additional information on AMCM functions and capabilities contained in NTTP 3-15.22.

The AMCM force consists of two squadrons, HM-14 and HM-15, and an AMCM Weapons Training School. The operational squadrons are organized and trained for rapid deployment and can be largely self-sustaining when operating from the MCS or a shore site. Principal capabilities of the aircraft include:

1. Sonar mine search and bottom mapping
2. Moored minesweeping
3. Influence minesweeping
4. Precision navigation.

4.2.1 MH-53E Helicopter

The AMCM helicopter is the MH-53E Sea Dragon, a three-engine aircraft capable of a maximum takeoff weight of about 31,640 kg (69,750 lb). The aircraft can fly for approximately four hours, assuming that environmental conditions do not restrict full-capacity fueling (see Figure 4-1).

4.2.2 AMCM Systems

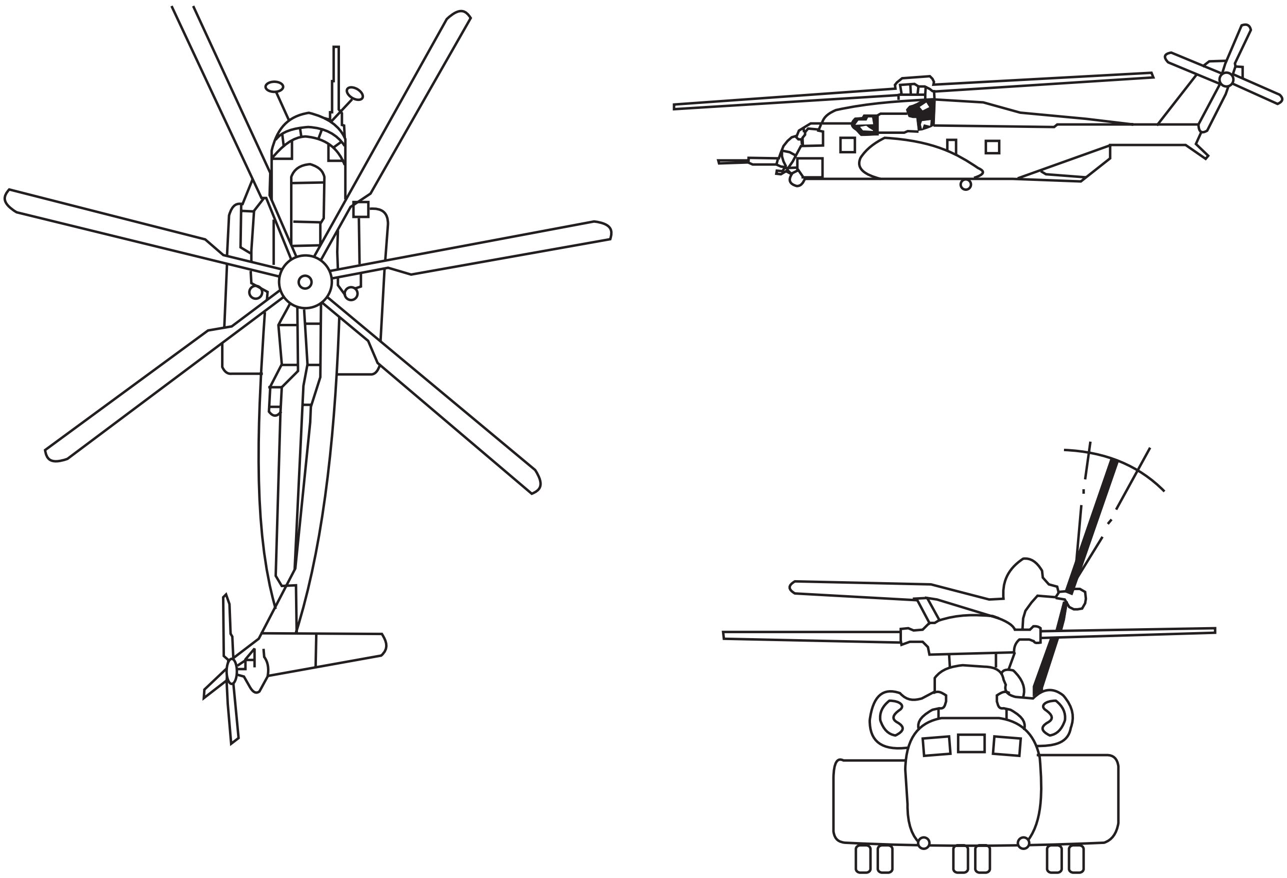
The major equipment used by the AMCM forces is described below and in Figure 4-2. The systems are modular to permit installation and removal.

4.2.2.1 Mk 103 Mod 2 Mechanical Minesweeping Equipment

The Mk 103 mechanical minesweeping equipment is used against moored mines in shallow water (see Figure 4-3). Positioned along the sweep wires are cable cutters that actuate when in contact with mooring cables. It is streamed, towed, and recovered by the helicopter. Use of a spotter helicopter with EOD embarked is necessary for disposal of severed mines.

4.2.2.2 Mk 104 Mod 3 Acoustic Minesweeping Device

The Mk 104 Mod 3 acoustic minesweeping device is the principal airborne acoustic sweep, towed by the MH-53E (see Figure 4-4). 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 rotates the disks causing a cavitation effect in the venturi tube producing a steady acoustic output. A drag-brake system permits the output frequency to be preset before the device is streamed from the helicopter.



DIMENSIONS	
LENGTH Unfolded Folded	 37m (99 ft) 22 m (71 ft)
HEIGHT Unfolded Folded	 9 m (28 ft, 4 in) 6 m (18 ft, 7 in)
WIDTH Unfolded Folded	 24 m (79 ft) 8 m (27 ft, 7 in)
TAIL ROTOR Diameter	 6 m (20 ft)
MAIN LANDING GEAR Tread	 4 m (13 ft)

Figure 4-1. MH-53E Helicopter

EQUIPMENT	MINE TYPES					
	MOORED			GROUND		
	CONTACT	ACOUSTIC	MAGNETIC	ACOUSTIC	MAGNETIC	COMBINATION
Mk 103 Sweep	X	X	X			
Mk 104 Mod3 Sweep		X		X		
Mk 105 Sweep			X		X	
AN/SPU-1/W (MOP) Sweep			X		X	
AN/AQS-14 Hunt	X	X	X	X	X	X
AN/ALQ-141 Hunt/Sweep		X		X		
Mk 106 Sweep		X	X	X	X	X
AN/SPU-1/W/A Mk 2(g) Sweep (Shallow Water)		X	X	X	X	X
Mk 105/A Mk 2(g)		X	X	X	X	X
A/N 37-U Controlled Deep Sweep	X	X	X			

Figure 4-2. AMCM Equipment

4.2.2.3 Mk 105 Mod 4 Magnetic Minesweeping Sled

The principal airborne magnetic sweep system is the Mk 105 Mod 4 towed hydrofoil, the operating functions of which are controlled by the helicopter (see Figure 4-5). Electrical current produced by the gas turbine and generator on the hydrofoil is connected to a buoyant cable and electrode array. This current produces the magnetic field for defeating magnetic mines. The hydrofoil and magnetic tail must be floated by a ship or from the beach and the tow transferred to the helicopter. Once in tow by the helicopter, succeeding aircraft-to-aircraft transfers can be made.

4.2.2.4 A/N 37-U Controlled Deep Sweep

A system developed to provide increased depth capability for AMCM use is the A/N 37-U controlled-depth sweep shown in Figure 3-3. 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 have 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 surfaces, may be necessary as depth increases. No surface floats are required.

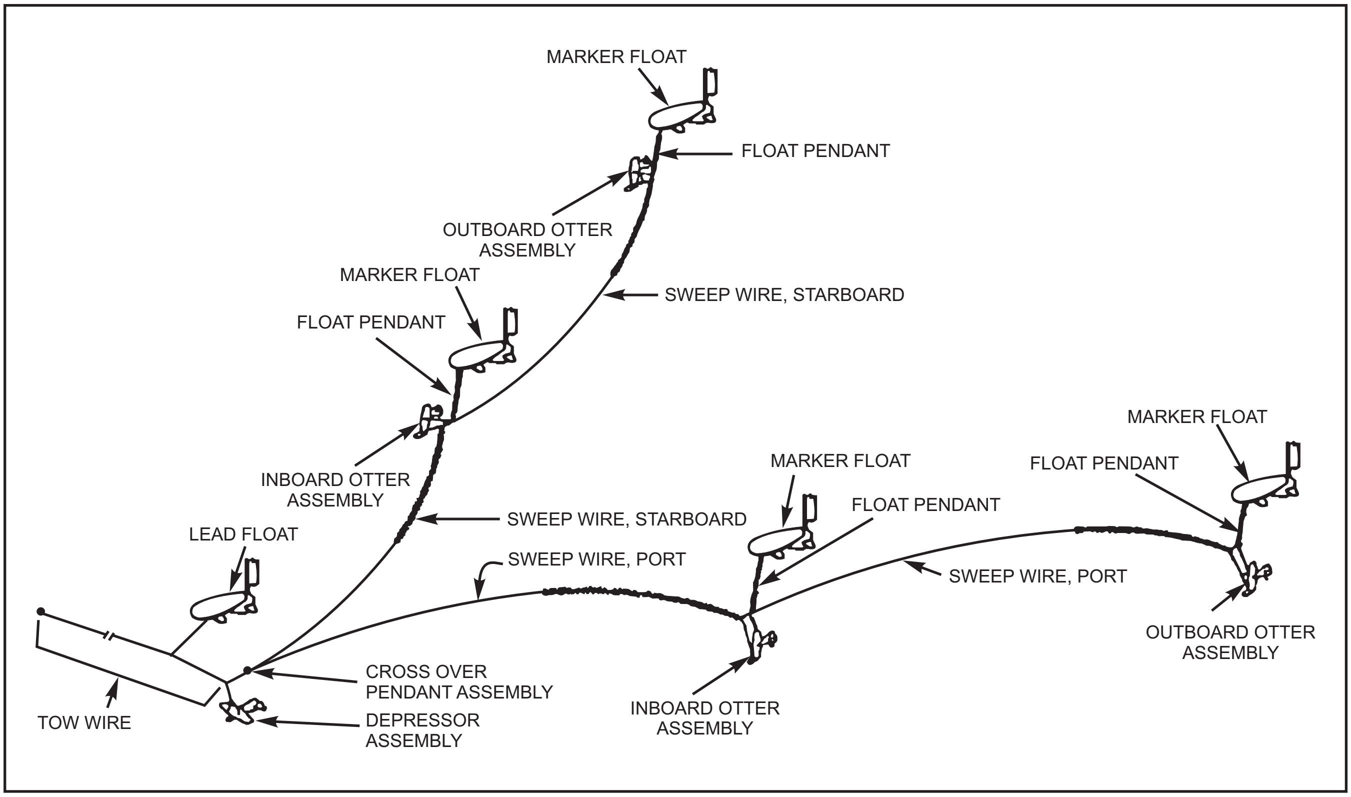


Figure 4-3. Mechanical Minesweeping Gear Mk 103 Mod 2, Assembly 02

4.2.2.5 AN/SPU-1/W Magnetic Orange Pipe

The AN/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 (see Figure 4-6). It is a ferrous metal pipe that is 30 ft long, 10 3/4 inches in diameter, weighs 1,000 lb, 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 magnetized 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 may be towed together by the MH-53E helicopter to increase the coverage.

4.2.2.6 AN/AQS-14A Airborne Minehunting Sonar

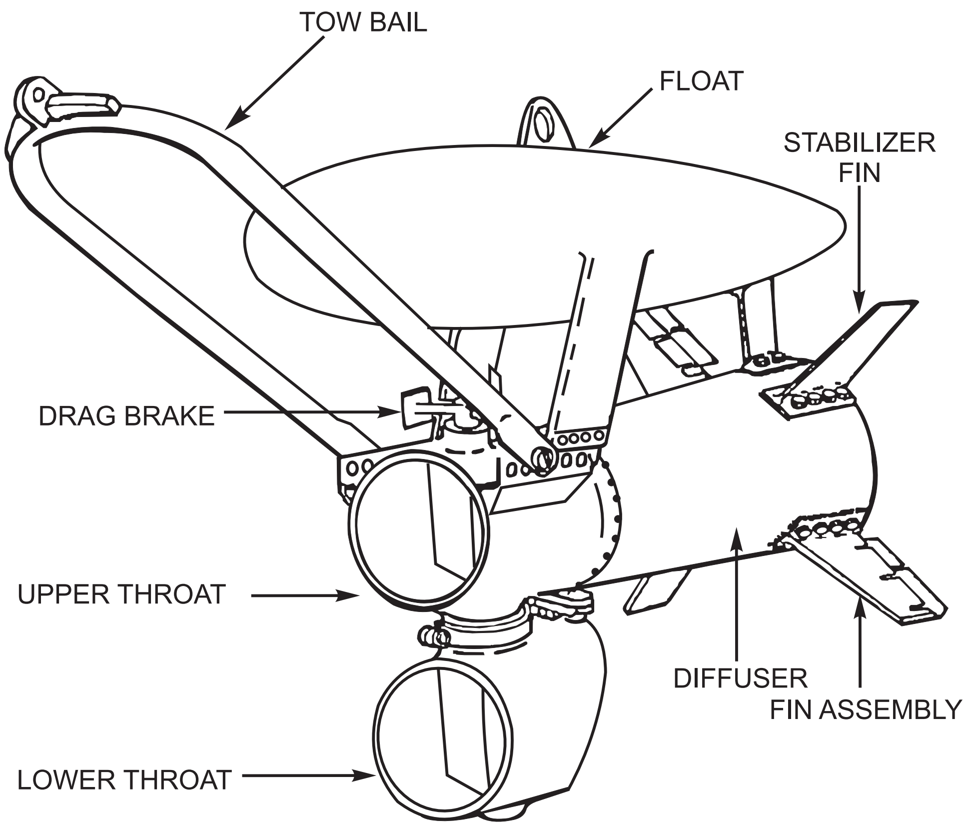
The AN/AQS-14A is a high-resolution, multibeam, side-looking sonar system (see Figure 4-7). The towed body is streamed from the helicopter and towed at speeds of 14 to 18 kts. System operators aboard the helicopter observe possible contacts on video displays. All images are digitally recorded on 8-mm data cards for post-mission analysis.

4.2.2.7 AN/ALQ-141 Mine Countermeasures System

AN/ALQ-141 is for use in specific circumstances described further in NTTP 3-15.22 (see Figure 4-8).

4.2.2.8 A Mk 2(g) Rattle Bars

The A Mk 2(g) Rattle Bars are a mechanically operated acoustic sweep consisting of closely fixed parallel pipes towed through shallow water to simulate hull noise and cavitation (see Figure 4-9). Water flowing through the pipes creates a venturi effect, which causes the pipes to resonate, producing 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.



DIMENSIONS	
LENGTH Float Body	 1.242 m (48.92 in) 26.04 cm (10.25 in)
WIDTH	26.04 cm (10.25 in)
HEIGHT	90.32 cm (35.56 in)
WEIGHT	45 kg (98 lbs) (without tow rope)
TOW SPEED Normal Maximum	 25 kts 27 kts

Figure 4-4. Mk 104 Mod 3

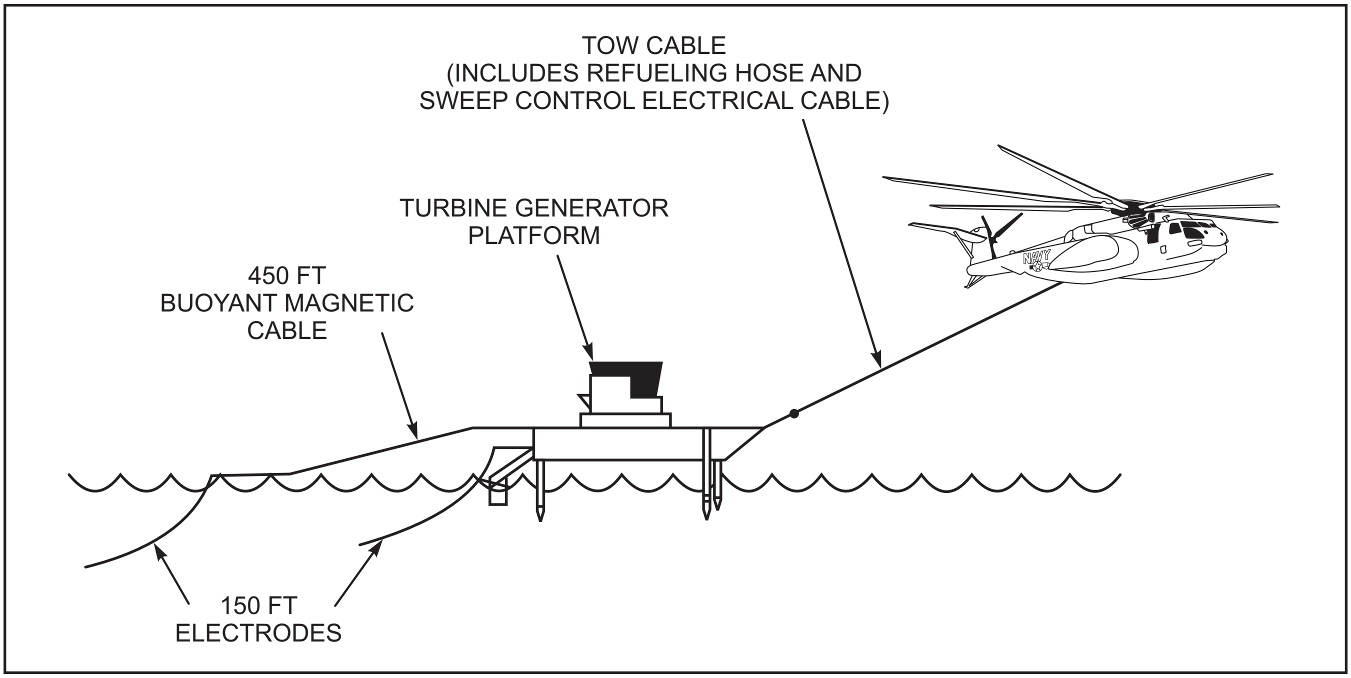


Figure 4-5. MH-53 with Mk-105 Magnetic Minesweeping System

4.2.2.9 Combination Influence Minesweeping

Influence minesweeping often requires more than one type of influence to satisfy the activation logic of specific mines. AMCM can perform acoustic-magnetic simultaneous influence sweeping using the following systems and configurations. Combination influence minesweeping can also be very effective against mixed minefields.

4.2.2.9.1 AN/SPU-1/W With A Mk 2(g)

A combined magnetic-acoustic influence minesweeping system composed of AN/SPU-1/W MOP and A Mk 2(g) Rattle Bars for shallow water use.

4.2.2.9.2 Mk 106

A combined magnetic-acoustic influence minesweeping system composed of the Mk 104 attached to the trailing end of the Mk 105 magtail.

4.2.2.9.3 Mk 105 With A Mk 2(g)

A combined magnetic-acoustic influence minesweeping system composed of Mk 105 magtail and A Mk 2(g) Rattle Bars.

4.2.3 Mine Spotting Aircraft

A critical requirement in MCM is the need for spotter aircraft during mechanical sweeping. While both AMCM and SMCM are highly effective in clearing an area of moored mines, visually spotting those mines on the surface is very difficult, particularly in heavy seas or poor lighting conditions.

Floating mines have a low profile, presenting only a small target area. The helicopter’s low altitude, along with its positioning ahead of the cutting gear, provides only a very long perspective and very low slant-range view to detect surface contacts.

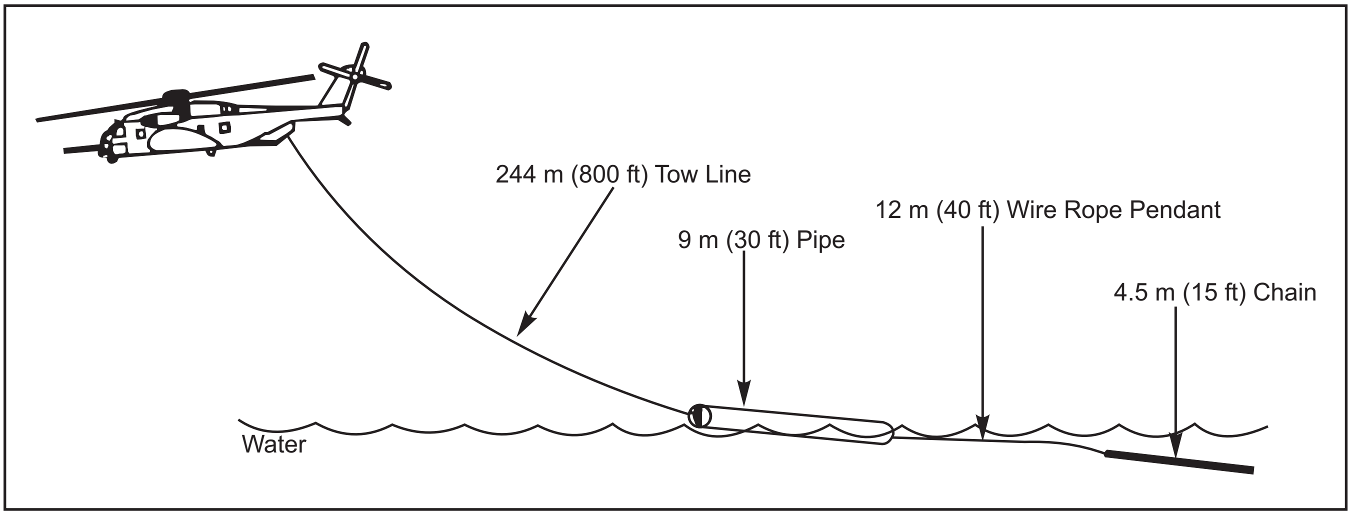


Figure 4-6. MOP (Single)

Helicopter rotor wash creates a turbulent wake on the water's surface. If a mine surfaces within the trail area it could be obscured in the surface chop.

Mines may be painted to blend in with their surroundings. Many will exhibit some degree of marine growth on their exterior surface, serving to mute the mine's color and edges.

The altitude and overhead view of a spotter helicopter allows its crew to better observe mines as they surface. They can:

1. Record location of helicopter using GPS
2. Make initial examination of mine type, age, and condition
3. Mark mine position with marine marker
4. Insert EOD swimmers for expeditious disposal of the mines.

4.3 SURFACE MINE COUNTERMEASURES

Surface elements of the MCM triad have the capability to hunt and sweep drifting, moored, and ground mines. Their primary strength is their extended round-the-clock operating time. However, it should be noted that they are unable to deploy rapidly in support of theater OPLANs without commercial heavy-lift shipping, which is not readily available. To ease this circumstance, several SMCM vessels have been forward deployed to critical areas of concern. Additional information on SMCM functions and capabilities is contained in NTTP 3-15.21.

Principal operational capabilities of SMCM are:

1. Sonar minehunting
2. ROV mine neutralization
3. Mechanical moored minesweeping (MCM 1)
4. Influence minesweeping (MCM 1)
5. Combination sweeping (mechanical-acoustic and magnetic-acoustic) (MCM 1)

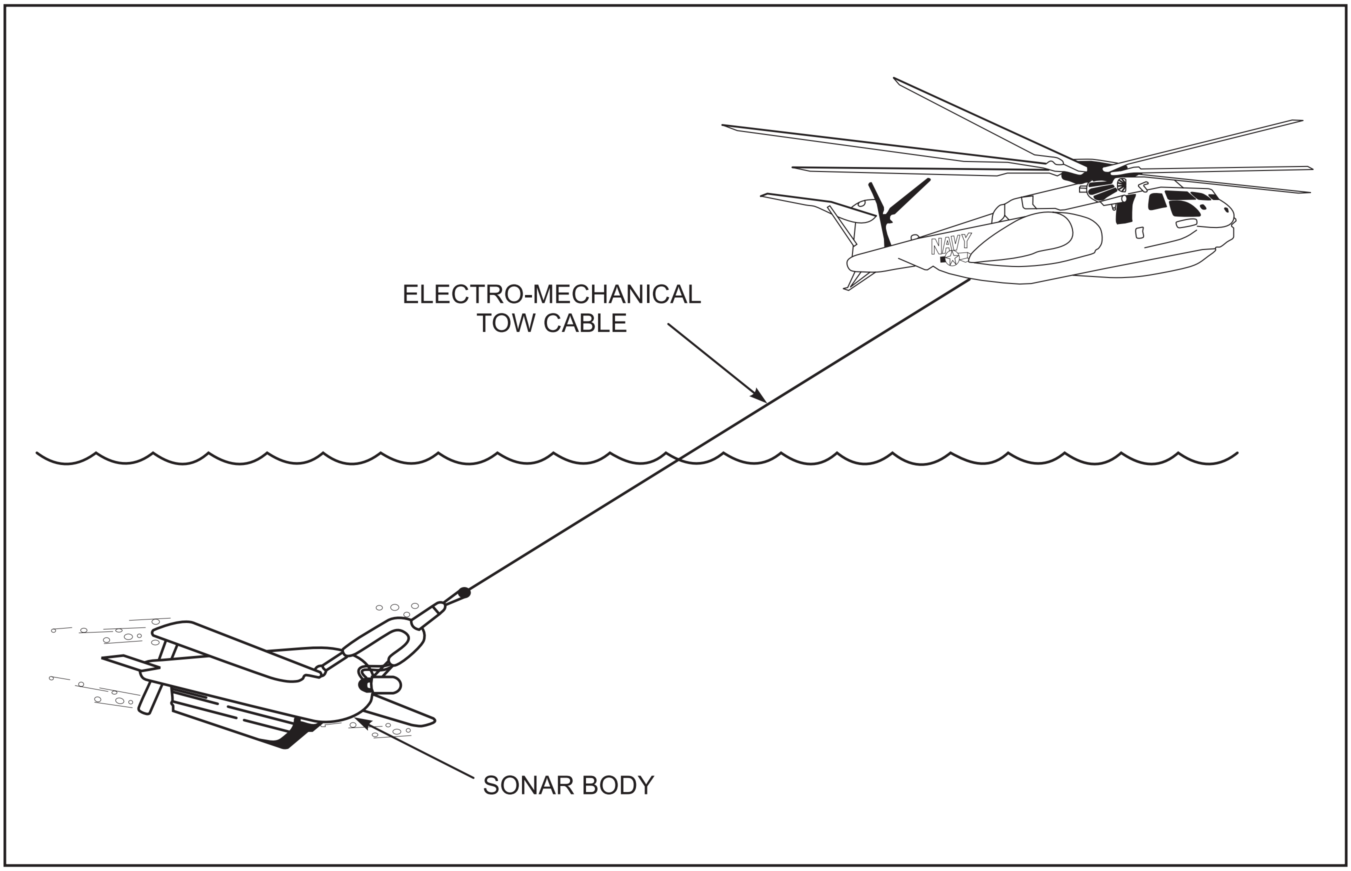


Figure 4-7. AN/AQS-14A Sonar Detecting Set

6. Support of EOD operations to neutralize, destroy, and exploit mines
7. Magnetic silencing
8. Precision navigation
9. Environmental measuring
10. Buoying equipment
11. Nonferrous design throughout to reduce magnetic signature
12. Propulsion designed to reduce acoustic signature.

4.3.1 AVENGER Class (MCM 1)

The MCM 1 Class has minehunting and neutralization capabilities and can conduct mechanical, influence, and combination minesweeping. Their hulls are constructed of wood with a laminated GRP outer shell to reduce magnetic signature. Propulsion is primarily diesel, with electric light load propulsion motors (LLPM) powered by a marine minesweeping gas turbine generator (MMGTG) for reduced acoustic signature. To increase maneuverability they have an electric bow thruster powered by the MMGTG. Two controllable-pitch propellers (CPP) generate forward and aft thrust with steering available via twin rudders. They participate in coordinated operations with amphibious and other supported forces, conduct independent MIW operations, and participate in integrated MCM operations. Figure 4-10 shows the MCM 1 and lists its major sensors, weapon systems, and MCM equipment.

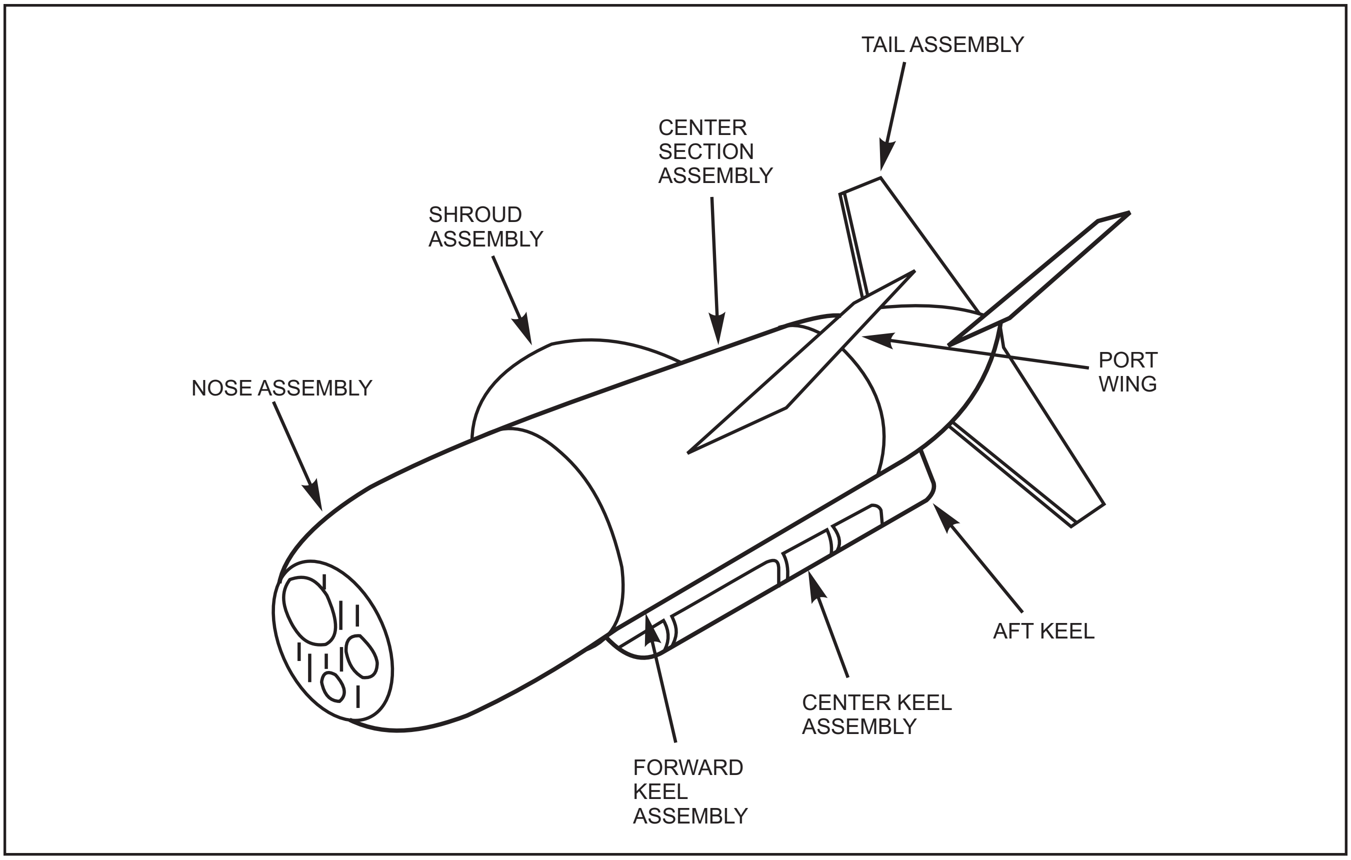


Figure 4-8. AN/ALQ-141 Airborne Minesweeping System

4.3.2 OSPREY Class (MHC 51)

MHC 51 Class ships are very maneuverable and have minehunting-neutralization capabilities. Their hulls are constructed from one piece of GRP to reduce magnetic signature. Propulsion is primarily diesel with enclosures for reduced acoustic signature. Steering and thrust are generated by a cycloidal propulsion system able to thrust instantaneously in any direction. They have no rudder system and no influence sweeping systems. Figure 4-11 shows the MHC 51 and lists its major equipment.

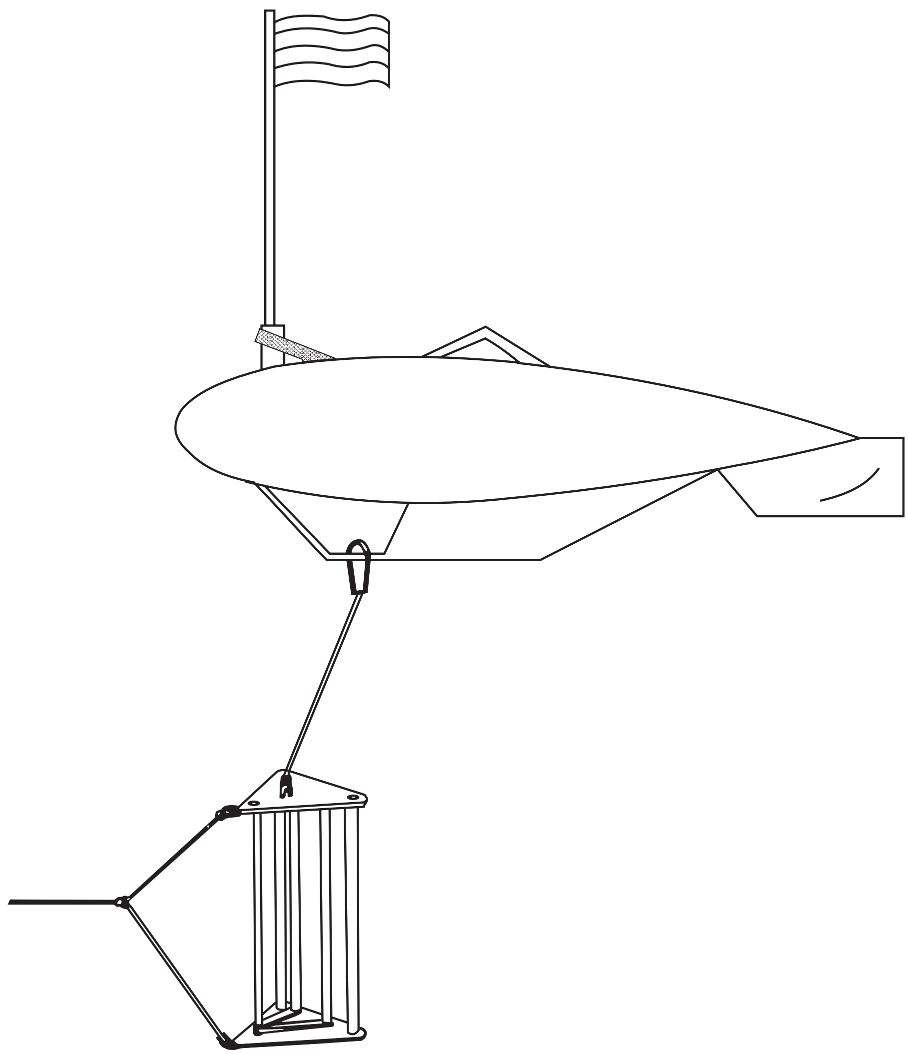
4.3.3 Surface MCM Systems

4.3.3.1 AN/SQQ-32 Advanced Minehunting Sonar

AN/SQQ-32 minesweeping sonar is a visually displayed variable-depth, directional minehunting sonar (see Figure 4-12). Capable of being operated from hull mount or deployed by cable through the ship's hull to operate at different depths to exploit sound velocity convergence zones, it can detect and classify moored mines in deep water. Computer-aided detection features assist the operators in determining which images on the screen are sufficiently minelike to warrant classification. The sonar has a long-range classification function that gives an estimate of an object's HAB, which can lead to the long-range, early classification of moored mines.

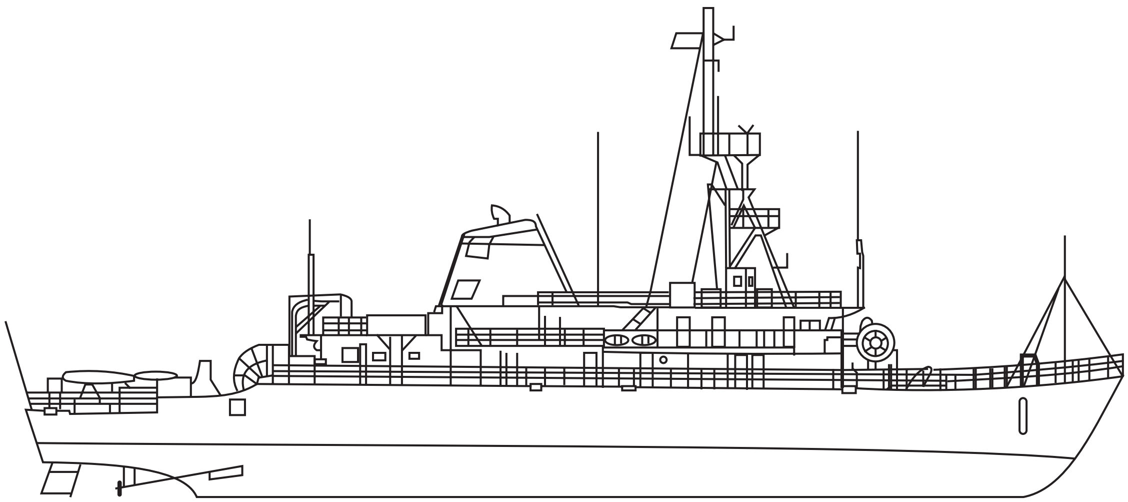
4.3.3.1.1 Detect Array

A detect array surrounds the center of the towed body. Capable of only limited resolution, it can detect contacts at long range. It is capable of simultaneously scanning two different tilt angles in 4° increments. Its 60° wide swath is electronically steered through 360°. It has computer-aided detection capabilities that assist the operator when in a high-clutter environment.



DIMENSIONS	
LENGTH	86 cm (34 in)
WIDTH	38 cm (15 in)
HEIGHT	36 cm (14.25 in)
WEIGHT	57 kg (125 lbs) (without cable)
TOW SPEED (NORMAL)	7-14 kts

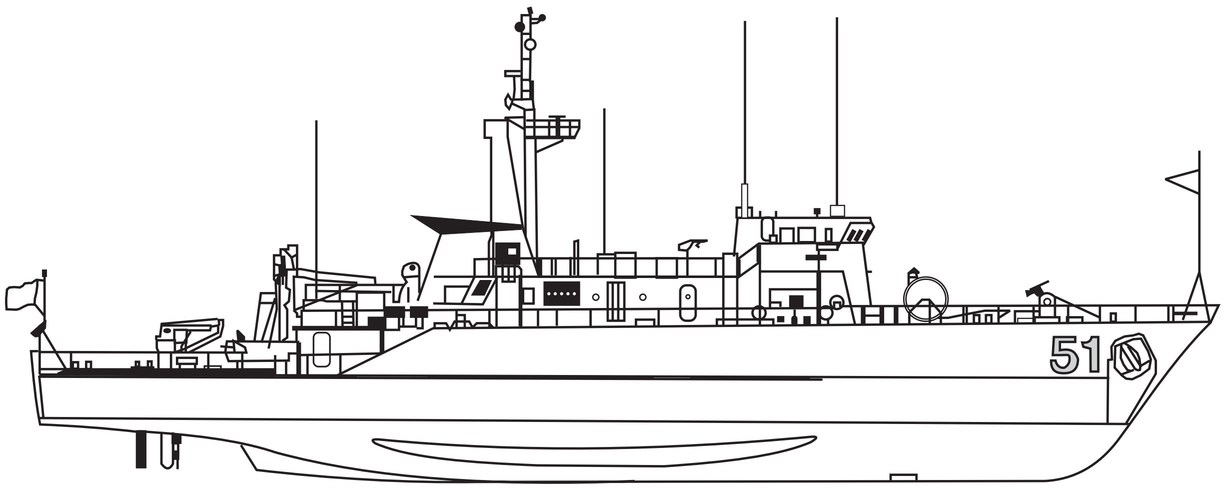
Figure 4-9. A Mk 2(g) Rattle Bars



MCM 1 CLASS CHARACTERISTICS	
LENGTH	69 m (224 ft) (OA)
BEAM	12 m (39 ft)
DRAFT	3.5 m (11.5 ft)
DISPLACEMENT	1,312 tons
DEGAUSSING	Automatic
HULL	Laminated fir/oak with fiberglass sheathing
SPEED	10 kts (economical)
PROPULSION	Twin screw, diesel, controllable-pitch propellers; bow thruster
NOISE QUIETING	Acoustically isolated couplings and machinery

MAJOR SYSTEMS	
AN/SLQ-38	Mechanical sweep
AN/SLQ-37	Magnetic/acoustic minesweep
AN/SQQ-30 or -32	Variable depth or advanced minehunting sonar
AN/SLQ-48	Mine neutralization system
AN/SSN-2	Command, control, and precise navigation
AN/BQH-7(A)	Environmental measurement

Figure 4-10. MCM 1 Class Ships



MHC 51 CLASS CHARACTERISTICS	
LENGTH	57.3 m (188 ft)
BEAM	10.9 m (36 ft)
DRAFT	2.8 m (9.5 ft)
DISPLACEMENT	851 tons
DEGAUSSING	Automatic
HULL	Glass-reinforced plastic (GRP) monocoque
SPEED	10 kts (economical)
PROPULSION	Twin Voith-Scheider propulsors, diesel-driven
NOISE QUIETING	Acoustic shielding and cradling for engine and major equipment

Figure 4-11. MHC 51 Class Ships

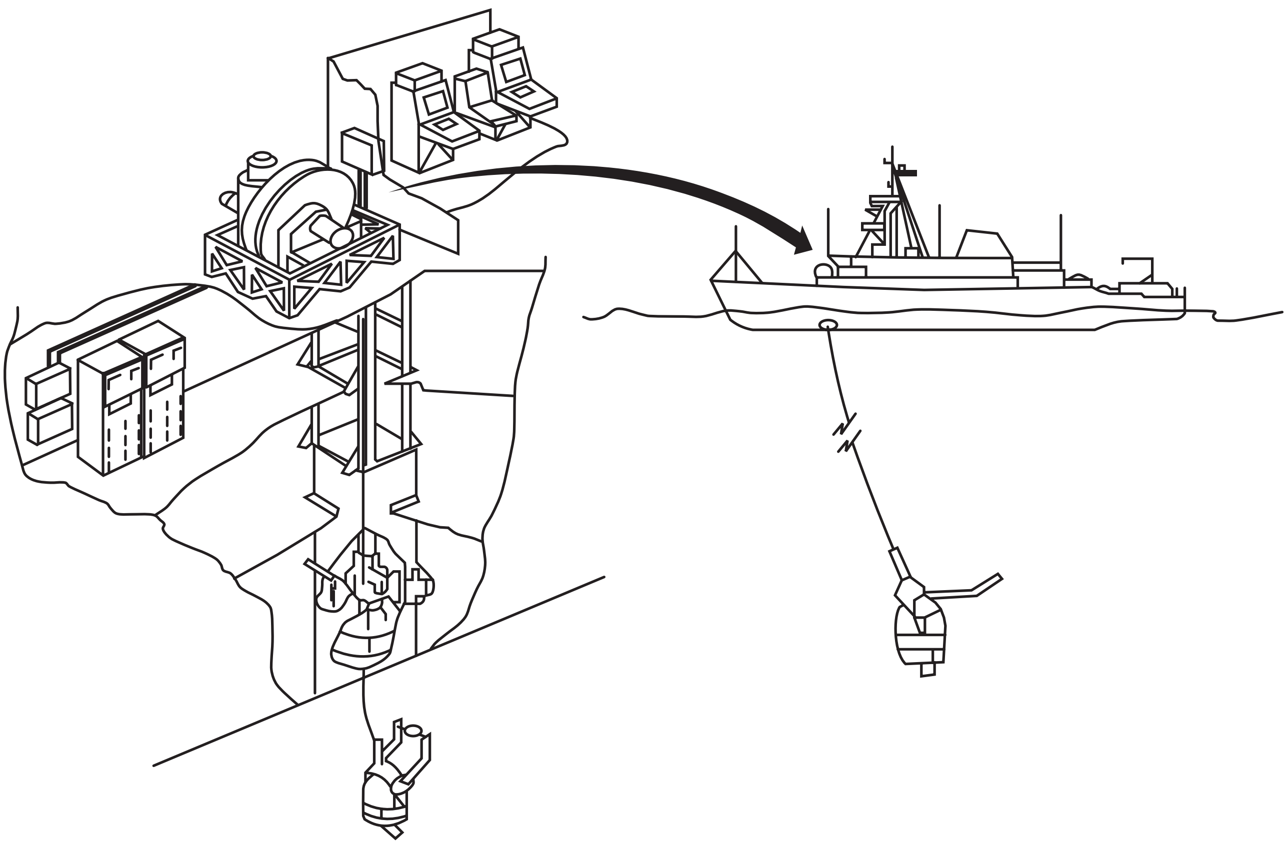


Figure 4-12. AN/SQQ-32 Minehunting Sonar

4.3.3.1.2 Classify Array

A classification array is attached to the bottom of the towed body. Capable of high resolution, it can determine if contacts have sufficient characteristics to be classified as MILCs. It is mechanically steered and tilted independently of the detect array.

4.3.3.2 Mine Neutralization System (AN/SLQ-48)

This MNS uses its onboard sonar and video cameras to locate, visually identify, and neutralize moored and ground mines. It is composed of an unmanned, remotely controlled MNV, operator consoles located in CIC, and UCHS that provides power and control signals between the MNV and the ship. The MNV (see Figure 4-13) has its own visually displayed sonar used for mine location and is propelled by four reversible hydraulic thrusters that provide propulsion in three planes. It has two video cameras located forward and on top that are used for MNV control and visual identification of mines, and executes one of three different mission packages (MPs). Time in the water is virtually unlimited due to power from the umbilical cable. The MNV transports and deploys mission packages (MP-1, MP-2, and MP-3). The vehicle is guided to the target vicinity with the MNS tracking system and the ship's sonar. As the vehicle approaches, the MNS operator guides it to the mine using the MNV's own sonar and cameras.

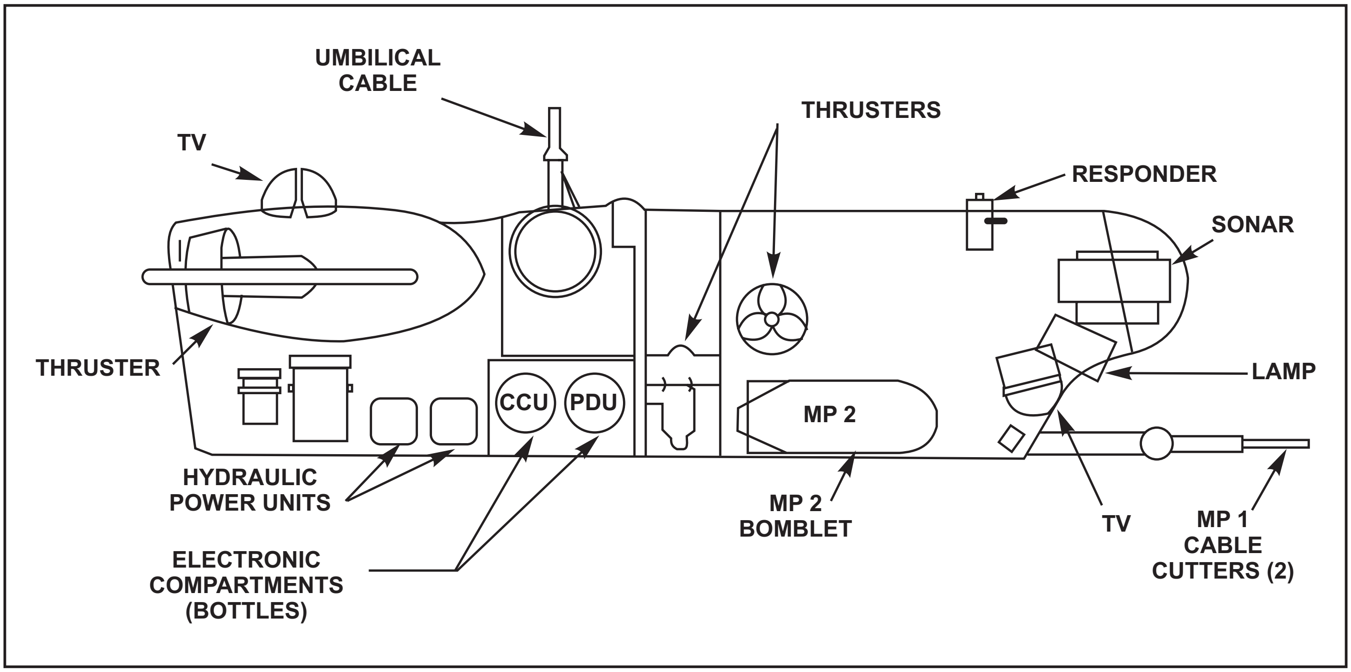


Figure 4-13. AN/SLQ-48 Mine Neutralization Vehicle

4.3.3.2.1 Mission Package MP-1

The MP-1 is an explosive-driven cable cutter that is remotely activated from a coded acoustic signal. It is used to cut a mine's mooring cables, freeing them to float to the surface where they must be quickly neutralized by EOD. There are two MP-1 cutter arms on the front of the MNV. The pilot flies the MNV to the mine cable and attaches one of the two MP-1 cutter arms to the mooring cable below the mine case. The MNV is then recovered. A coded acoustic fire signal is sent when the ship is a safe distance from the MDA. When the fire signal is received, the MP-1 fires, cutting the mooring cable, which allows the mine case to float to the surface for prosecution by EOD.

4.3.3.2.2 Mission Package MP-2

The MP-2 is an explosive bomblet used to neutralize ground mines by overpressurization. It is remotely activated by a coded acoustic signal. The MNV flies close to a ground mine and drops the MP-2 bomblet adjacent to the mine case, and then the MNV is recovered. A coded acoustic detonation signal is sent when the ship is a safe distance from MDA. When the signal is received, the bomblet detonates, neutralizing the mine.

4.3.3.2.3 Mission Package MP-3

The MP-3 has been developed to neutralize moored mines. It uses a cable gripping release, similar to an MP-1 cutter arm, and a bomblet with a float assembly and hardware. It is attached below the mine case, and the bomblet is released, allowing it to hang from the mooring cable; then the MNV is recovered. A coded acoustic repositioning signal is sent when the ship is a safe distance from MDA. When the repositioning signal is received, the bomblet floats to the mine case level. A coded acoustic detonation signal is then sent, and the bomblet detonates, neutralizing the mine.

4.3.3.3 Battlespace Profiler

The battlespace profiler (BSP) is an environmental sensor and computer model to assist in establishing optimum sonar configuration. When deployed, it takes numerous water temperature and salinity readings at various depths from surface to bottom. Data is sent to a computer system where an operator can manipulate a sonar and threat model to identify sound velocity convergence zones and projected sound-speed velocity while determining optimum sonar settings.

4.3.3.4 Magnetic-Acoustic Influence Minesweep (AN/SLQ-37) (MCM 1 Class Only)

The AN/SLQ-37 (see Figure 4-14) includes magnetic and acoustic capabilities. It has two acoustic sweep devices and high-current magnetic sweep cables and electrodes.

4.3.3.4.1 Acoustic Minesweeping System

The system uses the TB 26 (A Mk 6(b)) and TB 27 (A Mk 4(v)) towed astern to broadcast broadband low and or medium frequencies to activate sensors of passive-acoustic influence mines. Selectable frequencies and pulse waveforms provide some performance flexibility against newer mines with advanced logic features.

1. The TB 26 (A Mk 6(b)) is an electro-mechanical device that produces a low frequency acoustic output. It is a nonsteamlined, nonmagnetic box with an oscillating diaphragm mounted in each side. The diaphragms oscillate with variable stroke and frequency depending on which eccentric mechanism is installed.

2. The TB 27 (A Mk 4(v)) is an electro-mechanical device that produces medium frequency in varying waveforms. Sound is produced by means of a mechanically driven hammer striking a diaphragm causing it to vibrate over a broad range of frequencies at variable intensities. It is remotely controlled by the acoustic power panel.

4.3.3.4.2 Magnetic Minesweeping System

The AN/SLQ-37(V)3 magnetic minesweeping system uses cable and electrode arrays that are electrically pulsed to produce a magnetic field while being towed astern. Its selectable pulse waveforms provide some performance flexibility against newer mines with advanced logic. The major components are a 5,000-amp DC or AC MMGTG, an influence minesweeping waveform generator, and a magnetic sweep cable assembly. The waveform generator regulates the minesweep generator and directs current flow, 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 replicates the field produced by a ship. The following standard cable configurations are used:

1. The M Mk 5 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 electrical circuit. This configuration is effective against vertical component mine sensors and, depending on the environmental conditions, some horizontal component sensors.

2. The M Mk 6 open loop diverted sweep configuration diverts the long leg of the sweep to one side using a diverter wire, float, and otter. This improves the sweep effectiveness, making it useful against both horizontal and vertical component mines and shifts the magnetic sweep signature to one side of the ship.

3. The M Mk 6 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.

4.3.3.5 Mechanical Minesweeping System (AN/SLQ-38) (MCM 1 Class Only)

The AN/SLQ-38 (Oropesa) is a simple mechanical sweep (see Figure 4-15). The AN/SLQ-38 cuts the cable of moored mines in the volume.

Mechanical minesweeping is a technique in which the sweep equipment physically contacts the mine, the mooring cable, or its appendages.

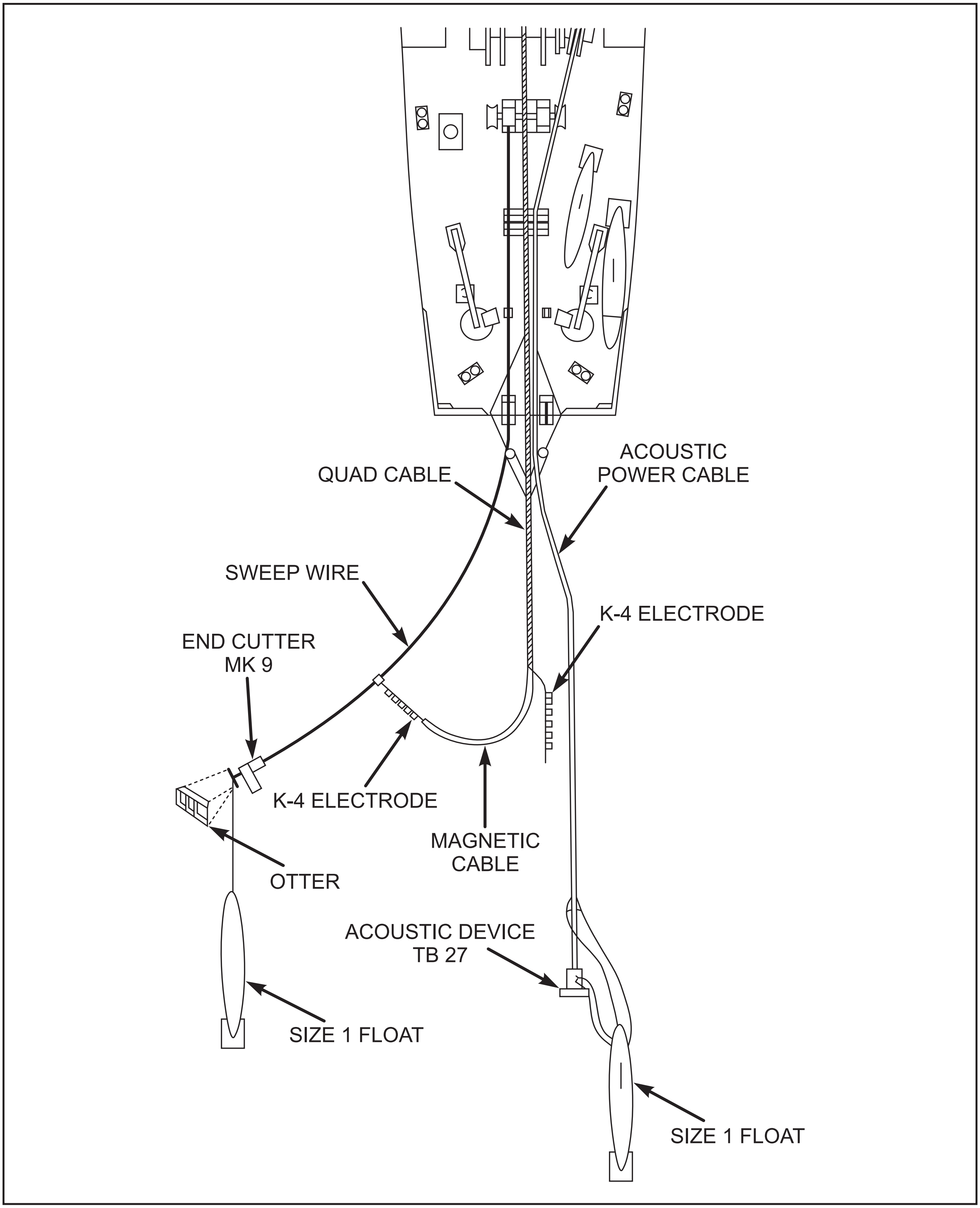


Figure 4-14. AN/SLQ-37 Combination Influence Sweep

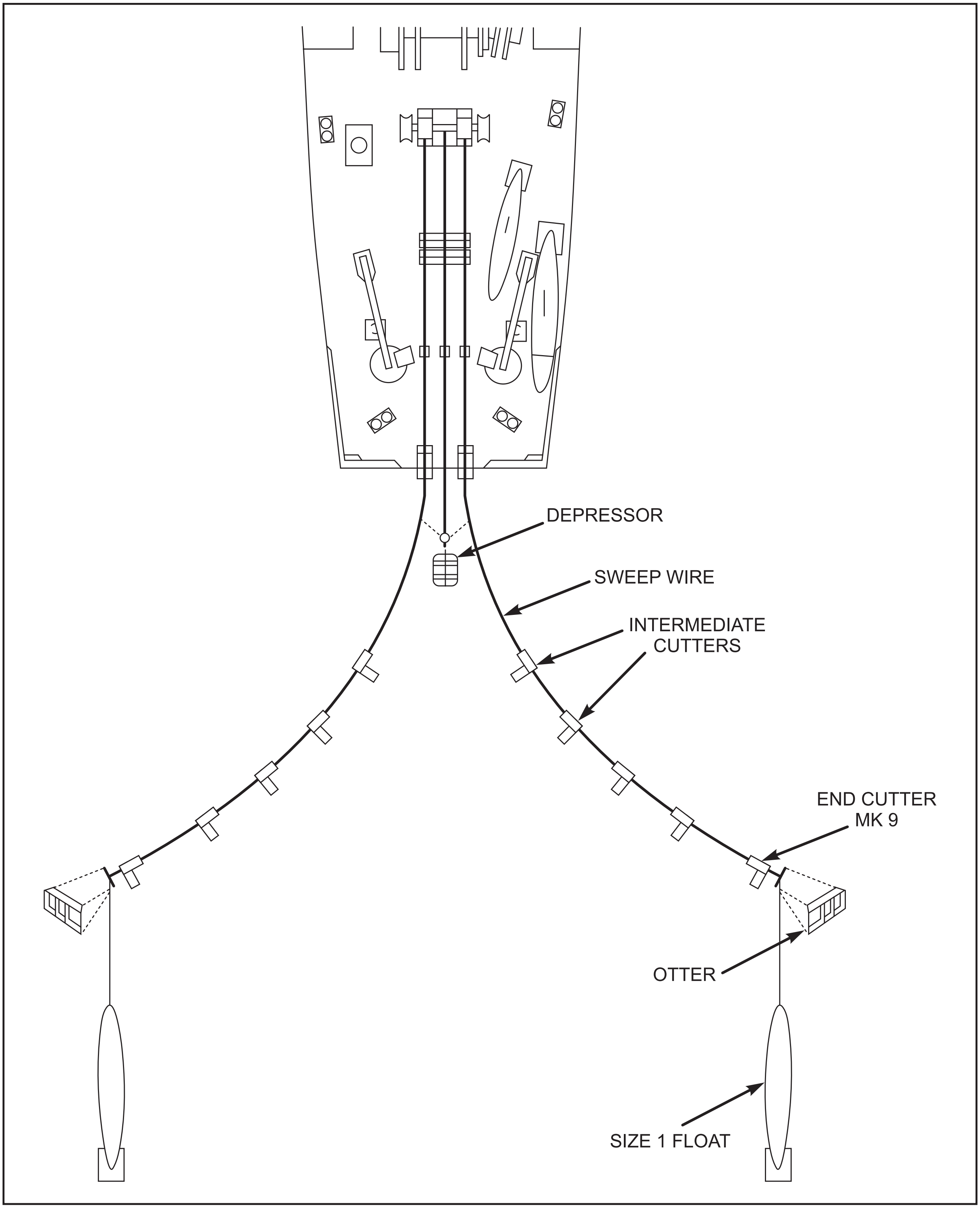


Figure 4-15. AN/SLQ-38 Mechanical Sweep

An Oropesa sweep consists of one depressor wire and one or 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 being streamed. The ends of the sweep wire are spread by otters (also called kites or diverters), which pull outboard under hydrodynamic load. The length of a pendant that connects the otter to a surface float determines the depth of the end of the sweep wire (otter depth). Various pendant lengths are available or can be made aboard ship.

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

Against moored mines, Oropesa mechanical sweeps are designed to cut the mooring cable so the mine surfaces. Unless the mine has an antidisturb function or antirecover hydrostatic actuator, once the mooring is cut, the mine becomes a floater (usually still functional). These must be disposed of, preferably by EOD divers operating from a ship or helicopter.

In mechanical sweeping by surface ships, the ship is obliged to transit the MDA ahead of the sweep, actuating any moored mines shallower than the ship's draft. AMCM can operate without being exposed to mines. Consequently, tactics dictate a precursory sweep by AMCM or require sweeping the first track in safe water with the sweep diverted into the MDA.

4.3.3.6 Combination Sweeps (MCM 1 Class Only)

Combination sweeps are the most advanced sweeping methods. They are arranged to counter specific mines that detect multiple influences with advanced logic, as well as specific mixed minefields. Acoustic magnetic and acoustic mechanical sweeps are composed of elements of the AN/SLQ-37 and AN/SLQ-38 configured to operate in concert.

4.4 UNDERWATER MINE COUNTERMEASURES

This section describes the general capabilities of UMCM assets and their systems. Additional information on UMCM functions and capabilities contained in NTTP 3-15.23.

4.4.1 Explosive Ordnance Disposal

The purpose of EOD forces is to provide detection, identification, render-safe, recovery, evaluation, and disposal of ordnance that has been fired, dropped, launched, projected, or placed in such a manner as to constitute a hazard to operations, installations, personnel, or material. This mission includes disposal of ordnance that has become hazardous by inadvertent damage or deterioration when the disposal of such items is beyond the capabilities of personnel normally assigned the responsibility for routine disposition.

4.4.1.1 EOD MCM Detachments

EOD MCM DETs operate in conjunction with SMCM and AMCM units, locating or reacquiring, identifying, neutralizing, recovering, and disposing of sea mines into shallow water depths. EOD Mobile DETs deploy as part of the BG or ARG and can be used to support amphibious missions. However, their manning and training do not permit them to operate in the VSW up to the SZ. This particular assignment is the domain of NSCT1. EOD MCM DETs are deployable on short notice and are able to sustain operations for approximately 30 days without major resupply.

4.4.1.2 EOD MCM Capabilities

EOD divers use underwater breathing apparatus (UBA) to permit extended working times. Their operating limitations are currents of 1 kt or less in Sea State 3 or less. Beyond 27 m (90 ft), periodic, timed decompression stops are required during ascent, which reduces bottom time. Operating times are further reduced at temperature extremes, which also limits bottom time. A diver can make only one decompression dive per dive day.

The following are some of the EOD MCM capabilities:

1. Mine identification (by type)

2. Shallow water surveys

3. Precision navigation

4. Small area search

5. Render-safe procedures

6. Mine removal and exploitation

7. Initial technical exploitation of mines for intelligence purposes

8. Mine destruction

9. Use of MMS to search, detect, classify, and neutralize.

4.4.2 Naval Special Clearance Team One

Following the Persian Gulf War, as the U.S. Navy adopted a focused view of warfighting in the littorals, it became evident that a dedicated force properly equipped and structured would be required to confront the mine threat in the VSW region of the water column. As such, NSCT1 was created to meet those increasingly complex challenges presented in the 40- to 10-ft depth contours. Their primary mission is to conduct low-visibility mine exploration and reconnaissance in that zone. NSCT1 conducts mine exploration, hydrographic reconnaissance, and mine clearance in support of expeditionary operations. They are a specialized unit composed of SEALs, EOD divers, and USMC reconnaissance specialists who operate as dive teams in conjunction with MMS (EX 8). The detachment is capable of detecting, classifying, identifying, and neutralizing mines while opening assault lanes for landing craft. They are able to:

1. Confirm the presence or absence of mines within selected portions (e.g., proposed boat lanes) of the VSW environments

2. Reacquire and identify minelike contacts in the VSW environments

3. Provide the CATF with reconnaissance data to determine mine density

4. Enable a smooth, uninterrupted transition across the water column to support an amphibious operation

5. Perform mine neutralization.

In peacetime NSCT1 is based in proximity to amphibious groups and Navy special operations forces in order to support force integration and interoperability. They are under the operational control of COMINEWARCOM and administrative control of COMEODGRU ONE. Accordingly, they participate in fleet training exercises to hone tactics and procedures while also serving as a warfighting laboratory to test and assess evolving prototype equipment. Additional details relative to NSCT1 can be found in NTTP 3-15.23.

4.4.2.1 Naval Special Clearance Team One Capabilities

NSCT1 teams conduct low-observable exploratory and reconnaissance missions to search and map the seaward approaches to LPSs and LPPs up to the SZ.

VSW MCM operations are conducted in the context of a near-shore hydrographic survey. The element assigned to the operation will conduct a survey to collect pertinent hydrological data, including natural or man-made obstacles and mines. Stages include reconnaissance of possible LPPs, establishing a navigational grid, and then swimming predetermined search patterns to detect, locate, classify, and map obstacles and mines. This preliminary effort may be followed by clearance. Specific capabilities include:

1. Locating, marking, and mappping shallow water mines from the 40- to 10-ft depth contour
2. Locating and marking lanes
3. Clearing mines within VSW seaward approaches to amphibious landing beaches
4. Precise navigation, obstacle location, and bottom mapping.

NSCT1 divers, in addition to their personal issue of clothing and equipment, use:

1. The Integrated Navigation Sonar System (INSS)
2. Viper low-magnetic breathing apparatus for shallow water MCM tasks
3. Low observable insertion craft
4. The combat rubber raiding craft (CRRC) with outboard motor.

4.4.3 Underwater MCM Equipment

UMCM operates in a unique environment under adverse conditions, requiring specialized equipment.

4.4.3.1 Diving Equipment

1. Mk 16 UBA
    a. The Mk 16 UBA is a closed-circuit, mixed-gas underwater breathing apparatus using an oxygen-helium or oxygen-nitrogen medium.
    b. Advantages:
        (1) The rig is acoustically quiet and made of nonmagnetic materials.
        (2) It is portable, efficient, and provides the diver with excellent mobility.
    c. Disadvantages:
        (1) It requires extended decompression profiles for long bottom time or deep dives.
        (2) It has limited physical and thermal protection and no voice communication.
        (3) It is limited to a depth of 46 m (150 ft) or 61 m (200 ft), depending on the breathing medium.
        (4) Repeated decompression dives are prohibited.
2. Self-contained underwater breathing apparatus (SCUBA)
    a. Consists of commercial, open-circuit diving apparatus.

b. Advantage: It is easily deployable and effective for many fleet support diving operations.

c. Disadvantage: It does not meet low-influence signature requirements.

3. Viper rebreather diving apparatus

   a. It is composed of closed and semiclosed gas control circuits.

   b. Low profile with nonmagnetic features.

   c. It is designed for work in surge conditions.

4.4.3.2 Sonar

1. AN/PQS-2A

   a. Hand-held sonar designed to assist in location of submerged objects or detect active acoustic pingers

   b. Capable of detecting bottom objects at ranges up to 110 m (360 ft)

   c. Capable of passively detecting sonar beacon pingers at ranges up to 1,825 m (6,000 ft).

2. INSS

   a. Integrates technology to provide a consolidated acoustic x-y baseline navigation sensor

   b. Features a visual-display image function, coupled with a sonar capability to detect, classify, and locate mines

   c. Enables dive teams to provide MCMC with a bottom-mapping, hydrographic reconnaissance product that can be downloaded for detailed analysis.

4.4.3.3 Specialized Equipment

1. Mk 2 Mod 1 flotation bladder

   a. Nylon-covered inflatable rubber sphere, with a diameter of 1.2 m (48 in).

   b. The bladder is inflated remotely from two attached cylinders through an electrically initiated explosive valve.

   c. Submerged mines can be raised using the bladders.

2. Specialized EOD tool sets. EOD teams carry several specialized tool sets for remote beaching, disassembly, photography, radiography, and underwater render-safe procedures.

3. Mk 10 ordnance locator

   a. Transistorized gradiometer magnetic anomaly detector used to locate hidden or buried ferrous objects.

   b. Self-contained, portable, and designed for hand-held diver use in all orientations and background fields.

   c. May be used in fresh or salt water and on land.

   d. Locator measures anomalies in the Earth’s magnetic field.

e. Underwater ranges achieved against a 450-kg (1,000-lb) bottom mine are approximately 3 m (10 ft) and 2 to 3 m (7 to 10 ft) on buried mine targets.

f. Designed to withstand submergence in water depths to 61 m (200 ft), with capability to operate in depths up to 55 m (180 ft).

4.4.3.4 Support Equipment

The following items of equipment are not individual detachment allowance items. They are assigned to EOD mobile units as deployable support facilities that may be deployed with one or more detachments. The system is capable of treating all dive casualties requiring recompression treatment.

1. Fly-away recompression chamber (FARC) consisting of:

   a. Life support skid (LSS) measuring 2.74 x 2.44 x 2.44 m (9 x 8 x 8 ft) and weighing 9,090 kg (20,000 lb)

   b. Recompression chamber measuring 6.1 x 2.4 x 2.4 m (20 x 8 x 8 ft) and weighing 6,590 kg (14,500 lb)

   c. Portable diesel generator measuring 3.23 x 1.85 x 2.26 m (10.6 x 6.1 x 7.4 ft) and weighing 910 kg (2,000 lb).

2. Fly-away diving locker (FADL):

   a. Housed in a standard 6-m (20-ft) modular container.

   b. Weighs 4,540 kg (10,000 lb).

   c. Requires 110 or 220 volt AC power.

   d. Provides climate control for sensitive spare parts and electronic equipment, along with secure stowage for equipment and publications.

   e. If FADL is unavailable, an oxygen-safe space approximately 9 m^2 (100 ft^2) is required for Mk 16 UBA maintenance and gas transfer.

3. Portable magazine:

   a. Provides secure transportation and stowage for the detachment’s explosive allowance

   b. Measures 2 m^2 (6 ft^2)

   c. Has an empty weight of 908 kg (2,000 lb).

4. Communications van. Selected EOD Mobile Units possess vans with essential communications equipment and materials for use in remote or sustained operations.

4.4.4 EOD Marine Mammal Systems

EOD MMS DETs can operate independently or in conjunction with other MCM forces to detect, mark, and neutralize moored and ground mines. The dolphins used in these systems are trained to search for minelike objects. With EOD divers, they can locate minelike targets for neutralization and exploitation. They can operate in conjunction with SMCM and AMCM units to expedite overall operations.

Mk 4 or Mk 7 can deploy on short notice with the ability to operate independently with only minimal support once at the forward station. This includes all major equipment required for navigation, local transportation, communication, and animal husbandry.

4.4.4.1 MMS Mk 4

Trained dolphins are used to detect moored mines and place a marking or neutralization device on the mooring cable near the mine. An animal handler on the surface controls the dolphin.

4.4.4.2 MMS Mk 5

The MMS Mk 5 is a sea lion mine recovery system.

4.4.4.3 MMS Mk 7

MMS Mk 7 consists of trained dolphins that detect proud (Mk 7 Mod 0) and proud and buried (Mk 7 Mod 1) minelike shapes, and place a marking or neutralization device adjacent to each. An animal handler on the surface controls the dolphin.

4.4.5 Area Search Detachments

ASDs are used primarily to reacquire minelike contacts already located by other means using a towed side-scan sonar deployed from a suitable boat in combination with GPS. Detachment manning consists of an OIC and three equipment operators.

When a suspected mine is initially located, the position of the contact is passed to the ASD. They set up a local search grid around the position of the contact and then conduct a search to reacquire and mark the contact for subsequent prosecution. The ASD also possesses a limited independent search capability and can be employed in this role as a last resort, in the event no other MCM asset is available.

This operational concept involves acceptance of substantial additional risk to personnel and equipment.

4.5 MINING SURVEILLANCE

The surveillance of an area that is, or might be, mined will contribute significantly to the scope of MCM operations and aid in the design of AOA-LPA geometry.

4.5.1 General

There are several sources that can report on mining activity or its absence. Among these are:

1. Attachés and staffs of friendly embassies

2. Merchant seamen or firshermen who may have observed a mine loading or laying activity or been diverted or warned by those engaged in such actions

3. Minewatchers who detect-fix the position of minelaying activity with trained ship crews manning watch stations, tracking delivery vehicles, and establishing mine drop locations by optical triangulation using visual bearings

4. National surveillance assets.

4.5.2 Mobile Inshore Undersea Warfare

MIUW units establish areas of visual, radar, and acoustic surveillance seaward of their assigned area of responsibility. They have the capability to detect the clandestine placement of offensive minefields near friendly ports.

4.5.3 Task Force Assets

The BG has some surveillance capabilities and has access to others. Among the resources are:

1. Radar surveillance
2. Air patrols
3. NSW investigations
4. Ship sonars, such as AN/SQS-56 and AN/SQS-26/53 modified to provide capability to detect moored mines
5. National surveillence systems (OTC requests assistance from aircraft and space surveillance systems)
6. MIUW command and control van (AN/TSQ-108A), as described in Chapter 6
7. Novel systems.

4.6 OTHER DETECTION TECHNIQUES

4.6.1 Aerial Visual Search

Aerial observers can sometimes sight moored and ground mines. Such sightings require clear air and water and the proper solar altitude (40° to 70°). However, a lack of sightings does not confirm the area is clear of mines, even if favorable conditions exist. MCM assets should not be used for this task if aircraft of opportunity are available.

4.6.2 Electro-Optical Techniques

Devices employing E/O techniques are not in general service. Some developmental equipment employing scanning lasers has been successfully applied in both testing and in operational situations.

4.6.2.1 Radar Detection of Floating and Drifting Mines

Radar can detect mines on the surface only under the most favorable circumstances. Even in the best case, an absence of radar contact should not be equated to an absence of mines.

The best radars for search are those designed for detecting small objects such as periscopes. Those on the LAMPS Mk1 and Mk 3, the S-3, and P-3 are of this type. Surface search radar systems on ships are handicapped by less than optimum frequency, signal processing, and vertical beam form.

4.6.3 Infrared Detection of Floating and Drifting Mines

Forward-looking infrared (FLIR) systems have shown considerable capability in detecting floating and drifting mines. The mast-mounted sight is an adaptation of a U.S. Army helicopter system and was used in the Persian Gulf War with good results. Successful IR detection depends on a temperature differential between the target and its background. A mine can provide an adequate target during the day in calm water, but at night or when it is awash, the IR signature can disappear.

CHAPTER 5

Command, Control, Communications, Computers, and Intelligence

5.1 COMMAND

Planning and execution of MIW operations, both MCM and mining, require detailed subject matter expertise. For most operations requiring dedicated MCM assets, Commander Mine Warfare Command (COMINEWARCOM) and the supporting battle staff, one of the three MCM squadron commanders (COMCMRON ONE, TWO or THREE), or one of the two forward-based mine division commanding officers (COMCMDIV 11 and COMCMDIV 31) will act as the MCMC. For small-scale operations or those operations employing a single type of MCM asset (i.e., AMCM or UMCM only), the commanding officer or OIC from an AMCM squadron or EOD mobile unit or detachment may be assigned as the MCMC. When assigned as the MWC, the MCMC is also responsible for planning and executing mining operations. When no MWC is assigned under the commander, joint task force (CJTF), responsibility for planning and executing mining operations usually rests with the strike commander.

5.2 ORGANIZATION

The command organization and relationships involving MIW forces will vary for each operation or exercise. Key factors that affect the command organization include size, scope, area, objectives, number and type of MIW forces assigned, and the available time frame to conduct operations. In most cases, MIW operations are conducted under the framework of a CJTF or naval task force (NTF) architecture with the MWC or MCMC reporting directly to the maritime component commander (MCC) or BG commander. MIW can also be executed under the supported-supporting concept (e.g., the MCMC, operating as MCM TF commander under the NTF commander or MCC can be assigned as a supporting commander to the ATF commander in support of an amphibious assault), particularly for actions in support of a specific objective. When operations are conducted under the CJTF or NTF architecture, command organization will normally be specified in structured OPGEN, OPTASK, and TASK FORCE COMPOSITION messages.

5.2.1 Relationships With Allies and Partners

MCM operations may often involve allied and coalition forces. The MCMC should be the focal point for all MCM matters involving the cooperating nations. Such operations require the use of complex plans and reports with which the MCMC will be familiar. He will act as the central point for the exchange of plans and information with allies.

5.3 COMMAND RESPONSIBILITIES

5.3.1 MCM Commander

The MCMC exercises tactical control of all assigned MCM units. Duties include:

1. Coordination of the MCM effort and assignment of MCM forces to individual tasks
2. Issuance and modification of MCM task orders to counter the threat
3. Coordination of support for assigned MCM forces

4. Coordination with Navigation Communication System (NCS) and Allied Wartime Navigational Information Service (AWNIS) authorities regarding the control and routing of shipping

5. Arranging for force protection.

5.3.1.1 Delegation of MCM Command Authority

The MCMC retains responsibility but may delegate authority for the following:

1. Tactical control of MCM operations in a specific area and issuance of necessary tasking

2. Establishment of MCM tracks and track sequences

3. Specification of sweeps and systems to be used

4. Assistance for ships transiting in the MDA

5. Identification of MCM support requirements.

5.3.1.2 MCM and the Battle Group

The MCMC will prepare force MCM requirements, including:

1. Area coordinates

2. Environmental data

3. Support required

4. Expected mine threat

5. Characteristics of own force

6. Time available for MCM operations

7. Evaluation of adversary surface, subsurface, and air threat to the MCM force and force protection required.

These requirements are generally published in the OPTASK MCM and OPGEN formats.

5.4 MINE COUNTERMEASURES COMMAND CENTER

The function of the command center is to manage MIW operations. Each level of MCM command is required to collect, evaluate, display, and report MCM information.

5.4.1 MCM Command Center Functions

The command center must have facilities that:

1. Maintain the status of the MCM operation, including condition of forces, progress, estimate of threat reduction, and projection relative to the completion of assigned tasks

2. Present complete and current threat information, location of own or other friendly naval forces, and status of ports and operation areas

3. Maintain tactical control of assigned forces

4. Manage required messages and reports.

5.4.2 Information Flow

Complex, periodic reports will be received from MCM units, other shipping, and port authorities as well as from adjacent commands. Information will be needed from the analyses of past operations in order to evaluate current efforts. A library of publications and databases must be maintained onscene.

5.4.3 MCM Command Center Facilities

The physical facilities may be fixed or mobile.

5.4.3.1 Fixed Facilities

At the senior command levels, nominally component or fleet commander level, the facilities of the command center should be part of the permanent infrastructure. This approach assures that adequate communications and billeting support will be available.

5.4.3.2 Mobile Facilities

Command levels that require direct contact with operating units should be near the scene of operations. This requires a mobile or portable facility. The MCMC will be accommodated aboard the MCS with a full communications suite as well as ample work and support spaces. Alternatively, if the MCS is not available, or if a forward-based command center must be operational prior to the MCS arrival onscene, a mobile command center can be airlifted forward and deployed ashore near the operating area. The MCM command center will maintain MEDAL and GCCS-M, as well as manual or computer-supported status boards, files, plots, and a variety of dynamic logs and records. Specific demands will be dictated by the tactical situation. For a major operation, this requirement would be working space for a staff of six to eight people maintaining an around-the-clock watch with an arrangement that resembles a CIC setting.

5.4.4 Staffing

5.4.4.1 Staff Composition

For C2 to be effective, each level of command requires personnel with MIW experience. Few general-service officers will have had previous experience in MCM. There are many aspects of MCM that have no parallel in other warfare areas. The equipment, tactics, computations, and vocabulary are unique. This is the compelling reason why commanders faced with a mine threat should request assistance from COMINEWARCOM.

5.4.4.2 Staffing Levels

The scale of the MCM operations and methods employed will determine the level of staffing.

5.4.4.3 Staff Augmentation

When MCM operations escalate, staff augmentation can be requested through the chain of command.

5.4.4.4 Operational Complexity

An operation involving the entire MCM triad merits the assignment of an MCMRON commander and staff. COMINEWARCOM can tailor a staff for less-intensive operations upon request. Small-scale operations involving a single type of MCM system can usually be supervised by the commander or officer-in-charge of the assigned unit.

5.5 COMMUNICATIONS

The type, quantity, and security of the communications requirements of the command center and the participating MCM forces will vary with the magnitude, tempo, and location of the operation and the command structure of the forces involved. The communications requirements may generally be as follows:

1. Secure ship-to-ship and ship-to-shore circuits (SATCOM)
   a. CUDIXS
   b. SECVOX
   c. OTCIXS.
2. IP data circuits (SHF, INMARSAT B-HSD, HF, VHF)
3. Joint Worldwide Intelligence Communications System (JWICS) (SCI)
   a. SIPRNET (GENSER)
   b. NIPRNET (UNCLAS)
   c. NIDTS (NATO SECRET)
   d. BFEM-66.
4. POTS (SHF, INMARSAT B-HSD)
   a. STE
   b. Voice
   c. Fax.
5. Tactical secure voice (HF, VHF, UHF LOS)
6. VTC (SHF).

The anticipated traffic load warrants consideration for dedicated circuit assignments in the BG communications plan.

5.5.1 Communication Capabilities

Figure 5-1 depicts a summary of MCM communications capabilities for the MCM DETs.

5.5.2 Communication Requirements

The following communications circuits are considered the minimum required for MCM operations. Where operations occur with allied or coalition forces, provisions must be made for exchange of classified messages, voice transmissions, and IP data.

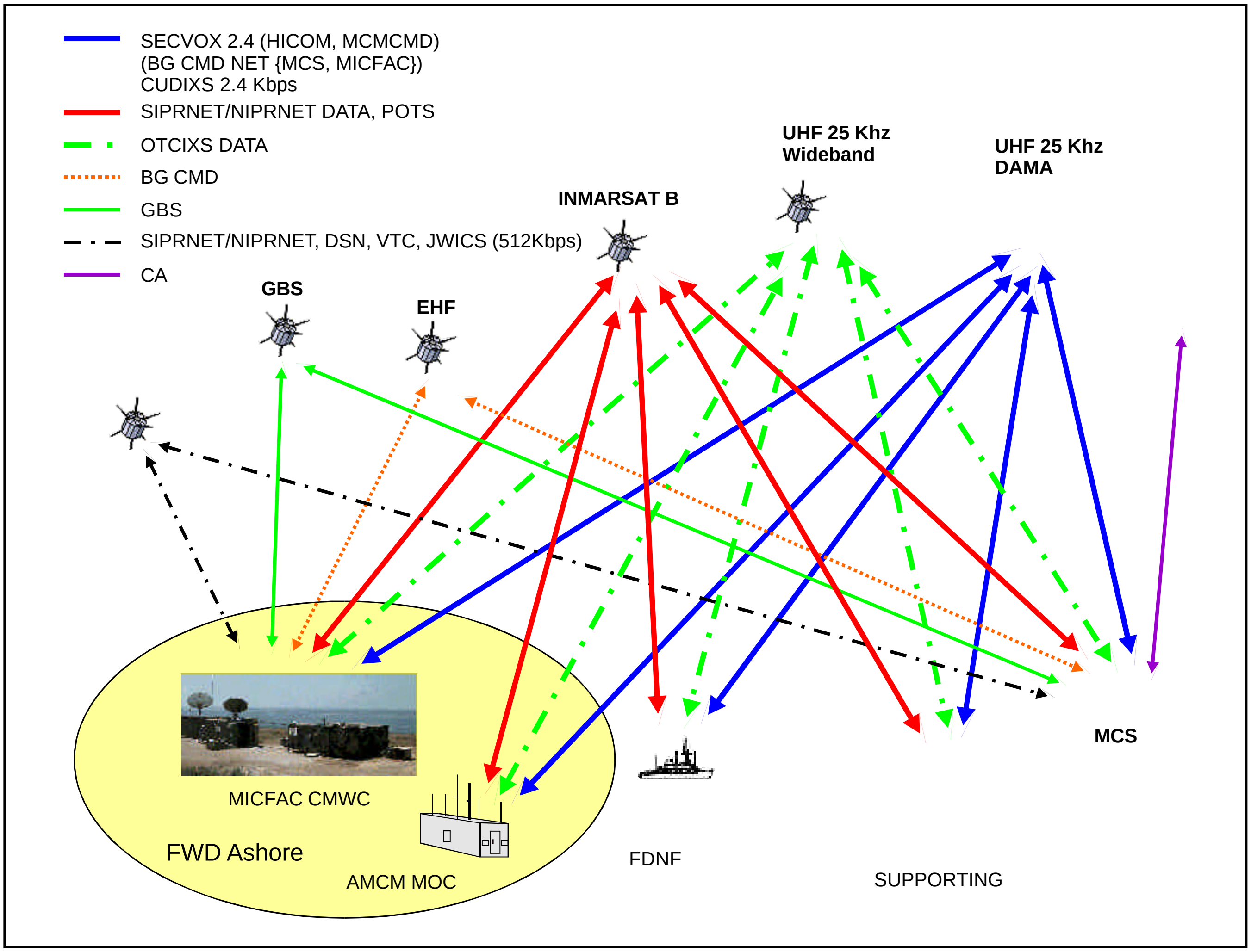


Figure 5-1. MCM Communications Capabilities

5.5.2.1 Among Area Commander, Sub-Area Commander, MCM Commander, and OTC

1. Record message (secure) SATCOM including ship-to-ship and ship-to-shore
2. IP data SATCOM/non-SATCOM, both unclassified and secure
3. Voice (secure) SATCOM/non-SATCOM via a secure tactical system or secure telephone
4. VTC SATCOM, both unclassified and secure.

5.5.2.2 Among MCM Commander, OTC, and Assigned Forces

1. Record message (secure) SATCOM including ship-to-ship and ship-to-shore
2. IP data SATCOM/non-SATCOM, both unclassified and secure
3. Voice (secure) SATCOM/non-SATCOM via a secure tactical system or secure telephone
4. Visual via flashing light, flag hoist, and special MCM signals.

5.5.2.3 Among Assigned MCM Forces

1. Record message (secure) SATCOM/non-SATCOM including ship-to-ship and ship-to-shore

2. IP data SATCOM/non-SATCOM, both unclassified and secure

3. Voice (secure) SATCOM/non-SATCOM via a secure tactical system or secure telephone

4. Visual via flashing light, flag hoist, and special MCM signals.

5.5.2.4 Airborne MCM Operations

When AMCM helicopter assets are assigned, one dedicated UHF and one HF data-link circuit are required for positive navigational control and to pass tactical data during MCM operations. Current MH-53E data link supports priority voice over data when HF circuit is required to support voice communications.

5.5.2.5 Guard

OPTASK COMMS will provide units with requirements for circuit guarding.

5.5.3 Communications Security

Information passed by electronic means, either voice radio or teletype, must be afforded the same classification protection as would be afforded the same information transmitted by written communication. All electronic emissions are subject to interception in varying degrees. The interception of UHF communications is generally limited to LOS. However, radio circuits in the VHF range and below are vulnerable to intercept at longer ranges, depending on the atmospheric conditions and the transmitted power being used. If all required radio communications during an MCM exercise were passed in the clear and were intercepted, the adversary would possess as much information about the progress of the operation as the OTC. If the adversary possesses the capability to replenish the minefield, this could provide him with adequate information upon which to base his timing, thus providing the maximum disruption of MCM. Therefore, the following precautions should be observed:

1. UHF communications should be transmitted at the minimum power that is required to ensure reception by addressees.

2. Sensitive information relating to MCM operations should be encrypted mechanically, electronically, or by the use of encryption tables. Judicious use should be made of authentication procedures and all individuals handling voice radio circuits must be thoroughly trained in proper procedures.

5.5.4 Communications Support

5.5.4.1 Existing Command Center

Where the MCM command center is part of an existing headquarters, the communications facilities will normally be part of the infrastructure.

5.5.4.2 Mobile Command Center

When MCM command is from a mobile control center, all communications will need to be provided. MICFAC currently supports the minimum requirements.

5.5.4.3 MIUW Command and Control Van (AN/TSQ-108A)

The primary mission of the MIUW unit is to conduct coastal surface and subsurface surveillance missions in support of the coastal warfare commander. Owing to naval littoral warfighting requirements, a MIUW unit is often located within proximity of critical MIW areas of interest (e.g., ports, SLOCs, etc.). A secondary mission area for these units includes support of MIW tasks. The surveillance and communication capabilities embedded within these mobile forces can assist in provision of necessary command and control and force protection requirements for a shore-based MWC. The MIUW communications suite has the capability to provide minimal levels of voice, data, and common tactical picture connectivity through a variety of satellite, OTH, and LOS circuits.

5.6 INTELLIGENCE

Intelligence regarding adversary mining and counter-countermeasures capability is essential for proper MCM planning. The essential elements of information (EEI) for MCM operations should be provided to those forces. Obviously, knowledge of the threat is a critical part of MCM. When coalition MCM forces are involved, the MCMC must coordinate disclosure of adversary mine threat information with appropriate authorities.

5.7 MINE COUNTERMEASURES COMMUNICATIONS PLAN

The MCMC must develop a detailed communications plan (COMPLAN) to support all MCM forces. The MCM COMPLAN should be included in the force OPTASK COMMS. Some major considerations are:

1. Flexible EMCON plans
2. Available communications equipment
3. Effective communications ranges for equipment
4. Brevity codes
5. Interval and duration of scheduled transmission windows
6. Atmospheric effect on communication ranges
7. Available satellite resources
8. Emergency communications procedures
9. Backup communications
10. Primary and backup circuit control assignments.

5.8 MINE COUNTERMEASURES REPORTING

MCM operations require a variety of reports and directives, including formatted, structured, and visual or voice messages. Reporting procedures usually require successively higher levels of command to collate reports from subordinate units for further submission of consolidated reports. The vast majority of MCM messages are contained in the following publications.

1. U.S. Message Text Formats (USMTF). The USMTF database contains all formatted messages used by U.S. military forces. MCM messages contained in the database are the MCMREP and the OPTASK MCM. Mining messages contained in the file are the OPTASK MINING and the MLAYREP. The formats in USMTF are unclassified and have been released to many allied and coalition nations. Whenever possible, available message drafting software (e.g., Turboprepâ or COE MP) should be used to ensure the accuracy of USMTF messages.

2. APP-4, Allied Formatted and Structured Messages. APP-4 is a NATO publication that contains all formatted and structured messages used by naval forces within NATO. Formatted MCM messages contained in the database are the MCMREP and the OPTASK MCM. Formatted mining messages contained in the file are the

OPTASK MINING and the MLAYREP. The formats in the APP-4 supporting database (AdatP-3) are currently NATO-CONFIDENTIAL and can only be used when operating with other NATO nations.

3. ATP-1, Vol. II, Allied Maritime Tactical Instructions and Procedures. ATP-1, Vol. II is a NATO publication that contains all visual and voice signals used by NATO forces. A MIW signal is frequently referred to phonetically as "Mike Whiskey" because it is contained in the tab marked "MIW." The Mike Whiskey signals can also be sent as record messages. The formats in ATP-1, Vol. II are currently NATO-CONFIDENTIAL and can only be used when operating with other NATO nations.

4. EXTAC 1007. EXTAC 1007 is a NATO-UNCLASSIFIED publication developed for conducting MCM operations with PFP and other non-NATO nations. It contains releasable versions of various MCM reports taken from classified NATO publications.

5. The following guidelines are used to determine which reports should be specified:

   a. U.S. report formats should be used when all assigned forces are U.S. only. The MCMC can elect to use NATO or EXTAC formats during U.S.-only exercises if those exercises are designed to prepare for operations with NATO or other allied forces.

   b. NATO report format should be used when all assigned forces are with NATO.

   c. EXTAC report formats should be used when assigned forces include non-NATO forces. The MCMC can elect to use U.S. report formats if they have been released to all participating nations.

5.8.1 MCM Report Descriptions

5.8.1.1 Structured Operational General Message

The Structured Operational General (OPGEN) message provides broad general guidance for operating forces. Commander, Second Fleet is responsible for issuing the standing Navy-wide OPGEN. The standing Navy-Wide OPGEN is intended to be supplemented by numbered fleet commanders regarding mission and area of operations specifics, including issuance of fleet-level OPGEN/OPTASK SUPPS addressing unique theater characteristics, command relationships, and operational-tactical direction. It provides policy for the commanders of naval forces operating within naval, joint, or combined organizations. Prior to the commencement of an operation or exercise, the OTC will normally issue an OPGEN to the force. The OPGEN format is contained in APP-4. Additional guidance regarding the OPGEN can be found in the CWC Handbook.

5.8.1.2 Structured Operation Tasking MCM and MCM Support

The OPTASK series of structured messages provide functional warfare area (e.g., MCM, STRIKE, COMMS, etc.) specific policy and guidance. Commander, Second Fleet is responsible for issuing standing Navy-wide OPTASK messages. COMINEWARCOM is responsible for preparing and submitting the Navy-wide OPTASK MCM message and subsequent updates or changes to Second Fleet for approval and promulgation (COMINEWARCOM and COMOMAG provide input to the standing Navy-wide OPTASK STRIKE message for mining operations). The standing Navy-wide OPTASK MCM is intended to be supplemented by numbered fleet commanders regarding mission and area of operations specifics, including issuance of fleet-level OPTASK MCM SUPPS addressing unique theater characteristics, command relationships, and operational-tactical direction. Prior to the commencement of an operation or exercise, an OPTASK MCM or OPTASK MCM SUPP will normally be issued to the MCMC by the appropriate operational control authority (OCA). When required, the MCMC will prepare an additional OPTASK MCM SUPP to provide specific information to assigned MCM forces and any supported or supporting forces. The OPTASK series formats and general drafting guidance are contained in APP-4.

5.8.1.3 The MCM Operational Directive and the Tasking Message

The operational directive (MCM OPDIR) is used by the OCA to order general execution of MCM operations. The OPDIR is normally issued to the MCMC. The OPDIR structured message format is contained in APP-4 and in ATP-1 Vol II as the MW124 signal.

Note

> The OPDIR was historically the primary format used for the OCA to provide general direction and guidance to the MCMC. The MCM OPDIR is being superceded by the OPTASK MCM and OPTASK MCM SUPP format for this purpose.

5.8.1.4 Mine Report

The MCMREP is used by individual MCM organizations or a commander, task unit (CTU) to report results of MCM operations. The MCMC will specify the periodicity for MCM assets or CTUs to submit MCMREPs. They are normally required:

1. Upon the detection of the first mine of a differing type
2. At the completion of each ordered task
3. At a specified time each day.

The daily MCMREPs from subordinate forces are used by the MCMC to compile a consolidated summary message such as MCM situation reports (MCM SITREPs). There are three versions of the MCMREP message currently in use by U.S. MCM forces: the NATO Formatted MCMREP, the NATO Structured MCMREP, and the U.S. Formatted MCMREP. The NATO Structured MCMREP and Formatted MCMREP are contained in APP-4; the U.S. Formatted MCMREP is contained in the USMTF database. The U.S. version of the formatted MCMREP has been significantly modified to support MEDAL-MEDAL communications.

5.8.1.5 Situation Report

The MCM SITREP is used by the MCMC to provide a daily summary of MCM operations up through the operational chain of command. The MCM SITREP format is contained in APP-4.

5.8.1.5.1 MW125 (MCM Task Order)

The MCMC (or subordinate CTU) uses the MW125 for tasking individual MCM assets. The MW125 format is contained in ATP-1, Vol II.

5.8.1.5.2 Formatted OPTASK MCM

The U.S. formatted OPTASK MCM message is used for the tasking of individual MCM assets in the same manner as the MW125 signal. It has been extensively modified to allow for the passing of MCM planning and tracking information between MEDAL users. The NATO version of the formatted OPTASK MCM is used to publish instructions and information to naval commanders and convoys operating in the vicinity of MCM operations. The NATO formatted OPTASK MCM is being renamed as the MCM Transit Instructions (MTRANSIT) message to avoid confusion. The NATO version is contained in APP-4.

5.8.1.5.3 Mine Detection Report

The structured Mine Detection Report (MINEDETREP) is used by non-MCM organizations to report the detection of sea mines. The MINEDETREP message format is contained in APP-4. Information for non-MCM assets concerning the use of the MINEDETREP message is contained in ATP-1, Vol I.

5.8.1.5.4 LOCATOR

The formatted LOCATOR message has recently been modified to allow for the reporting of sea mines, normally by non-MCM assets. This modification to the LOCATOR format will allow naval units to report the location of sea mines in the same manner as they report other hostile platforms (e.g., adversary ships, aircraft, etc.). Once fully implemented, the LOCATOR format will be used instead of the MINEDETREP message. The LOCATOR message format is contained in both APP-4 and the USMTF database.

5.8.1.6 TECHREP

Technical reports (TECHREPs) are used to report the results of more detailed exploitation of a mine, normally by EOD personnel. The TECHREP format is contained in AEODP-1 (Navy), Vol I.

5.8.1.6.1 COMTECHREP

The comprehensive technical report (COMTECHREP) is used to report the results of initial field evaluation of a mine or minelike object. EOD or supporting laboratory personnel conduct this evaluation. COMTECHREP format is contained in AEODP-1 (Navy), Vol I.

5.8.1.6.2 PRETECHREP

Preliminary technical reports (PRETECHREPs) are used to report the results of an initial examination of a mine or minelike object before it is disturbed. The PRETECHREP format is contained in AEODP-1 (Navy), Vol I.

5.8.1.6.3 LEADTHROUGH Messages

A series of three structured messages dealing with LEADTHROUGH operations are contained in APP-4. The LEADTHROUGH INFORMATION, LEADTHROUGH TRANSIT INSTRUCTIONS, and LEADTHROUGH ORDER messages are used to order or provide information about LEADTHROUGH operations to convoys, MCM forces, shore authorities, and others as appropriate.

5.8.1.6.4 Q-MESSAGES

The Q-Message System is used when the AWNIS has been activated. The AWNIS system is used during war when adversary mining is confirmed or suspected and allows for the routing of shipping along predetermined routes. This process enables MCM forces to concentrate their efforts on designated routes and other areas. Formats for the messages used in the AWNIS system are contained in AHP-1.

5.8.1.6.5 Mine Danger Area Messages

The MCMC or other designated authorities provide information regarding the establishment or cancellation of MDAs using free-form messages broadly termed MDA reports.

5.8.1.6.6 DETECHREP

Detailed technical reports (DETECHREPs) are used to report the results of detailed exploitation of a mine, normally by shore-based laboratory personnel of a special investigation team. The DETECHREP format is contained in AEODP-1 (Navy), Vol I.

CHAPTER 6

Environmental Factors Affecting Mine Countermeasures

6.1 INTRODUCTION

In no other phase of warfare do environmental considerations in both tactics and planning play a more dominant role than in mine warfare. Mine cases, mine sensors, target signals, and MCM systems are all affected to some extent by a large number of environmental factors. Many of these are of major importance and may affect the selection of MCM equipment or procedures. The basic decisions to hunt or sweep, and subsequent techniques to be used in an area, are based on an assessment of the environment.

6.1.1 Oceanographic

Considerations unique to the coastal oceanographic area are tides, tidal currents, surf conditions, wave height and direction, and turbidity. Salinity (conductivity), water temperature, and temperature gradient as functions of depth should be considered in the evaluation of sonar performance.

6.1.2 Meteorological

Atmospheric elements are magnified in the coastal environment. Wind speed and direction, and therefore wave height, direction, and shape, are affected by land and sea breezes. Particulate matter such as smoke and dust affects ambient light. 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 MCM.

6.1.3 Acoustic

The decision to sweep is based on the aphorism, "hunt where and when you can; sweep when and where you must." While there are some limited applications of nonacoustic 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. This measure of effectiveness will be used in the decision to hunt or sweep.

6.1.4 Hydrography, Bathymetry, and Geophysics

This combined category encompasses all the properties related to the bottom, or seabed, 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. Moreover, the MCMC will consider bottom conditions: type, roughness, burial, and clutter (which include both magnetic and acoustic characteristics).

6.1.5 Anthropogenic

These effects in the littoral environment entail manmade influences on mine and MCM systems. This includes pollution, the creation of artificial reefs and fishing havens, and military operations where ordnance and debris have been left behind. Merchant and fishing ships create turbulence and can produce sediment upwelling. Shipwrecks, trash, fishing traps, nets, pots, and wellheads all influence events.

6.2 INFLUENCE OF ENVIRONMENT ON MINE COUNTERMEASURES

The primary environmental factors that affect MCM operations are shown in Figure 6-1. Data on these factors is obtained by special mine warfare environmental surveys (MWES), promulgated by mine warfare pilots (MWPs). These are a geographically oriented series of publications relative to specialized mine warfare planning charts. In addition to pertinent oceanographic data from a variety of historic sources, the MWPs and charts also contain data on specific mine and MCM environmental characteristics. Q-Route surveys also provide vital environmental data and may be more recent than MWES surveys. The collection of this data is a continuing effort. Information from MWPs and onsite measurements provide data for making decisions to alter minesweeping or hunting methods and techniques.

6.2.1 Environmental Effects on Mine Warfare Weapons, Systems, and Decisions

MIW planners and tacticians will know and consider those problems facing the adversary miner, including the environment. The operational impact on mines as discussed in Chapter 2 is the starting point for the MCM effort.

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

1. Stable characteristics include bathymetry and topography (valid data from prior surveys).

2. Transient characteristics include thermal properties of the water column and meteorological conditions (information obtained in situ).

6.2.1.1 Stable Factors

Such factors are generally constant in nature and include water depth and bottom topography. This information may be available as the result of past surveys.

6.2.1.2 Transient Factors

These factors include thermal structure, weather, and underwater visibility. Information is based on observations taken in situ, although previous surveys may indicate average or normal readings.

6.3 ENVIRONMENTAL FACTORS AFFECTING MINEHUNTING

The following environmental factors affect hunting:

1. Water depth

2. Bottom topography

3. Bottom composition

4. Reverberation

5. Sound velocity profile (SVP)

6. Sea state

7. Clutter

8. Underwater visibility (clarity)

ENVIRONMENTAL FACTORS	
SEA CONDITIONS	
Depth	Seabed Characteristics
Water Depth Fluctuations (Tides, Storms, Runoff)	Roughness, Composition
Sea State	Bottom Strength and Stability
Current	Clutter
Surface	Water Column Properties
Subsurface	Temperature
Current patterns	Salinity
Acoustic Environment	Clarity
Sound Velocity	Biologic Environment
Sound Propagation	Bio-Fouling Conditions
Attenuation	Hazardous Marine Life
Scattering and Reverberation	Biological Acoustic Sensor Interference
Magnetic Environment	Ice
Electrical Resistivity	Thickness and Extent of Sea Ice
Ambient Magnetic Background	
Pressure Environment	
Natural Pressure Fluctuations Due to Wave Action	
GEOGRAPHIC AREA	
Choke Point	Open Ocean
Estuary	Coastal Topography and Landmarks
Port	Natural and Manmade Landmarks
ATMOSPHERIC CONDITIONS	
Climate	Wind
Duration of Darkness	Precipitation
Visibility	Storm Frequency
Air Temperature	Icing Conditions

Figure 6-1. Environmental Factors That Affect MCM Operations

9. Water density

10. Underwater and surface obstacles

11. Tidal streams and currents

12. Climate and weather

13. Marine life.

6.3.1 Stable Environmental Characteristics Affecting Minehunting Operations

6.3.1.1 Water Depth

The types of mines used will be determined in large measure by the water depth in the area of interest. Depth will affect the use of variable-depth minehunting sonar and, in some instances, will be the determining factor between sweeping and hunting. Segmentation of an area by depth may serve to improve MCM efficiency.

6.3.1.2 Clutter, Nonmine Minelike Bottom Objects, and Non-minelike Echos

6.3.1.2.1 Bottom clutter

This 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 fish traps, wellheads, oil drums, refrigerators, and other such flotsam and jetsam. Generally, as the density of clutter increases, the more degraded minehunting operational performance becomes. All echoes detected by a minehunting sonar system as being repeatedly above the noise or the average reverberation background, are referred to as clutter. From route survey information, bottom clutter is currently assessed into broad categories defining bottom types. Clutter, as well as its impact, depends on the type of sonar being used.

6.3.1.2.2 NOMBO

Nonmine minelike bottom objects (NOMBOs) are objects such as rock outcroppings, coral reefs, and man-made debris, which may give minelike responses on minehunting sonars. Such objects need not have mine case dimensions in order to have minelike sound-reflecting properties. The quantity per unit area of seabed is known as NOMBO density.

6.3.1.2.3 NOME

Such echoes within the clutter are referred to as non-minelike echoes (NOMEs). The source of these echoes need not be NOMBOs. NOME density is the number found per unit area of seabed. This figure can be estimated from route survey information. In general, as density increases, minehunting operational performance decreases. It is emphasized that this density depends on the type of sonar being used.

6.3.2 Transient Environmental Characteristics Affecting Minehunting

6.3.2.1 Tides and Tidal Currents

These influences affect the maneuver and navigation of the minehunter as described for the sweeper. Maintaining station while prosecuting a MILC presents a challenge to the hunter directly proportional to the adverse forces acting against the ship’s control systems. Strong tidal currents in conjunction with sandy bottoms may produce 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 also affect the salinity profile, which affects hunting sonar performance.

6.3.2.2 Climate and Weather

Minehunters are subject to the same climate and weather factors as minesweepers; however, prevailing weather during a hunting campaign may have an even more pronounced effect. For example, sustained high winds and associated sea states will limit hunting operations more severely than sweeping because of low-speed maneuvering requirements for the hunter, the attenuating 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 launch and recovery of remotely operated underwater vehicles, as well as boats and divers.

6.3.2.3 Underwater Visibility (Clarity)

The ability of remotely operated vehicles to locate optically and identify both moored and ground mines depends predominantly on horizontal underwater visibility. Although an ROV can localize a MILC for neutralization using sonar only, mine destruction cannot be ascertained without visual verification. Poor vertical visibility will adversely affect aerial hunting for ground mines, and poor horizontal visibility affects the search for moored mines by both visual and electro-optical means. The neutralization rate of divers and underwater vehicles decreases sharply with a reduction in visibility.

6.3.2.4 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. This bending will cause the intensity and direction of approach of the acoustic beam to vary from that expected for an isovelocity medium. Minehunting 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 hunters are equipped with variable-depth sonar and are able to minimize the adverse effects of sound velocity gradients.

6.3.2.5 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.

6.3.2.6 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 minehunting sonar. This temperature effect is negligible below about 4 °C, but the effect is significant at temperatures of 27 °C and higher, such as are found in tropical regions.

6.3.2.7 Water Density

Changes in water temperature or salinity may change density and thus the buoyancy of the water. This in turn may influence the operation of divers and of remotely controlled underwater vehicles.

6.3.2.8 Bottom Topography

Smooth, flat bottoms pose no significant problems to minehunting. Moderately rough or rippled bottoms result in an increased reverberation level, leading to higher background noise. When the topography is characterized by depressions, obstructions, ridges, rocks, or rapidly sloping relief features, the performance of sonar systems is seriously degraded as mines may be obscured in holes or behind bottom relief features. The current may form ridges across the seabed, made up predominantly of sand and gravel. Under these conditions, the optimum search course for an ahead-looking sonar may be parallel to the ridges to reduce shadow zones.

6.3.2.9 Bottom Composition

Bottom sediment will affect impact burial and subsequent burial. In general, impact penetration does not take place in a sand, rock, gravel, or sand-gravel bottom, but occurs primarily in mud. Subsequent burial may occur on a sand bottom over a period of time as a result of scouring due to current or wave action. Burial may be partial or complete and will severely erode the detection capability of sonar systems.

6.3.2.10 Reverberation

Hunting sonar detects a target when the return signal strength of the target is strong enough to be seen by the operators against the background noise on their displays. The background noise is heavily influenced by surface and bottom reverberation since hunting operations normally take place in shallow water. Mud or sand gives a low reverberation background, whereas gravel, shingle, or rock bottoms give high reverberation levels. Volume reverberation is caused by the numerous discontinuities or scattering sources within the sea that reflect the projected energy of the transmitted sonar beam back to the receiver. Surface reverberation occurs when the sonar beam meets the water surface and levels increase as seas become rougher.

6.3.2.11 Underwater and Surface Obstacles

MCM ships conducting minehunting are subject to the same problems as sweepers when considering underwater and surface obstacles. An additional hazard when conducting these operations in the presence of floating debris or ice is the danger of damaging the sonar towed body.

6.3.2.12 Tidal Streams and Currents

A careful distinction must be made between tidal streams (in some countries referred to as “tidal currents”) and currents. Tidal streams are horizontal movements of water in response to the tide-raising forces and do not cause any net transfer of water. Mixed in with the tidal stream, however, are currents, some of which are regular and some entirely unpredictable. These can be caused by oceanographic factors such as water of differing salinity or temperature, by meteorological factors such as differing barometric pressure and wind, and by topographical factors such as irregularities in the seabed. Tidal streams and currents affect the capabilities of divers and remotely controlled underwater vehicles and may cause navigational and mine burial problems. Additionally, the hunter must also consider the effect of current on the following:

1. Mine rolling. Mine rolling is uncommon in most minable waters. Normally a rapid current is required, although 1 kt is sufficient to roll a mine over a smooth, firm bottom.

2. Mine walking. Mine walking occurs when tides and currents cause a moored mine to shift position by lifting its anchor.

3. Underwater visibility. Sediment carried in water will affect visibility. The amount that can be carried depends on the rate of current and on the type of bottom sediment.

4. Sonar target location and speed error. The towed body of any towed or variable depth sonar (VDS) sonar can be affected by current, which may lead to errors in contact position-fixing.

6.3.2.13 Climate and Weather

Minehunters are subject to the same problems from climatic condition as minesweepers. However, the prevailing weather may have a more pronounced effect on the efficiency and performance of the hunter. For example, in high winds and a heavy swell there may be difficulty in maneuvering at slow speed. An increased sea state will enhance ambient noise. This is caused by disturbance of the surface due to wind and rain. In addition, increased wind strength will intensify surface reverberations due to a disturbed surface and the formation of bubbles upon the water.

6.3.2.14 Marine Life

Organisms attached to the sea bottom can be highly detrimental to the successful conduct of hunting. Attached masses, such as fucus, kelp, or sea grasses, and marine creatures, such as sea turtles and large jellyfish, can significantly affect MCM. The presence of large areas of such growth will usually prevent effective hunting.

6.4 ENVIRONMENTAL FACTORS AFFECTING MINESWEEPING

The following affect mechanical and influence sweeping operations:

1. Water depth
2. Bottom topography
3. Bottom composition
4. Underwater and surface obstacles
5. Sea state
6. Geographic restrictions
7. Magnetic sweeping environment
8. Acoustic sweeping environment
9. Tidal streams and currents
10. Climate and weather
11. Marine life.

6.4.1 Stable Environmental Characteristics Affecting Minesweeping Operations

6.4.1.1 Water Depth

The sweeping technique employed is influenced by depth. When segmenting areas for sweeping, or choosing reference buoys, known variations in water level must be taken into account. SMCM rarely operate in less than 10 m of water, but they are well suited for ocean sweeping. Depths less than 10 m (33 ft) are generally too shallow for the operation of conventional ships and require both a special kind of vehicle such as a helicopter or ROV and a special sweep technique.

6.4.1.2 Bottom Topography

The presence of abnormal variations of bottom gradient (deep holes, peaks, etc.) imposes restrictions on handling sweep gear, track orientation, and depth segmentation while increasing the probability of damage or loss of equipment. Variations in bottom gradient may complicate the minesweeping effort by necessitating changes of a mechanical sweep depth. When using mechanical sweeps, it may prove impossible to reach moored mines laid close to pinnacles or in crevices. Further, a complex bottom topography may require both sweeping and hunting to reach the desired clearance level. A relatively smooth bottom is required for a chain drag to maintain contact with the bottom.

6.4.1.3 Bottom Composition

Bottom strength and stability will be determined by composition, which will further indicate the burial potential for ground mines. Burial in soft sediment may affect the sensitivities of acoustic and pressure mechanisms and, thus, the actuation widths of the sweeps. It will also have an effect on the damage radius of these mines and may limit enemy options to the use of those that are moored or of magnetic influence. The potential for burial will influence the decision on whether sweeping or hunting techniques are to be used.

6.4.1.4 Underwater and Surface Obstacles

Wrecks and manmade underwater obstructions restrict the use of sweep gear and may require area avoidance. Large masses of drifting debris suspended in the water may obstruct sweep gear and reduce its effectiveness. This may be a particular problem when operating in the vicinity of a river. Mooring wires of reference buoys may be fouled, causing them to be pulled beneath the surface. Debris may pose navigational problems for SMCM and obstruct or damage sweep gear. This is particularly true near a river or an estuary. Additionally, the extent of sea ice could influence operations, especially diverted and helicopter-towed sweeps. Ice may also interfere with the surface destruction of any swept moored mines.

6.4.1.5 Geographic Restrictions

Geographic restrictions may limit the use of certain sweeping equipment or the employment of certain formations and maneuvers. Prominent landmarks and special coastal features are of use in both planning and conducting MCM operations because these characteristics may affect navigation and maneuver. For example, rivers and estuaries pose problems in the use of sweeping gear, while cliffs and hills may cause turbulence or reduced air space, which restricts helicopter use.

6.4.1.6 Magnetic Sweeping Environment

Factors affecting magnetic sweeping are:

1. Conductivity

2. Water depth

3. Electrical characteristics of the seawater and sea bottom.

While fairly complex in theory and planning, there are two principal elements to consider in magnetic minesweeping: the electrical conductivity of water and the ratio of electrical depth to actual depth (ED/AD).

6.4.1.7 Acoustic Minesweeping Environment

The most important factor in acoustic sweeping 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.

For acoustic sweeps, the important environmental features are:

1. Water depth

2. Bottom geology

3. Sound velocity profile.

6.4.2 Transient Environmental Characteristics Affecting Minesweeping Operations

6.4.2.1 Tides and Tidal Currents

Planning and conducting MCM 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 navigation, maneuver, 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 computed in the ship's speed over the ground.

6.4.2.2 Climate and Weather

Conditions of heavy rain, storms, or fog may hamper operations, while rough seas can degrade the minesweeper's performance. Airborne operations are particularly affected by inclement weather, as wind is a significant factor. Sortie times and load limits can decrease at high ambient temperatures and low air pressures (high-density altitude). Reduced visibility restricts sweeping operations, particularly AMCM. Wind speeds of greater than 30 kts limit helicopter-tow operations. Also, wind direction can impose towpath limitations. Turbulence causes a loss of aircraft maneuverability and subsequent difficulties in controlling sweep equipment. The effect of wind on surface craft varies with displacement and sail area as well as course and speed relative to the wind. Wind affects track-keeping ability and must be taken into account in determining track displacement and navigational error.

6.4.2.3 Wind

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

6.4.2.4 Air Temperature and Pressure

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

6.4.2.5 Visibility

Reduced visibility hampers sweeping operations, especially with regard to moored minesweeping, in which the usual method of spotting floaters by helicopter is degraded. While influence minesweeping by ship is relatively unaffected by visibility, helicopter and diving operations (independent of the parent ship) may be prevented altogether.

6.4.2.6 Sea Swells and Waves

Under the right conditions, swells and 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.

When wave action creates those conditions, acoustic and magnetic sweeps can be effective against combination magnetic, acoustic, or pressure mines. For planning purposes, it is essential to have background wave data for the area of interest.

6.4.2.7 Marine Life

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

The presence of heavy growth on the bottom must be considered when sweeping moored mines. Kelp beds, for example, may fire explosive cutters or foul mechanical cutters. In general, heavily armed sweeps are necessary where dense marine growth is present on the bottom.

6.5 ENVIRONMENTAL FACTORS AFFECTING UNDERWATER MINE COUNTERMEASURES

6.5.1 Stable Environmental Characteristics Affecting EOD and VSW Operations

6.5.1.1 Water Depth

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

6.5.1.2 Bottom Conditions

Once in the water and prosecuting a ground mine, bottom type and condition become prime concerns for the diver. A rough seabed will increase the time and effort required to execute a bottom search 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, natural and manmade, can render bottom hand-held sonar and visual searches more difficult. Topographical characteristics affect a diver’s ability to locate a MILC. Craters, ridges, coral heads, and other formations may give an underwater sonar signal very similar to an actual mine.

6.5.1.3 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, which causes a loss of visibility. Mines buried in mud or sand may not be visible to divers, thereby exposing them to significant danger from inadvertent mine actuation. Magnetic ordnance locators may be required.

6.5.2 Transient Environmental Characteristics Affecting UMCM

6.5.2.1 Tides and Tidal Currents

Except in VSW environments such as river mouths, estuaries, and harbors, tides generally pose no special problems for diving operations. Current, on the other hand, is of major concern. Surface currents will affect small boat handling and navigation, but underwater currents have an even more significant impact. The greater the underwater current, 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 the current. It is important that the diver be aware of currents, both surface and subsurface. In deep water, a relatively light current (1 kt) may prevent the diver from reaching the bottom.

6.5.2.2 Water Temperature

The colder the seawater temperature, the more adversely affected the diver's physical and mental functioning becomes. Cold temperatures directly degrade efficiency and endurance. Extremely cold water may affect the functioning of dive equipment (i.e., icing) and will considerably reduce the diver's efficiency and endurance.

6.5.2.3 Wind

Small-boat launch and recovery operations may be limited by sea state; however, airborne insertions of EOD personnel may be made in relatively worse conditions if necessary.

6.5.2.4 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 prevent such operations.

6.5.2.5 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, they must be tended from the surface by boat; therefore the sea state limitations outlined above will govern whether the diver can attempt the mission.

Once submerged, the diver may be relatively unaffected by the sea state. However, support craft may have difficulty tending the diver, and underwater visibility will be reduced if the sediment is disturbed. Note that surf and swell have a combined influence on a diver's performance in the VSW region, particularly when in proximity to mines. A Sea State 3 or greater will interfere with divers operating from small craft.

6.5.2.6 Hazardous Marine Life

Bio-fouling on mine cases may make identification hazardous and difficult for mine investigation and exploitation missions. Also, growth on drifting mines designated for surface destruction 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. Heavy seaweed (kelp, for instance) can present major entanglement and visibility problems. The presence of predators such as shark, barracuda, sea snakes, poisonous fish, or jellyfish can make a diving mission dangerous and may curtail underwater tasks.

6.6 ENVIRONMENTAL FACTORS AFFECTING AREA SEARCH DETACHMENTS

6.6.1 Sea State

A Sea State greater than two will seriously reduce the effectiveness of the sonar. The heave associated with building seas and ground swells will cause small craft to jerk the sonar through the water, distorting the display. White caps create high surface reverberation levels, masking bottom contacts. Additionally, small craft navigation is adversely affected at Sea State 2 or greater as steering becomes difficult at towing speeds of 3 kts.

6.6.2 Current

The effect of current on the towfish of the sonar is twofold. First, the towfish is assumed to be directly astern of the small craft and bottom currents may laterally displace it. This offset cannot be accurately measured. Secondly, to minimize lateral offset, search areas are arranged so that currents run parallel to search tracks whenever possible. When traveling with a strong current, the small craft may be unable to maintain steerageway at the required speed (3 to 4 kts). Increasing the speed decreases the probability of detection.

6.6.3 Bottom Topography and Composition

The topography and composition of the seabed may degrade sonar performance by either masking or burying the targets. Seabeds can vary from smooth, hard, and flat to extremely rough or soft. While a smooth, hard bottom poses no problem to the sonar operator, a bottom contour that is rough or contains deep mud, silt, or shifting sand limits sonar detection. Deep gullies, large rocks or debris, and large ridges not only mask mines but also increase the possibility of snagging the towfish on the bottom. Since the sonar has no bottom penetration capability, complete or partial burial precludes or diminishes the probability of detection.

6.6.4 Thermocline

This is a horizontal layer produced by temperature variations. It can cause refraction of the sonar signal, which can affect range.

6.7 ENVIRONMENTAL FACTORS AFFECTING MARINE MAMMAL SYSTEMS

The principal factors affecting MMS are:

1. Low salinity
2. High temperature
3. Pollution.

Specific details are contained in NWP 3-15.23.

6.8 MINE COUNTERMEASURES ENVIRONMENTAL DATA COLLECTION

Where areas appropriate to MCM operations are too large for timely completion of a comprehensive MWP, an MWES should be carried out.

MWESs should be conducted along planned wartime routes, in anchorages, ports, and other operational areas in order to:

1. Establish routes in most favorable hunting areas
2. Assess where effective hunting is not possible and amount of sweeping required, which will engender more detailed study of local acoustic and magnetic propagation factors
3. Assess force level requirements and time required to complete specific operations.

6.8.1 Environmental Data Collection

One of the most important keys to successful MIW combat operations is the accurate collection, collation, and dissemination of environmental information obtained during peacetime and immediately after the cessation of hostilities. The precision and quality of this data directly affects the time required for completion of operations, the safety of MCM forces, and risk to friendly shipping after completed operations. The effort to provide accurate data should be of the same priority as the effort to provide quality mine intelligence.

Peacetime environmental data collection efforts are not normally welcomed in the waters of an adversarial nation. In the past, archival files, best estimates, and educated guesses have been used when more precise information was required. While accurate and timely data is available from the Naval Oceanographic Office (NAVOCEANO), commercial and academic sources for environmental information frequently are available for most littoral nations of the world. 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 a belligerent nation's suspicions during peacetime. While of great importance, the information collected during peacetime is generally insufficiently specific for the degree of precision required.

Increasing risk of hostilities creates conditions that hinder collection efforts. While precision and quality are in greater demand, the ability to gather data is even more restricted than during peacetime. Knowledge of the precise geographic locations of suspected minefields or planned operating areas leads to more focused MCM operations. The type of MCM operation to be undertaken can be better defined with the databases from peacetime collection coupled with information from in situ collection efforts.

In situ collection from forces on location actually engaged in operations is the best, most precise information available. This collection can directly influence risk to MCM forces, efficiency of MCM, risk to transiting forces, and, ultimately, the time required to complete the mission. Data collected while on site is done in real-time and much that directly affects combat system performance and environmental prediction models can be collected by MCM platforms. While bathymetry information can be collected by expendable Bathythermographs (BTs), much 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 reverberation noise and clutter can be refined by the sonar.

6.8.2 Sources for Environmental Data

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

6.8.3 Prediction Models

These generally fall into four categories: environmental prediction (mine burial, current circulation, or magnetic surveys), acoustic prediction (sound speed profile), combat system performance prediction (sonar range prediction or magnetic sweeping safe current prediction), and tactical decision aid models (which integrate the first three models). 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 must be registered (acoustic data collected in the same geographic area as magnetic data, for instance) and in a usable format for MCM operational use.The NAVOCEANO is the repository for all environmental models and can access models outside of DOD sources as well.

6.9 Q-ROUTE SURVEYS

The aim of a Q-Route survey, normally conducted in peacetime, is to assess the suitability of conditions in a given area for hunting and to detect and locate MILCs for future removal or avoidance. These contacts, if not removed, should be confirmed at frequent intervals. A reliable record of the Q-Route in any given area is of great assistance to MCM operations.

Two types of surveys are employed:

1. General survey. These establish minehunting conditions along a route. The objective is to determine the effectiveness of hunting in the area and to recommend avoidance of unfavorable areas where possible.

2. Detailed survey. The aim here is to produce a detailed chart showing the type of minehunting bottom and the nature of MILC and other NOMBOs.

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CHAPTER 7

Mine Countermeasures Navigation

7.1 INTRODUCTION

MCM operations require very precise navigation to minimize errors in determining the position of cleared channels, MDA, sonar contacts, and force locations. Among other advantages, precise navigation provides:

1. A reduction of the required channel width. The width of a typical channel is about six times the largest standard deviation of navigational error of expected ship traffic.

2. An improvement in the efficiency of MCM. This is due to reductions in area overlap and the time necessary to reacquire contacts.

3. The precise locations where MCM efforts have already been applied. This allows MCM platforms to remain in previously cleared waters.

4. A reduction of risk to traffic. More efficient MCM translates into fewer mine encounters for ships in transit.

7.2 STANDARDS AND CONVENTIONS

The Earth flattens at its poles of rotational axis and bulges at its equator. The resulting geometrical figure is an ellipsoid of revolution, which is the figure obtained by rotating an ellipse about its shorter axis.

Many attempts have been made to define the ellipsoid that most closely approximates the shape of the Earth. Universal acceptance of a single ellipsoid is difficult to obtain because mean figures for the entire Earth are not always the best for surveying a particular region. Ellipsoids that fit better locally are preferred for surveying and charting.

A geodetic datum is defined by the ellipsoid and by the relationship of the Earth to that ellipsoid. One result is that reference points given with respect to one datum and ellipsoid may differ from the same points given with respect to another. Consequently, the same landmark will have different latitude and longitude on charts having different datums.

The World Geodetic System (WGS) is a geocentric (Earth-based) system that provides a common reference for establishing compatibility among coordinates of interest in different geodetic networks. The latest designation is WGS-84.

7.3 NAVIGATIONAL ERROR MEASUREMENTS

7.3.1 Terms and Definitions

Standard Deviation of Navigational Error (e). This is a one-dimensional measurement made relative to the mean ship track; it is a measure of cross-track variability about the mean ship track made good. Standard deviation of cross-track error is used in planning and evaluating MCM operations that use multiple parallel tracks to achieve area coverage.

Cross-Track Root Mean Square. This is a one-dimensional measure of cross-track error made relative to the intended track.

Distance Root-Mean-Square (DRMS). This is a two-dimensional measurement of circular error of position. An example of its use is to measure the accuracy of ship, contact, or mine position. The DRMS value is the radius of a probability circle of error.

R95. This is the radius of the smallest circle, centered at the "true" position point that encompasses 95 percent of the measurements.

Geometric Dilution of Precision (GDOP). All geometric factors that degrade the accuracy of position fixes derived from externally referenced navigation systems contribute to the figure of merit called GDOP. These factors are typically the lane width and the crossing angle of lines of position (LOP) in the vicinity of the fix for land-based systems, and elevation angle and azimuth for satellite systems. GDOP as applied to GPS also includes a time-related dilution of precision factor in addition to the geometric factor.

Horizontal Dilution of Precision (HDOP). This is the component of GDOP that lies in the horizontal plane and is more commonly used for surface ship navigation accuracy.

7.3.2 Geodetic Versus Relative Navigation

Geodetic positions are those related to actual locations on the Earth. Relative positions are those related to a superimposed reference such as a long-range aid to navigation (LORAN) network. Geodetic MCM navigation is navigation by use of GPS, or any other navigation system where transmitter locations have been surveyed. Relative MCM navigation is that which has the accuracy required for the mission but does not meet the requirements of geodetic navigation.

7.3.3 Precision Versus Accuracy

Accurate navigation is a primary factor influencing the selection and conduct of the MCM objective and has a direct bearing on the assets required. Precision is a measure of the amount of variation among estimates from repeated samples. As applied to navigation systems, it is associated with the repeatability of computing a position. Accuracy is a measure of the displayed position of a navigation system relative to its true position. Accordingly, to determine accuracy, a ground truth is required. The relationship of precision and accuracy is shown in Figure 7-1.

7.3.4 Repeatability

Repeatability is the measure of the precision with which a user can return to a specific position having coordinates that have been determined previously with the same exact navigation system and sensor.

7.4 STANDARD DATUM CONVERSIONS

7.4.1 Standard Datum

The WGS-84 datum is taken as the standard datum for MCM near CONUS. In other parts of the world there are 92 additional datums that should be supported. GPS receivers support 47 of them.

7.4.2 Defense Mapping Agency Conversion Algorithms

Defense Mapping Agency (DMA) algorithms and constants should be used for conversions from LORAN-C time delays (TDs) to latitude-longitude. COMINEWARCOM will maintain a set of conversion pairs (latitude-longitude to TDs, TDs to latitude-longitude). The DMA seawater model algorithms will remain as the standard conversion model.

7.4.3 Reporting Conventions for Positions

Latitude-longitude for positions (MILC, Q-Route, etc.) in all MCM operations are to be reported and documented in degrees, minutes, and decimal minutes to at least three decimal places.

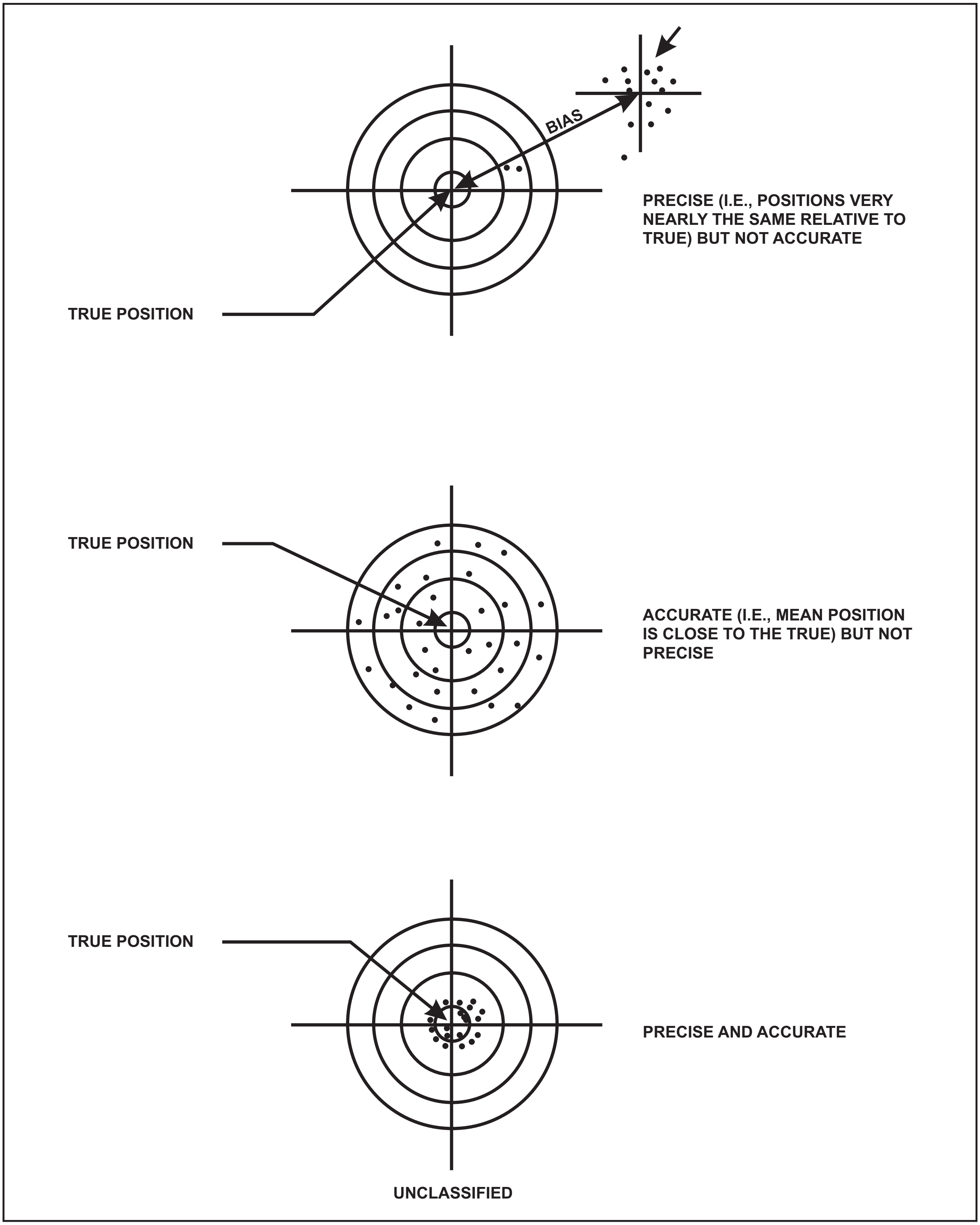

Figure 7-1. Relationship Between Precision, Accuracy, and Bias for Fixed Objects

7.4.4 Reporting Accuracy

When directed, report:

1. Datum used for calculating latitude-longitude of any MILC

2. Accuracy of navigation system in terms of 2 DRMS.

7.5 SOURCES OF NAVIGATION ERROR

There are many sources of navigation error. In general terms, the total error is the square root of the sum of the squares of the individual errors. While total error is dominated by the largest source, maximum reduction in overall error requires reduction of all error sources. In selecting navigation systems and estimating the magnitude of navigation errors, the MCM planner should review the error sources to ensure that no important source has been overlooked. Figure 7-2 contains a comprehensive list of error sources.

7.6 HOW NAVIGATION ERRORS AFFECT MINE COUNTERMEASURES

Navigation errors affect MCM in several ways:

1. Tracking errors can reduce percentage clearance in areas where MCM has been applied.

2. Systematic errors affect boundaries of areas that the MCMC believes has been cleared.

3. Tracking errors and lack of precision in receiver systems increase risk by letting the sweeper or hunter enter uncleared waters.

4. Error bias between precise systems reduces the likelihood that one system can relocate minelike objects detected by another.

5. The long-term variability in route survey navigation systems hampers later relocation of objects.

7.6.1 Effect of Tracking Error on Percentage Clearance

As an MCM platform sweeps or searches along parallel tracks, it wanders about its intended path due to steering inaccuracies and the continually changing forces of wind, current, and sea. These steering errors cause occasional gaps in the coverage, called “holidays,” which lower the percent clearance in the middle of the area. This condition can exist even if the navigation system is absolutely correct, although random errors in the navigation system add to the tracking error and also cause holidays.

7.6.2 Defining Boundaries of Clearance Areas

It is important to clearly define the boundaries of cleared areas for the benefit of traffic that will transit the area. The MCM planner must understand that boundary definition is of the utmost importance when the clearance area is long and narrow much like a Q-Route. Several actions can be taken to mitigate the bias between the MCM navigation system and that of the traffic ship:

1. The edges of the clearance area can be marked with buoys or other markers that traffic ships can read.

2. A larger area can be cleared to give traffic a better chance of staying within boundaries.

3. Various traffic navigation systems can be co-calibrated (i.e., each can be compared to the MCM standard) to correct for the systematic errors between them and the MCM navigation system.

RECEIVERS	
Receiver Resolution Error	This is the typical 2-m (6.5-ft) error cited by manufacturers.
Width of Lanes	Any land-based receiver error is magnified when the lane width gets larger.
Calibration of Receivers	One receiver will not display exactly the same reading as another receiver of the same make and model.
Standardization of Receivers	Different receiver makes and models receive and process data differently to generate the LOP(s).
Conversion Routines	Different makes and models of receivers convert from LOPs to coordinate systems (e.g., lat-long) using different conversion algorithms. LORAN-C is required to be accurate to within a quarter nautical mile.
Calibration of Antenna	Position of antenna must be known accurately with respect to the center of yaw of the MCMV.
Internal/External Interference	Internally generated interference can cause partial or complete loss of signal. This is a particular problem on helicopters and antennas near the water's surface. External interference generated by supporting platforms also causes problems.
PLOTTING	
Scale	For proper precision, minehunting requires a scale of 1 in = 100 yd; actual scale is usually 1 in = 200 yd or greater.
Accuracy	On 1 in = 100 yd scale, the diameter of a grease pencil point is about 10 yd; on 1 in = 200 yd scale, the diameter is 20 yd.
Interpolation Error	Eyeball interpolation between lines of latitude and longitude is not as good as automated interpolation.
Reference Conventions	Different charts use different lat-long conventions. Some use degrees, minutes, seconds while others use degrees, minutes, decimal minutes. Navigators sometimes confuse these conventions.
Ellipsoids	Different charts are based on different ellipsoids, most commonly NAD-27, WGS-72, or WGS-84. The difference between NAD-27 and WGS-72 in the San Diego area is about 230 m (250 yd).
Light Bug on the DRT	The diameter of the light bug at the 1 in = 100 yd scale is substantial. In addition, the bug is not always accurately calibrated.
Conversion from Lat/Long to Along/Athwart	In several MCM exercises in 1987, both lat-long and along-athwart positions were reported. These seldom agreed within 90 m (100 yd).
SONAR POSITIONS	
Sonar Towed Body Position	Position is unknown, especially if no transponder system is used for localization.
Speed of Sound in Water	Range of contact painted on a sonar scope or trace is based on an assumed speed of sound through fresh water. If that assumption is wrong, the range will be incorrect. When it has demonstrated that multiple sonar fixes on the same object do not coincide, then an averaged position is displayed.
Slant Ranges	Most sonars present slant ranges to objects, which are then plotted as horizontal ranges.
Ray Bending	When triangulation is used to calculate horizontal range, chart calculation assumes straight-line transmission, when frequently rays bend up or down, depending on sound velocity gradient.
Ray Bearing	The azimuth of sonar bearings is not known precisely. Side-scan sonars in particular yaw as they move through the water. Even if the body position is known precisely, the bearing error is unknown and is not used in plotting.
Resolution of Display	Spot size causes inaccuracy. Range resolution depends on the pulse length and deconvolution of the return from the pulse shape.

Figure 7-2. Sources of Navigation Error (Sheet 1 of 3)

STATION NETWORK	
Station Survey	For relative navigation, stations must be surveyed accurately in local coordinates. If geodetic accuracy is required, those positions must be converted accurately to geodetic coordinates, or, preferably, surveyed using differential GPS.
Station Co-Calibration	A precise navigation network may offer very precise local coordinates for repeatability or relative navigation with other receivers of the same system, while being completely incapable of handing off positions to other precise navigation systems. (Precision is not the same as accuracy.) This is considered to be one of the largest sources of error among diverse MCM assets attempting to exchange contact positions. Differences in station surveys are magnified by GDOP (see below).
Antenna Sway	Antennas lean and sway in the wind.
Ground Planes	Networks such as HYPER-FIX require radical ground plans for which sufficient ground may not be available.
Local Interference	Electrical lines near the ground plane or power transmission near stations can cause distortion of transmission pattern.
Station Geometry	LOP crossing angles and DOP divergence multiplies the effect of receiver error many times. These effects, which are called Geometric Dilution of Precision (GDOP), make some station networks ineffective for portions of the Q-Route to be covered.
Baseline Extension	An extreme form of GDOP occurs where the MCMV must cross the baseline extension of either a hyperbolic or range-range network. On the baseline extension, navigation error is infinite.
Lane Skipping	Many precise systems require continuous reception of signal. If the reception is broken, lanes may skip causing errors, which are multiples of the lane width in the region being navigated. The lane skipping is insidious and may or may not become apparent after the mission.
Initialization	Many precise navigation systems, such as HYPER-FIX, require moderately accurate (about 300 m (330 yd)) initialization, which may result in errors due to an inaccurate initial position being assumed. When lanes are lost, position must be reinitialized, repeating the opportunity for initial position error.
Watch Circles	Stations mounted on buoys (master reference buoys, RAYDIST buoys) have watch circle errors. These watch circles cause three types of errors, two of which depend on the station geometry. (1) Lateral movement of both stations (vector components in x and y directions that are common to both stations forming a baseline); (2) rotational movement of both stations (error will result from range of object from baseline and amount of rotation) (3); compression/expansion (length of baseline changes, causing LOP crossing to disappear or be created) (resulting error can be infinite in some locations).
ENVIRONMENTAL EFFECTS	
Sea-Land Discontinuity	Causes distortion and phase changes in radio navigation systems. This is most pronounced in LORAN-C but also occurs to a lesser extent in line-of-sight systems.
Frontal Systems	Causes interference and changes sea-land effect.
Blocking of LOS	Can be caused by landmasses or even ship movements in the vicinity.
Rain Squalls	Causes interference and lane skipping.
Diurnal Effects	Direction reception of LORAN-C becomes difficult at night when the ionosphere starts to break up causing multi-path reception.
Season Variations	Results in long-term jitter in LORAN-C reception.
Ship Roll	In a sea, the ship's roll and pitch cause the antenna position to move, creating short-term errors. On one observed test of the RAYDIST system, calculated ground speed was jumping routinely from 2 to 15 kts due to antenna movement. Filtering will reduce, but not eliminate, this cause of error.

Figure 7-2. Sources of Navigation Error (Sheet 2 of 3)

OTHER	
Steering Errors	Even if the receiver provides perfect navigation data, there is a limit to how precisely the helmsman can steer the ship.
Kalman Filter Effects in Turn	Kalman filtering can be very accurate for straight-line navigation, because the receiver noise becomes predictable. In turn, receiver noise changes and the solution has a transient error.
Data Transmission (Garbling, etc.)	
Human Errors	

Figure 7-2. Sources of Navigation Error (Sheet 3 of 3)

4. Highly accurate navigation systems can be used (GPS or precise systems calibrated to GPS).

5. The MCM platform can provide a navigation leadthrough to show the traffic exactly where the clearance has been applied.

7.6.3 How Navigation Error Affects Risk

For some operations, the progressive sequence reduced risk pattern is used to lower MCM risk. The principle is to employ a large sweep width and always sweep a track adjacent to the previously swept area, so that the track remains in waters swept on a previous track. The smaller the errors, the less likely the sweeper is to enter uncleared waters.

7.6.4 Relocation of Minelike Contacts

Relocation requires precise navigation when the same MCM platform attempts to relocate its own MILCs or when one MCM platform attempts to relocate an object reported by another. Two precise navigation systems often cannot hand off contacts to one another because there is a difference between them.

7.6.5 Q-Route Survey

By nature and definition, route surveys are usually conducted and documented in peacetime. This facilitates the detection of objects that later appear during hostilities. In route surveys, positioning of the MCM platform is only one of the requirements. Positions of detected objects (two- or three-dimensional) must also be accurately established, particularly if they are not prosecuted at once. In hunting operations in which disposal is not conducted immediately, accuracy and precision in the location and plotting of a contact become more important. Relocation of a contact, perhaps by an MCM platform other than the one that initially located the contact, demands the highest degree of positional accuracy. There are two types of route survey: general survey and detailed survey.

7.6.5.1 General Survey

This survey assesses the environmental conditions over a broad area for selection of Q-Routes and does not require precise or accurate navigation.

7.6.5.2 Detailed Survey

This survey localizes the position of individual objects for future relocation. Therefore, the function of detailed survey is the same as that for relocation of MILCs during minehunting, with one notable exception: in a detailed survey, an MCM platform must locate an object found long ago, whereas in hunting, the relocation of the MILC generally occurs in a very short period. The protracted time-base causes problems with navigation systems that vary with atmospherics, such as LORAN-C. MILCs localized using LORAN-C can normally be relocated by the same MCM platform during a 1- to 2-week minehunting operation, but not necessarily after 3 or 4 months.

7.7 SELECTION OF NAVIGATION SYSTEMS

Selection of navigation systems and establishment of the MCM navigation and reporting datum are the responsibility of the MCMC.

While there is a natural tendency to allow individual MCM assets to use their most accurate systems, this does not always produce optimum force efficiency. In establishing his MCM navigation policy, the commander should consider the following factors relative to navigation systems as they pertain to the assigned task and allocated assets:

1. Availability
2. Coverage of task area
3. Reliability
4. Accuracy
5. Precision
6. Objective
7. Tactics
8. Clearance methodology.

Figure 7-3 tabulates navigation systems available to MCM platforms in descending order of priority, subject to particular operational or tactical considerations by the MCMC.

The MCMC is responsible for the selection of a standard navigation datum in which to conduct MCM operations. All navigation coordinates should be promulgated in reference to selected datum.

Consideration must be given to the datum that local charts use. If there is a difference between the MCM datum and local chart datum, correction factors in range and bearing and offsets in latitude and longitude should be determined and given to local units for use in correcting their charts to the MCM datum while traveling through MDAs. In some overseas ports, an unconventional datum may be in use with no conversion immediately available. The use of an MCM leadthrough vessel will be necessary to ensure that local units transit MDAs with the required navigational accuracy.

7.8 DESCRIPTION OF AVAILABLE NAVIGATION SYSTEMS

7.8.1 NAVSTAR Global Positioning System

GPS is a worldwide satellite-based radio navigation system. It is based on a constellation of satellites uniformly spaced in six orbits. This provides continuous three-dimensional navigation. A position is achieved by determining the distance from the receiver to three selected satellites. Each satellite broadcasts a continuous signal containing the satellite position and time generated by an atomic clock. Once the range and positions of three or more satellites are known, the vessel's antenna position is determined mathematically using the intersection of arcs of possible position.

In an effort to reduce the atmospheric attenuation of a satellite signal, the GPS receiver will reject a signal until a satellite has reached a position greater than 10° above the horizon. Once a satellite is being tracked, the GPS receiver will retain use of this satellite even with lower elevation angles if a satellite with better geometry is not available. It is conceivable that the satellite signals might be jammed or the satellite destroyed by an adversary during an operation. In the MCM 1, the AN/WRN-6 is interfaced to the Precise Integrated Navigation System (PINS) (AN/SSN-2). In the MHC 51, the AN/WRN-6 is interfaced with the AN/SYQ-13 navigation C2 system. The system consists of a receiver, two control display units, an antenna amplifier, and system antenna.

SYSTEM	PLATFORM								
	SURFACE			AIR	UNDERWATER			OTHER	
	SAM	MCM 1[1]	MHC 51[2]	MH-53E	ASD	MMS	MCM DET	NSW	MIUW
Differential GPS									
Military GPS		X	X	X	X[3]	X[3]	X[3]	X	
Civilian GPS	X				X[3]	X[3]	X[3]	X	
LORAN-C		X	X		X				
Sunburst		X	X						
Radar		X	X		X				X
SANS								X	

NOTE:
[1] AN/SSN-2 (PINS)
[2] AN/SYQ-13
[3] Available at Mobile Unit level

Figure 7-3. Navigation Systems Available to MCM Platforms

AMCM helicopters use the AN/ARN-151 GPS receiver, which is integrated with other AMCM navigation gear.

EOD DETs employ the AN/PSN-8 Manpack and various hand-held commercial GPS receivers.

7.8.1.1 GPS Operational Modes

The GPS is designed to produce accurate and reliable information to authorized users. Several techniques are employed to furnish the requisite level of accuracy while simultaneously denying the most accurate positioning to unqualified users.

Selective availability and antispoofing (S/A and A-S) are available only to military standard receivers that have cryptographic keys to receive and process the signals. S/A modifies the satellite signal, a process sometimes referred to as “dithering.” Authorized user units recognize the modifications in the signal and process them. This capability provides a more accurate position determination than can be achieved by a civilian receiver. S/A can be turned on or off by the Department of Defense. It is in the best interest to use it unless the units participating in an operation are not all equipped with crypto-capable receivers. In this case, it may be advantageous to turn S/A off so that all units are using the same frame of reference.

There has been much discussion of the accuracy attained with GPS. As a planning tool, users should not rely on any accuracy better than about 20 m (22 yd) CEP with S/A and about 40 m (44 yd) without it. These values can be degraded if there are too few satellites in view and/or their altitudes are too low.

Military GPS receivers are classified confidential when they have cryptographic keys for selective availability and loaded to accommodate antispoofing. Operational use of a classified navigational device can create severe distribution and deployment problems. The precision positioning service (PPS) was developed to alleviate these problems. Basically, PPS consists of programmable solid-state devices that cannot be exploited or reverse-engineered. GPS receivers with PPS are unclassified even when keying information has been loaded into them. This capability is particularly useful in backpack receivers or those used in landing craft and other vehicles.

Because of the consequences of an error, it must be verified that participating units have receivers that are crypto-capable.

7.8.2 Differential GPS

Differential GPS corrects GPS to the local geographic datum. A correction factor is communicated to all user units. There is a reference station that has a receiver, processor, and a data link. The reference station measures the GPS signal and computes its position that is then compared with its known surveyed position to yield the corrections. Corrections are then sent to the users who apply the corrections to their GPS positions. The assumption is that the most significant errors are caused outside the receiver and the receiver itself does not contribute much. Because most of the outside errors are common to the reference and other users for up to several hundred miles, they can be computed and corrected.

7.8.3 Long-Range Aid to Navigation

The LORAN-C system is composed of a series of transceiver stations linked to form a "chain." Each chain contains a master station and two to four slave (secondary) stations. The master and secondary transmissions are synchronized. Position fixing is based on the time it takes a LORAN receiver to receive a transmitted pulse from the master and the secondary. The time differential plots as a hyperbolic line on a LORAN chart. The intersection of two or more lines establishes a position.

Where precise navigation is not available, LORAN-C is the most preferred navigation system for route survey. LORAN-C does not provide the required geodetic accuracy but has the potential to provide the needed repeatability.

7.8.4 Sunburst Plot

The sunburst plot technique is a simple and somewhat imprecise method used by MCM ships to plot contacts while hunting. It is an alternative to be used only when more accurate methods are not available.

The use of the sunburst technique requires an object on which radar ranges and visual bearings can be taken. As the ship proceeds along track, the plotting team takes frequent visual bearings using an alidade coordinated with radar ranges. The periodic fixes can be supplemented by additional fixes when sonar reports a contact. The virtues of this technique are:

1. It requires no capabilities exterior to the ship. If no suitable object for taking fixes is present, the ship can plant a buoy.

2. Positions of interest can be revisited by re-creating the range and bearing of the first fix.

The disadvantage of the technique is that it is wholly related to the sensors of one ship. Contacts cannot be accurately marked for other MCM platforms.

7.8.5 Integrated Navigation Sonar System

This is a consolidated sonar detection and acoustic x-y baseline grid navigation system used by divers of EOD and NSCT1.

7.8.6 AN/SSN-2 Precise Integrated Navigation System

The PINS installed in the MCM 1 Class is a computer-centered navigation system that can receive position information from several position-fixing subsystems. The computer receives the position information and processes it automatically with a digital filtering technique to arrive at the best position fix from all available input information.

PINS uses GPS, LORAN-C, HYPER-FIX, and an acoustic transponder system. The Doppler navigator and its Doppler sonar component in the dead-reckoning group are also part of PINS. For additional navigation input, PINS interfaces with the gyrocompass and the electromagnetic speed log. For target acquisition information, PINS interfaces with the minehunting sonar, MNS (manual interface only), radar, and fathometer.

7.8.7 AN/SYQ-13 Navigation-Command and Control System

The AN/SYQ-13 is used on the MHC 51 and provides systematic coverage of a mined area. The computer is used to keep accurate plotting data for determining results of MCM. The tactical display consoles exhibit the ship's track and contact data for aid in tactical decision making. The system is designated the integrator for the command and control subsystem and receives data from the minehunting sonar, radar, sonar sounding set, MNS, and command and control tactical displays.

7.8.8 Airborne MCM GPS

A GPS receiver is installed in the helicopter. This method of navigation offers greater accuracy, range, and coordination between units.

7.9 GENERAL NAVIGATION PROCEDURES

7.9.1 Identification of Q-Routes

Q-Routes planned for use by U.S. ships in wartime are defined in latitude and longitude and are defined in the AHP-7 series. The publications provide Q-Route coordinates in NAD-27, WGS-72, and WGS-84.

7.9.2 Identification of Master and Secondary LORAN-C and HYPER-FIX

The WGS-84 datum should be used for these systems.

7.9.3 Survey Procedures

Differential GPS survey equipment should be used to determine the accurate geodetic locations of the transmitter sites of other navigation systems.

7.9.4 Conversion of Airborne MCM Side-Scan Sonar Positions to Latitude-Longitude

7.9.4.1 AN/AQS-14A Sonar Contact Position Determination Using Target Localization

This is a computer program developed as an aid in determining the position of AN/AQS-14A sonar contacts. Inputs to this program come from a sonar operator's log and from the AMCM helicopter's precise navigation system. Target localization (TARLOC) provides the latitude-longitude of the contact and its range and true bearing from the helicopter position at the time of detection.

7.9.4.2 AN/AQS-14A Sonar Contact Manual Position Determination

This procedure was used by AN/AQS-14A operators before TARLOC became available. Sonar contacts are marked on both the sonar videotape and the Precise Navigation System (PNS) tape to mark the position of the helicopter when the sonar target was called by the operator. Using the known sonar vehicle trail-back, the helicopter heading when the PNS was marked, and range of the sonar contact from the vehicle the position of the sonar contact is inscribed on the OPAREA chart.

7.9.5 Radar Assistance to MCMVs and Traffic Ships

The radar of a vessel traffic service (VTS), MIUW van, or a ship can be used as a backup navigation system for both airborne and surface MCM platforms.

If these sources have been used to conduct MCM, then ship traffic should be vectored over the same route by the same system.

The order of preference, subject to the CO's decision is:

1. VTS

2. MIUW van

3. Ship's radar.

7.10 INTEROPERABILITY CONSIDERATIONS

7.10.1 Co-Calibration Procedures

Contact locations often cannot be accurately transferred from one navigation system to another. This is because different systems are not calibrated to the same precise reference, and each has different system-bias errors. The site locations of navigation systems having fixed transmitter sites should be accurately surveyed in latitude-longitude for a standard datum. This will allow the accurate conversion of contact positions to latitude-longitude, although system-bias errors may still degrade contact location accuracy. Another means of improving interoperability between navigation systems is to co-calibrate them. This is accomplished by measuring the bias and applying a bias correction between systems.

7.10.2 Handing Off Contacts Between Specific Systems

This chapter has provided detailed information on a number of navigational systems and techniques of varying utility and availability. The most critical, overwhelmingly important system is GPS. The preferred navigational system should always incorporate GPS and great effort should be exerted to supply units with GPS.

CHAPTER 8

Mine Countermeasures for Non-Mine Countermeasures Ships

8.1 CONCEPTS

This chapter discusses self-protection 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 MDA where MCM forces are operating.

8.1.1 Detect and Avoid

The most effective action for self-protection that can be taken is to detect and avoid minefields. It is the task of the miner to make the fields 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 vessels under his command to elude that threat. Most ships are not equipped to detect mines, and although some ASW sonars have been modified to improve their detection capability, even these do not have a high enough probability of detection or are not sufficiently accurate 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 that avoidance.

8.1.2 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 and 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.

Many factors determine where certain mines can or cannot be used. By combining available information on mines likely to be encountered with a study of the environment, waters that are unsuitable for mining and are therefore safe for maneuver may be revealed. The following are examples:

1. Bottom (ground) mines are not considered effective against surface craft in anything over 300 ft of water unless they are rising mines.

2. Moored mines will experience significant dip in areas where current flow is strong. 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 circumnavigate waters most likely to be mined or estimate where mining is more likely.

8.1.3 Organic MCM Systems and Capabilities Assigned to the Battle Group

8.1.3.1 Airborne MCM SYSTEMS

8.1.3.1.1 MH-60S Helicopter

The MH-60S will be the Navy's primary assigned organic MCM platform. It will incorporate all five developmental AMCM systems within a common architecture that can be rapidly reconfigured to engage a given mine threat. The MH-60S will also be capable of conducting combat search and rescue, vertical replenishment, and airborne mine warfare. It will be deployed initially on aircraft carriers and large-deck amphibious platforms (CV/N, LHA, and LPD, for example), although cross-decking and "lily-padding" to smaller combatants is feasible. Deployment from small combatants is a potential future capability that would provide added flexibility in employing AMCM systems. The MH-60S has a maximum speed of 170 kts, a 2.5-hour mission capability, plus fuel reserves and is capable of all-weather day-night flying, but not nighttime MCM operations.

8.1.3.1.2 Airborne Laser Mine Detection System

The Airborne Laser Mine Detection System (ALMDS) is a nontowed, electro-optic system that can detect, classify, and locate floating and near surface moored minelike contacts for subsequent prosecution by other MCM systems (e.g., Rapid Airborne Mine Countermeasures System (RAMICS) or EOD divers). ALMDS is a quick response system employed by the MH-60S to provide upper water column detection coverage for minelike objects and to complement other assigned MIW systems in executing collective coverage for the full water column.

8.1.3.1.3 AN/AQS-20/X Sonar Mine Detection Set

The AN/AQS-20/X is a towed minehunting system that will be deployed from the MH-60S helicopter to provide assigned MCM capability to BGs and ARGs. The AN/AQS-20/X system consists of a towed body that houses minehunting sonars and a mine identification sensor, an airborne common console to control and convey power to the towed body and to perform signal processing and display functions, and aircraft-mounted handling equipment. The system will be capable of detecting, localizing, and classifying bottom, some close-tethered, and volume mines. It will be capable of identifying bottom and some close-tethered contacts previously detected and classified as minelike. Moored or tethered and bottom mine identification is constrained by towed-body depth limitations.

8.1.3.1.4 Airborne Mine Neutralization System

The Airborne Mine Neutralization System (AMNS) is an expendable, non-towed mine neutralization system that will be deployed from the MH-60S to explosively neutralize unburied bottom, close-tethered moored, and volume mines. Mine detection, classification, and identification will have been accomplished previously by a minehunting system such as the AQS-20/X, ALMDS, or RMS. AMNS will reacquire the target and then guide the ordnance delivery system into optimal position to fire a self-contained shaped charge or other type of warhead.

8.1.3.1.5 Rapid Airborne Mine Clearance System

RAMICS is a non-towed mine neutralization system that can be carried by MH-60S helicopters. It will provide a rapid response clearance capability against near-surface minelike objects that have been detected, classified, and located by ALMDS. The system will fire supercavitating projectiles using a laser targeting fire control system. Mine deflagration caused by the RAMICS projectile will provide evidence as to whether the ALMDS minelike contacts were indeed mines.

8.1.3.1.6 Organic Airborne Surface Influence Sweep

Organic Airborne Surface Influence Sweep (OASIS) is a towed system that will be deployed from the MH-60S helicopter. It will provide a limited-endurance, high-speed, shallow water, magnetic- and acoustic-influence sweeping capability to support mine clearance. Its ability to fully demagnetize permits the system to be transported in the helicopter, which will facilitate fast transit for OTH operations.

8.1.3.2 Surface MCM Systems

8.1.3.2.1 Remote Minehunting System (AN/WLD-1(V))

Remote Minehunting System (RMS) will provide surface combatants with a long-endurance, low-observable, and offboard reconnaissance and minehunting capability. RMS uses an air-breathing, diesel-powered semisubmersible remote minehunting vehicle (RMV) that deploys and retrieves a VDS (e.g., AN/AQS-20/X). The VDS includes acoustic sensors for detecting, classifying, and localizing bottom, close-tethered, and moored mines in the volume. The sensor body also includes an electro-optic sensor for identification of mines. The sensors can operate either in a hull-mount mode (in the RMV) or while being towed at variable depths. The VDS is deployed via a winch system from within the RMV and operates in either an altitude or depth-following mode. The RMV is also equipped with a forward-looking sonar (FLS), used primarily for obstacle avoidance. Additionally, a mast-mounted video camera provides surveillance in support of surface-contact avoidance. Moored or tethered and bottom mine identification is constrained by the towed-body's depth limitations.

RMS acoustic sensors are capable of sampling the environment in situ for sound velocity and bottom reverberation to optimize sensor placement and performance. The system operates via one or two data link subsystems (a line-of-sight UHF data link for near-ship operations and a VHF data link for OTH operations). The RMV uses a GPS for navigation to automatically follow predetermined waypoints for mission execution. The RMV can also be manually controlled with shipboard consoles. Missions can be downloaded via an encrypted data link or prestored prior to deployment. A data recorder on board the RMV stores mission information and archives sensor data during autonomous operations. RMS is operated as part of the AN/SQQ-89 (V) 15 Underwater Combat System.

8.1.3.3 Underwater MCM Systems

8.1.3.3.1 Submarine Systems

Submarine MCM is composed of two components: the submarines themselves equipped with high-frequency sonar systems and an unmanned underwater vehicle (UUV). The submarine sail-mounted HF sonar is capable of conducting clandestine bottom reconnaissance in water depths from 3,000 to 150 ft. The complementary Long-Term Mine Reconnaissance System (LMRS) provides clandestine coverage of water depths of 1,000 to 40 ft in areas where a mine threat exists.

8.1.3.3.1.a Submarine High Frequency Sonar Program

Two developmental SSN 688 HF sonar systems have been fielded with sufficient processing power to provide a high-resolution, high-discrimination, still picture of the bottom as well as the water column at speeds up to 15 kts. System displays have sufficient Nominal Recognition Differential (NRD) to allow the operator to detect a variety of mines or MILCs. With the addition of EC-18 on pre-SSN 688Is and ARCI phase IV on SSN 688Is, all SSN 688s will have the same capability.

Recent advances have allowed the fusing of system display pictures to produce a high-resolution 3-D map of the bottom and the water column. The introduction of vertical aperture to the forward-looking transducers also enables development of a precision navigation capability using bottom features. The addition of precision mapping and navigation to the SSN 688 HF sonar system, along with the planned installation of a wide-band communications system, will enable a submarine to provide the OTC with a high resolution, 3-D map of the bottom and the water column, annotated with all minelike objects. The precision mapping and navigation upgrade to the HF sonar system will begin installation in FY02 and complete in FY06.

8.1.3.3.1.b Long-Term Mine Reconnaissance System

The LMRS is a UUV that will provide SSN and NSSN submarines with a clandestine, offboard, wide-area mine reconnaissance capability. LMRS will be self-powered and self-propelled and will be launched, operated, and recovered via the submarine's torpedo tube. LMRS will be equipped to detect and classify minelike objects in an area of interest.

8.1.3.3.2 EOD Detachments

BG or ARG EOD DETs can perform UMCM operations to reacquire, identify, and neutralize floating, moored, and bottom mines. They are deployed from most large deck platforms (CV, LHA, LPD, etc.) and are an additional asset for the MWC.

8.1.4 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 critical element of an amphibious operation, and current MCM capabilities are insufficient to counter that threat without causing significant delay to the operation. The concept of in-stride MCM is to equip the amphibious force with assets that will permit them to counter mines without interrupting the assault timeline.

8.2 SYSTEMS AND PROCEDURES

8.2.1 Battle Group Capabilities

Most BGs have some capability for self-protection. Ships with embarked helicopters can provide visual and radar searches for drifting mines or signs of other mines along the intended track. Surface combatants with sonar and radar can provide some degree of reconnaissance along the track ahead of other ships not so equipped. However, real capabilities across the BG are not currently available to protect against ground or moored mines. Systems for this purpose are included in ongoing research and development projects as part of an effort to mainstream MIW through the use of organic MCM.

8.2.2 Moored or Drifting Mine Self-Protection

The majority of moored or drifting mines that might be detected by ships without minehunting sonar will be contact actuated mines, the majority of which will be found by visual search. These can be defeated by any means that prevent the ship from coming into direct contact with the mine. If it is possible to reduce the ship’s draft by off-loading material or water ballast, the result will be a direct reduction of any potential for striking a moored contact mine.

8.2.2.1 Lookouts

All ships should employ additional lookouts when operating in MDAs. Normal lookouts may not be well placed or equipped to detect mines and may be distracted from the mine search by other duties. Designated mine lookouts whose sole responsibility is to detect mines in the ship’s path and who are specially equipped for mine spotting will be more effective. They should be positioned to have the best available view forward of the ship and be provided with the following equipment:

1. Polarized-lens sunglasses that reduce glare and improve ability to detect mines just below surface
2. Binoculars (preferably stabilized 10 by 40 mm)
3. Night vision devices (NVDs).

8.2.2.2 Helicopter Visual Search

A helicopter can be very effective in conducting a visual search for mines along the ship or BG track. The most effective choice will be an aircraft that has several crewmembers searching for contacts. In some helicopters, additional crew may be added to increase the number of eyes conducting the search or to allow a rotation so that eye fatigue does not prevent effective search. If 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 ft. However, mine patterns can be identified more easily at an altitude of approximately 1,200 ft. 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 for detection of mines below the surface. When the sun is above 70° in altitude, insufficient light appears on the surfaces of dark objects for the objects to be visible, and there is relatively severe glitter interference from surface reflection.

Airspeed of 25 to 35 kts is recommended, but adjustments may be necessary to cover the entire area of a ship or BG track in the time available to accomplish the mission.

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

8.2.2.3 Mast-Mounted Sights

The mast-mounted sight system has proven to be a valuable tool in searching for mines on the water surface. This 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, the case will cool quickly and eliminate the temperature differential.

8.2.2.4 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 many aspects of the Kingfisher Project were found to be operationally unsuitable, the AN/SQS-53 and AN/SQS-56 sonar modification was retained for further development. This 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 yd 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.

For object avoidance by surface combatants, Kingfisher has been accepted as a valuable system. However, it was not designed as a hunting sonar, and operators should not attempt to use it as such. The limited bearing coverage and certain platform characteristics that affect where 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 one is detected, to determine a safe path to avoid that contact.

8.2.3 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 employed to limit the ship's vulnerability. These include some obvious actions, such as maintaining the ship's degaussing system. A magnetic signature consists of multiple components derived 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 depermed to reduce the magnetic signature to a level that can be controlled by an installed degaussing system.

8.2.3.1 Degaussing

A degaussing system reduces the ship's magnetic field by creating a 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.

8.2.3.2 Check Ranging

The degaussing system is calibrated by transiting over a magnetic measurement range and making adjustments as directed by the Magnetic Silencing Facility (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 detailed in OPNAVINST C8950.2.

8.2.3.3 Flash Deperming

Ships that do not have an installed degaussing system can be flash depermed. 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 depermed before deployment based on the geographic characteristics in the proposed area of operations. If a change of OPAREA occurs, consideration must be given to the difference in the magnetic environment.

8.2.3.4 Other Sources

A static electric field is created by the presence of two or more types of metals in salt water. The bimetallic corrosion process generates a small electric current. 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 contribute 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, minimal rudder use, initiating only slight alterations in speed, implementing only those course deviations deemed to be necessary, and ceasing the use of nonessential machinery will serve to reduce vulnerability.

8.2.4 Acoustic Self-Protection

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

Material methods to reduce the ship's acoustic signature are the same as those employed for ASW. The installation and maintenance of vibration dampening systems and proper maintenance are the primary measures that can reduce that part of the signature generated by machinery. Additionally, ships that have been calibrated 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 levels.

8.2.5 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.

8.2.6 Pressure Self-Protection

Little can be done from a material standpoint to reduce signature against a mine sensor that uses pressure as one of its influences. The Bernoulli effect between the moving hull and sea bottom determines the pressure signature and, obviously, 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.

8.3 TACTICS

8.3.1 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 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 fully equipped damage control party in a topside area. Once a mine detonation occurs, it may be difficult for damage-control personnel to get to the repair locker to obtain equipment.

3. Have all personnel don protective garb 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 of some or all weapons systems while stowing ordnance in a configuration that will best withstand shock.

6. Proceed over the same path 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 there is no increased risk by following another vessel.

8.3.2 Drifting or Contact Mine Tactics

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

1. Post mine lookouts. See paragraph 8.2.2.1 for a discussion of equipment for mine lookouts.

2. Those on watch must be given special training to be effective. They should report any contact, and the OOD should investigate every report so that the watch understands the importance of their mission.

3. Use any available aircraft (helicopters are most effective) to conduct a visual search for drifting or floating mines along the intended track. A search should be conducted in the morning, at midday, and in the afternoon with an adjustment for set and drift. See paragraph 8.2.2.2 for a discussion of visual search techniques.

4. Increase surveillance following rough seas or storms that may have caused mooring cables to break, setting the mine adrift.

5. Plot drift patterns for the area. NAVOCEANO has a prediction program for drift patterns used to estimate the danger area of mines that break loose or are set adrift. If prevailing currents and winds are not known, special buoys tracked by satellite to reveal the drift pattern can be dropped.

8.3.3 Moored Mine Tactics

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

These sonars typically are effective for detection at speeds of 8 kts 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 yd. 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 yd. If there is reason to believe it may be an influence type, the dangerous distance should be increased to at least 300 yd.

To the maximum extent possible, prior to executing the turn, the 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 turn to avoid one may lead to collision with another.

8.3.4 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 turn off 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 consumes significant power.

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 as this changes magnetic signature from the electric motor driven winch and from the relocation of a large mass of metal. The same is true for movement of large weapons, 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.

8.3.5 Acoustic and Seismic Mine Tactics

Tactical measures for self-protection against acoustic and seismic mines are as follows:

1. Implement the quiet ship bill, which should reduce equipment use. Avoid noisy operations, such as operation of grinding or chipping tools or unnecessary use of weapon-handling systems.

2. Operate Prairie/Masker systems 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.

8.3.6 Pressure Mine Tactics

Tactical measures to reduce the pressure signature are relatively limited. They are as follows:

8.3.6.1 Maximize Water Depth

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

8.3.6.2 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.

8.3.6.3 Use Masking Techniques

A high sea state will tend to mask the ship's passage. Unfortunately, the tactical situation does not usually allow a delay until favorable weather conditions exist.

8.3.6.4 Defeat the Firing Sensor

Pressure sensors are not generally used independently but rather in combination. After consulting with available intelligence sources it may be learned that the secondary sensor can be more easily defeated. Once the secondary sensor is identified, tactics should be employed to defeat that particular sensor.

8.3.7 Group Self-Protection Tactics

Tactics for single ships also apply to groups of ships. Conducting a helicopter search ahead of a dispersed BG requires significant time and effort 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 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 area of coverage required and by allowing the ship to traverse the most favorable bottom environment that is practicable. This 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 NATO SECRET level). An area commander, such as Commander, U.S. Maritime Defense Zone, Atlantic (COMUSMARDEZLANT) or Commander, U.S. Maritime Defense Zone, Pacific (COMUSMARDEZPAC), originates the messages. The 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) to protect merchant shipping. This results in reduced efficiency for high-speed merchant traffic that must await convoy departure and travel at the speed of the slowest 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.

8.3.8 Preplanned Responses

Preplanned responses to certain situations should be established prior to encountering mines. The MCMC provides standardized procedures in the OPTASK MIW or OPTASK MIW Supplement. These should include rapid reporting procedures, standard maneuver instructions for different mine threats, mine contact identification, and disposal policy.

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

CHAPTER 9

Logistics Requirements

9.1 INTRODUCTION

As evident within most, if not all, warfighting disciplines, logistics support is also a key element in the successful execution of any MCM operation. This support requires extensive planning prior to movement to the OPAREA. Once in the OPAREA, the continuous availability of logistic support remains critical.

OPAREA logistics support for MCM forces hinges on the MCM command and support ship. This ship is the vital link in the MCM force logistics support chain. This was demonstrated during operations in the Persian Gulf and, prior to that, during Operation End Sweep mine clearance operations in North Vietnamese waters. For both endeavors, amphibious ships of opportunity were configured to temporarily fill the MCS role.

If the MCS is not available, the effort required to replicate that service aboard a similar ship is extensive. This effort may be necessary because it must support MCM DETs that have unique equipment with limited organic repair, maintenance, and supply capabilities. The support ship must provide:

1. Maintenance and repair services that include support for nonmagnetic engines and components

2. Medical, dental, disbursing and other personnel administrative support services

3. Storage space for spare and repair parts, munitions, gasoline, dive gear, and recompression chambers.

In addition to serving as the MCS for MCM DETs, the support ship also must support the MCMC and staff. This places increased demands on administrative and communications capability.

The remainder of this chapter summarizes the logistics requirements for each component of the MCM force. Detailed information can be found in NTTP 3-15.21 for MCM ships, NTTP 3-15.22 for AMCM, and NTTP 3-15.23 for EOD DETs and NSCT1.

9.2 OVERVIEW

Planning for an MCM force should assume that, at a minimum, it consists of the following units:

1. MCMC and staff

2. Seven MH-53E MCM helicopters

3. Three mine-spotting or SAR helicopters

4. SMCM Mine Warfare Readiness Group (MWRG) (MCM 1 and/or MHC 51)

5. Four EOD MCM Dets

6. NSCT1 (in event of amphibious operations)

9.2.1 Logistics Factors

This MCM force is complex and, when it is required to operate from remote bases, sustaining requirements are extensive. Factors that influence this complexity are listed below:

1. Continuous need for diverse maintenance and repair capabilities
2. Requirement for AMCM equipment storage
3. The availability of aircraft and countermeasures repair items and maintenance facilities
4. Constrained cruising range of SMCM imposed by limited capacity for fuel and provisions
5. Potentially large quantities of sweep gear expended in minesweeping operations.

Losses of sweep gear in an amphibious assault operation are usually greater than in routine clearance sweeping due to shallow water and the urgency of the operation.

Repair kits are essential as spare gear may not be available in an austere area.

Logistic support is available to forces afloat from shipboard spares, support ships, mobile support groups, advanced bases, or from shore activities. Requirements that cannot be met from within the MCM force should be coordinated with the OTC. Urgent requests for MIW material should be coordinated with COMINEWARCOM.

9.3 AIRBORNE MINE COUNTERMEASURES SUPPORT REQUIREMENTS

Rapid reaction and use of prior planning will determine the ability of an AMCM detachment to be deployed to a forward area in a timely manner. Movement of the detachment will require coordination of assets to allow movement of personnel and large quantities of bulk cargo. The amount of material involved in moving a detachment will depend on the threat involved. Intelligence that provides advanced information regarding the threat is of vital importance so that the detachment can be so tailored. The following sections highlight logistic requirements for AMCM units. A detailed discussion of these requirements can be found in NTTP 3-15.22.

9.3.1 Airborne MCM Transportation

9.3.1.1 Transportation by Land

Overland movement of AMCM equipment may be an alternative depending on distance. Transcontinental moves will be accomplished more efficiently using air transportation. Land movement in foreign countries should be carefully examined; the threat level, road conditions, and equipment availability should be taken into consideration. Movement of equipment to support an AMCM detachment (including 90-day support packup) will require approximately 20 to 30 trailer trucks, depending on the mix of sweep gear carried and available on-site support. Each Mk 105 device requires one low-bed trailer.

9.3.1.2 Transportation by Air

Only C-5 aircraft can deploy MH-53E helicopters. To facilitate air deployment the helicopters must be partially disassembled prior to departure and reassembled upon arrival in the staging area. Remaining AMCM equipment can be lifted by other airlift as weight and cube allows. Specific load requirements will be provided using a computer program developed to aid the embarkation officer in planning for USAF cargo aircraft. The Loadout Support System will estimate all AMCM hardware and support equipment needed for various detachment sizes. It can also be used to quickly estimate the number of pallets required and the number of cargo aircraft required to embark a detachment.

9.3.1.3 Transportation by Sea

Movement of aircraft and AMCM equipment is possible using a variety of surface platforms. Aircraft footprint, weight, and overall dimensions must be taken into account when staging on various flight decks. The size and bulk of MCM and related support equipment also requires close liaison with the ship's loading personnel.

9.3.2 Airborne MCM Operating Area Support

9.3.2.1 Airborne MCM Support Ship

Stringent deck space requirements will govern the loading of an AMCM detachment aboard amphibious ships if the MCS is unavailable. The hangar deck storage configuration must be designed to provide the maximum space for equipment maintenance. To facilitate loadout, the AMCM staff should include graduates of the Basic Amphibious Embarkation Course.

The simultaneous embarkation on a single platform of AMCM and USMC landing force assets will present a coordination problem and will affect the mission capability for both. Advanced planning and coordination are vital to alleviate friction.

9.3.2.1.1 Squadron Loadout

A seven-aircraft detachment requires approximately 390 m^2 (4,120 ft^2) of office and records storage space. Typical hangar deck loading for maintenance and MCM equipment storage on the MCS will include all of the aft vehicle stowage and half of the hangar deck. On an LPD, upper and lower vehicle stowage along with the well deck will be required. The detachment will provide an itemized equipment list upon tasking using the Loadout Support System computer program.

9.3.2.1.2 Work Centers

Maintenance work centers and administrative office spaces will be required. Approximately seven work centers will be used for aircraft maintenance with easy access to the flight deck. Three work centers are required for MCM maintenance with easy access to the hangar or well deck. A squadron ready room, administrative office, operations office, and a secure tactics and communications office will also be needed. In addition, if AMCM radar control plotting is to be conducted, a space with radar plotting and radio communications capability will be necessary. Figure 9-1 illustrates the number and types of office space and records storage space.

9.3.2.1.3 Berthing

Approximately 450 people (officers, chief petty officers, and enlisted) need accommodations.

9.3.2.2 Airbone MCM Replenishment

AMCM units require normal aviation support, ramp space, and fresh water. Additional requirements are listed below:

1. Petroleum, oil, and lubricants (POL)

   a. Fuel. The MH-53E and Mk 105 device both use JP-4 (MIL-T-5624), JP-5 (MIL-T- 5624), or equivalent jet fuel.

   b. Oil and Hydraulic Fluid. The MH-53E and Mk 105 use MIL-L-23699 oil for their engines and auxiliary power plant (APP). MIL-L-23699 is an acceptable substitute for DOD-L-85734 in the gear boxes. The MH-53E uses MIL-L-21260 oil for servicing of the rotary wing head and sleeve and spindle reservoirs. Both the MH-53E and Mk 105 use MIL-H-83282 hydraulic fluid for servicing.

	DIVISION	SPACE m^2 (ft^2)
1	Operations/Tactics/Communications	30 (300)
2	020	18 (190)
3	040/030	30 (320)
4	050	18 (192)
5	110/120 Airframes/Engines	48 (512)
6	12C/140	16 (176)
7	130	31 (336)
8	210/220 Electrical/Electronic	18 (192)
9	230	18 (192)
10	310/320	33 (352)
12	330	15 (160)
13	Administration/Personnel	24 (256)
14	Safety, Naval Air Training and Operational Procedures Standardization (NATOPS)	9 (100)
15	Medical Office	9 (100)
16	16A/16B/16C/16D	42 (450)
17	16A Storage	9 (100)
18	M020/M050	22 (192)

Figure 9-1. Required Office Spaces

c. Nitrogen. The MH-53E uses MIL-N-6011, Grade A, Type I or II nitrogen for servicing the landing gear blowdown bottle, APP accumulator precharge, blade damper accumulator precharge, and landing gear struts and tires.

d. Diesel and motor gasoline (MOGAS). AMCM support vehicles and equipment require diesel fuel and MOGAS.

9.3.2.3 AMCM Maintenance and Repair

The AMCM detachment provides its own maintenance personnel and equipment. The MCS must provide the workspace.

9.3.2.4 Ground Support Equipment

Equipment and facilities considered essential in the support of an AMCM detachment during shipboard operations are listed in NWP 3-15.22. They include the following:

1. Facilities for fresh water wash-down
2. Two NC-2 and one NC-8A mobile power units
3. Two AHT-64 hydraulic generators and three hydraulic check-fill stands
4. One 2-ton low-profile (maximum height 72 in) forklift and one 10-ton forklift
5. Two JG-75 tow tractors and four NT-4 towbars
6. Two B-4 workstands and one B-5 workstand
7. One 10-ton crane or overhead hoist with 30 ft of lift as well as left and right movement plus a crane with 4-ton capacity at a 30-ft radius (approximately 12- to 15-ton rating)
8. Two NAN-2 nitrogen trailers
9. Four 15-ton jacks and three 25-ton jacks
10. Two corrosion-control carts
11. One vacublast machine
12. A minimum of 300 tiedown chains; number will increase in the event of foul weather
13. Four CO_2 firefighting carts (50-lb minimum); for each Mk 105 device one CO_2 fire bottle (15-lb minimum).

For shore operations the following additional equipment is required:

1. One fuel truck capable of single point pressure and gravity refueling. Remote site Mk 105 basing will require a second fuel source with gravity refueling capability.
2. A certified crash crew.

9.3.2.5 AMCM Sustained Deployment Support

9.3.2.5.1 Aircraft 90-Day Packup

The 90-day packup consists of high-usage aircraft items required to sustain operations for 90 days. It consists of repairable and consumable items to provide organizational- and intermediate-level maintenance support of the aircraft, Mk 105, AN/AQS-14A, and AN/ALQ-141 systems. Additional ancillary packups support the civil engineering support equipment and RHIBs. It also includes MMF vans, pallets, and various containers for outsized items (rotor head, main gearbox, etc.) It includes one MMF for Mk 105, one for the AN/AQS-14, and one for the AN/ALQ-141 plus various outsized containers for the AN/AQS-14 and AN/ALQ-141 towed bodies, Mk 105 magtails, Mk 105 tow cables, etc.

Total weight and cube of the packup is 32,650 kg (72,000 lb) and 204 m^3 (7,204 ft^3). It is normally reserved for extended deployments OCONUS or areas in which MH-53E support is not available.

9.4 SURFACE MINE COUNTERMEASURES (MCM/MHC) SUPPORT REQUIREMENTS

9.4.1 Surface MCM Transit

The preferred means of transit for SMCM to support theater OPLANs is by heavy-lift transport. The lift is conducted in accordance with contract sponsorship of Military Sealift Command. The heavy-lift transport eliminates strain on the main propulsion systems of the SMCM while accelerating the transit. There are no government-owned heavy-lift transports, so commercially owned ships will be needed but may not be available. There are only a limited number of roll-on/roll-off (RO/RO) vessels available worldwide and they are under contract to foreign oil industries. A considerable expense will be incurred for MSC to enact a contract, unload the ship, move to load SMCM, and then transit to the theater of operations. If the MCM ships must sail under their own power, they require an escort ship, preferably the MCS, that can provide them with fueling and is capable of towing multiple MCM craft. The ships will need replenishment of fresh provisions and stores if the transit exceeds two weeks and will be subject to a systematic maintenance effort once in theater.

9.4.2 Surface MCM Operating Area Support

9.4.2.1 MCM Command and Support Ship

SMCM is self-supporting during MCM operations in the OPAREA. The services from the MCS that they require will be obtained during their off-station time and will be in the form of maintenance and repair, refueling, and resupply. Specific requirements include:

1. Consolidated ship's allowance list (COSAL) support for both MCM 1 and MHC 51 including the shore-stored portion of the MHC 51 COSAL

2. Refueling

3. Storage for:

   a. Eight drill mines and four Mk 74 VEMS

   b. Two complete spare sets of influence and mechanical sweep gear, including Size 0 floats and magnetic tails

   c. One spare AN/SLQ-48 mine neutralization vehicle

   d. One portable degaussing facility (2 CONEX boxes)

   e. Engineering spares (2 CONEX boxes).

The MCS needs to be in proximity to MCM effort.

9.4.2.2 SMCM Replenishment

9.4.2.2.1 Petroleum, Oil, and Lubricants

MCM ships have the capability to take on POL while underway or at anchor. If lubricating oil is contained in drums it can be transferred by highline while underway or by crane while at anchor.

9.4.2.2.2 Ammunition

Palletized or boxed ammunition, explosive cutters, and MP2 bomblets can be transferred by highline when underway or by crane at anchor.

9.4.2.3 SMCM Maintenance and Repair

SMCM require expert technical support for their systems. Specific support provided by the MCS includes:

1. Ferrous and nonferrous welding

2. Sheet metal repair

3. Main propulsion engine stowage and replacement

4. Minesweeper generator repair and replacement

5. GRP and wood repair

6. Magnetic tail repair

7. Degaussing system repair

8. AN/SLQ-48 MNV repair or replacement

9. Repair support for smal-boat engines, pumps and valves, air conditioning and refrigeration, hydraulics, electrical repair and motor rewind, gyro, and electronic repair

10. Crane lift capacity for MCM repair, equipment handling, and engine changes

11. Ability to moor MCM ships alongside and to provide electrical power and fresh water to the inboard vessels.

9.4.2.3.1 Minesweeping Support

Moored sweeping gear is vulnerable to damage from contact with the bottom or mine explosions and is particularly vulnerable if the minefield contains sweep obstructors. Apparatus may require replacement several times during an extended operation.

Magnetic and acoustic power cables are vulnerable to damage caused by prolonged storage, handling during sweep and recovery, chafing, and the explosive effects of mines. While minor damage may often be repaired by taping or the extended procedure of onboard revulcanizing, any major damage to either the buoyant acoustic power cable or the magnetic cables will require nonorganic repair support at a properly equipped facility and interim replacement of the cables.

The TB 27 (A Mk 4(v)) and TB 26 (A Mk 6(b)) devices may be exposed to mine detonations. Although these components are solidly constructed, nearby explosions can cause deformation and leakage requiring replacement of the device. Extended operation may result in casualties to the motor, bearings, gears, or other moving parts. It is unlikely that repairs can be made during the course of the operation and the equipment will have to be replaced. Master reference buoys and dan buoys may sustain damage either during placement or recovery, or may break away during heavy weather.

9.4.2.3.2 Minehunting and Neutralization Support

The minehunting sonar body and the MNS vehicle are also vulnerable to damage from contact with the bottom and mine explosions. The hunting sonar can be placed in a maintenance position for onboard repairs of minor damage. Minor damage to the MNV can be repaired on deck where the equipment is stowed. Any major damage to the equipment or power cables requires repair ashore at a properly equipped facility and replacement equipment may become necessary. MNS operations can continue after replacing the damaged vehicle and umbilical.

9.4.3 EOD MCM Detachment Transportation

One detachment consists of eight people and the equipment to be transported may include:

1. FADL: 20 x 8 x 8 ft trailer that stores all dive equipment and provides an O_2 -clean area for diving equipment maintenance.

2. FARC: 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-ft RHIB 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). The boat can be placed on a trailer or deflated for transportation.

Logistics support required for deployed operations is summarized below:

1. Land transportation: If stationed ashore, the detachment will require trucks to tow boat and equipment trailers as well as to transfer personnel.

2. Boat operations: If ashore, 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 should be acquired.

3. Recompression chamber: Unless supported by a local, certified recompression chamber the FARC will occupy approximately 350 ft^2. It can be self-supporting for 30 days except for diesel fuel.

4. Diving locker: The FADL requires about 200 ft^2 of deck space, a fresh water supply, and 3-phase 60-Hz power.

5. Explosive storage: The detachment has a portable magazine with 450 ft^3 of explosive storage space.

6. Compressed gas storage: Aviation grade O_2 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 8 to 12 personnel.

9. Office and work space: Except for short-term operations, a covered, climate-controlled office and work space is necessary.

9.4.3.1 Transportation by Land

Land transport of an EOD detachment's equipment requires a minimum of three trucks, each capable of towing an 8,000 lb trailer. These vehicles will be used to tow the two equipment trailers and one 22-ft workboat. Ideally, a fourth truck could be used to tow the 19-ft inflatable boat on its trailer. Although mobilizers (dollies) are available at EOD mobile units to attach to the FADLs, they are intended for transport around the general area of the parent command. For lengthy transits, use of a flat bed trailer is recommended. A mobile crane of at least 15-ton capacity may be required to place the FADL on a flat bed trailer or to place equipment on the deck of a ship or on an Air Force K-Loader. When deployed with the FARC and LSS, an additional flat bed and tractor is required.

9.4.3.2 Transport by Air

Compatibility waivers have been granted which allow the transport of EOD equipment and personnel on the same plane. Currently, the C-5 Galaxy is the only aircraft capable of carrying the weight and bulk of an MCM detachment on a single craft. Two C-141 Starlifter aircraft can be used if the detachment is deploying without the FARC and LSS; another plane is needed if the FARC and LSS are to be deployed. The entire detachment can be loaded aboard various airlift combinations. Refer to TPFDD documents for specific data.

9.4.3.3 Transport by Sea

For overseas surface lift, all equipment may be embarked on board most large class ships, particularly the MCM command and support ship. 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 preferable to deploy the EOD detachment on a larger ship and then transfer them to the MCM ship once within the operating area.

When transporting an EOD to an OPAREA via an ocean-going vessel, a minimum of 79 m^2 (850 ft^2) of cargo stowage space, capable of holding approximately 20,412 kg (45,000 lb) is necessary. An additional 125 m^2 (l,340 ft^2) and 15,875 kg (35,000 lb) are required for the FARC and LSS.

9.4.4 Detachment Operating Area Support

For general planning purposes, this section provides the requirements to embark a single MCM detachment with full complement of EOD equipment. It also provides similar information for the FARC and support crew. The EOD OIC and the MCM staff should consider the number of detachments, the FARC, and the need for an administrative and logistics support structure to ensure that all necessary forces are in place to support sustained EOD operations.

9.4.4.1 MCM Command and Support Ship

EOD support is extensive. It places unique demands on the MCS because of the personnel and equipment requirements dictated by diving regulations. Specific requirements include the following:

1. Portable Recompression Chamber. The chamber requires 84 m^2 (900 ft^2) of deck storage space. It also must have fresh water and electrical power services (110/220 VAC, 60 Hz, 50-amp service). An emergency generator with an external exhaust is required if the chamber is not located on a weather deck.

2. Diving Locker. The locker requires 74 m^2 (800 ft^2) of deck space, fresh water, and electrical power services (110/220 VAC, 60 Hz, 50-amp service).

3. Explosive Storage. Magazine storage is required for approximately 45 kg (100 lb) of Class A explosives and a like amount of Class C demolitions.

4. Compressed Gas. Storage space of 19 m^2 (200 ft^2) in proximity to the diving locker for compressed gas. This includes 30 bottles of HeO_2, 20 bottles of O_2, and 100 buckets of CO_2 absorbent.

5. Office Space:

   a. 28 m^2 (300 ft^2) of office space

   b. 33 m^2 (350 ft^2) for spare parts issue and inventory control.

6. Other Storage Requirements:

   a. 1,900 L (500 gal) of MOGAS

   b. Tools and equipment normally carried in EOD equipment trailers

   c. Four Mk 5 inflatable boats and two 22-ft Boston Whalers

   d. 42 m^2 (450 ft^2) of climate-controlled storage for spare parts.

7. Open Deck Space. Approximately 125 m^2 (1,350 ft^2) to accommodate:

   a. FADL (6.1 x 2.4 x 2.4 m (20 x 8 x 8 ft))

   b. Swimmer support craft (Mk 5 inflatable boat) (3 x 2.5 x 0.8 m (10 x 8.3 x 2.7 ft))

   c. Portable magazine (2.4 x 2.1 x 2.4 m (8 x 7 x 8 ft))

   d. Emergency generator (2.4 x 2.1 x 2.4 m (8 x 7 x 8 ft))

e. A 6.7-m (22-ft) Boston Whaler on trailer (8.8 x 2.1 x 3.7 m (29 x 7 x 12 ft))

f. Pre- and post-dive operations

g. Access space around each piece of major equipment.

8. Work Space. Approximately 19 m^2 (200 ft^2) of dedicated compartment space to stow specialized equipment not associated with diving will be used to perform administrative functions. This space should be climate controlled.

Note

If this requirement cannot be met, an additional 14 m^2 (150 ft^2) of open deck space is needed to accommodate an equipment trailer.

9. Flammable Liquid Stowage. An authorized area for stowing up to 1,140 L (300 gal) of MOGAS and diesel fuel in 210-L (55-gal) drums and portable containers.

10. Crane. An onboard crane capable of lifting 3,200 kg (7,000 lb) to launch and recover boats.

11. Messing and Berthing. Accommodations for one officer and seven enlisted people per detachment.

12. Electrical and Water. Three-phase 240 VAC, 60 Hz power to FADL. Fresh water access on deck for rinsing diving equipment and flushing outboard motors.

13. FARC Crew. Logistics support for the three-man FARC is basically the same as that of the MCM detachment. The FARC crew will not be supporting diving or small-boat operations but do have to maintain strict NAVSEA certification requirements.

9.4.4.2 Requirements for Embarking Aboard MCM Ships

Space restrictions on MCM ships preclude loading of all EOD equipment. An embarked detachment can provide limited search, reacquisition, verification, and neutralization of detected mines in support of minehunting operations. Additionally, they can provide neutralization of drifting and floating mines,including those cut from their moorings during mechanical sweeping.

1. Magazine. During an operation in which numerous mines might be encountered, magazine space for explosives, including detonators, should be available (approximately 7 m^3 (250 ft^3)). Depending on the mission, the detachment may also have small arms and ammunition.

2. Berthing. Berthing is required for one officer and five to seven enlisted people. In most cases, at least one of the enlisted will be a chief petty officer.

3. Boat and Equipment Stowage:

   a. Shipboard Space. A clean, climate-controlled space of at least 4.5 m^3 (160 ft^3) should be dedicated to the detachment. This space will be used to perform pre- and post-dive procedures on diving equipment, administrative functions, and to store equipment that is not suited for open deck stowage. The space should be equipped with a 1MC and have communication links with the bridge and CIC.

   b. Deck Storage. Approximately 9 m^2 (100 ft^2) of deck storage area should be allocated to store items not needed in the EOD space. If gasoline cannot be supplied by the SMCM, a flammable-liquid storage area capable of holding 210 L (55 gal) of gasoline is needed.

c. Inflatable Boat. There is insufficient room to stow the Mk 5 inflatable boat on deck. It must either be towed or suspended beneath a davit. Towing is not practical during periods of close maneuvering or backing. Stowage of a deflated boat on deck is not recommended.

9.4.4.3 Detachment Replenishment

Detachments usually deploy with assets to support 30 days of operation (except for gasoline and diesel fuel). For operations that extend beyond 30 days, the detachment will require replenishment in the form of basic staples such as food and water, fuel, consumables that support administrative and preventive maintenance functions, replacement parts, tools, and consumables that are peculiar to EOD operations. These may include but are not limited to:

1. Breathing gas — aviator's oxygen and helium-oxygen mix (HeO_2)

2. CO_2 absorbent

3. Explosives

4. Dry-cell batteries for radios, diving apparatus, search equipment, navigation aids, etc.

Replenishment of breathing gas, CO_2 absorbent, and explosives will have to be on a 3- to 7-day cycle. Requirements will vary depending on assigned mission, duration of embarkation, and other support provided.

FARC Replenishment. The FARC system is generally self-supporting for the first 30 days of operation, with the exception of diesel fuel. Other consumables include aviator's oxygen, air filters, lubricants, engine belts, filters, and hoses.

9.4.4.4 Detachment Maintenance and Repair

During sustained deployments, certification requirements such as air samples and gauge and relief valve calibrations must be maintained. These functions are beyond the capability of the FARC personnel and must be provided by the MCS. Additionally, emergency support to perform corrective maintenance on the system's two generators and air compressors may be required from the MCS to avoid extensive delays in operation.

9.4.4.5 Sustained Support

When deploying multiple EOD DETs for sustained deployments, the MCMC should consider deployment of a support structure to maximize their readiness and flexibility. EOD Mobile Units are manned and equipped to provide this capability.

1. Administrative and Logistics Support Structure. In addition to individual detachment replenishment, the need for a support structure for deployment of multiple detachments is essential. A cadre of administrative, supply, and maintenance personnel along with an adequate stock of detachment consumables and high usage repair parts, and an intermediate level maintenance and repair capability would enable maintenance of maximum readiness for all operating forces.

2. EOD Personnel. The existence of a support structure with a small cadre of EOD personnel would provide additional technicians to replace those injured or to augment seven-man teams for deep diving and larger missions, without degrading other detachments in the area.

3. Open Deck Space. Approximately 350 ft^2 to accommodate:

   a. FARC (6.1 x 2.4 x 2.4 m (20 x 8 x 8 ft))

   b. LSS (2.75 x 2.4 x 2.4 m (9 x 8 x 8 ft))

   c. Emergency generator (3.2 x 1.9 x 2.3 m (10.5 x 6 x 7.5 ft))

d. Aviator's oxygen pallet (1.6 x 1.6 x 1.5 m (5.25 x 5.25 x 5 ft))

e. Access space around equipment.

4. Flammable Liquid. Authorized area for stowing two 210-L (55-gal) drums of diesel fuel.

5. Messing and Berthing. Accommodations for four enlisted people.

6. Electrical. Three-phase 240 VAC, 60 Hz power to LSS.

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

9.5 EXPLOSIVE ORDNANCE DISPOSAL AREA SEARCH DETACHMENT SUPPORT

9.5.1 Area Search Detachment Transportation

9.5.1.1 Transportation by Land

The preferred method of transport of the ASD and all associated equipment by land is with a 3.7-m (12-ft) CONEX box (equipped with mobilizers) or pulled on the bed of a 13.6-t (15-ton) stake truck. The 8.3-m (27-ft) boat requires a separate vehicle with the appropriate towing gear. A craft of opportunity ranging in length from 11 m (35 ft) to 18 m (60 ft) can be used instead.

9.5.1.2 Transportation by Air

The preferred method of transport for the ASD and all associated equipment is by airlift. In planning, the weight, cube, and hazardous material information must be made available to the supporting command. Normally, the ASD loads all equipment for an operation onto the bed of a 1.8-t (2-ton) stake truck or a 0.9-t (1-ton) truck with trailer, which is then loaded onto the aircraft. The truck is needed for equipment transport after arrival.

9.5.1.3 Transportation by Sea

The preferred method of ocean transport is an amphibious ship with a well deck that can carry loaded trucks and launch any boat required. Personnel support is needed for one officer and five enlisted.

9.5.2 Area Search Detachment OPAREA Support

The ASD requires three spaces, each about 2.5 x 3 m (8 x 10 ft). The spaces are for an office, a work area, and a post-processing area for reviewing sonar tapes. Gasoline is required for shore station generators and small craft, with diesel fuel for trucks. Maintenance and repair is within the capability of the detachment, but sustained operations in excess of 30 days may require assistance in electronic and outboard motor repair.

9.6 MARINE MAMMAL SYSTEM DETACHMENT SUPPORT

Planning for employment of Mk 4 and Mk 7 MMS is contingent upon tasking through the chain of command. MMS are specialized tactical units assigned to COMEODGRU ONE.

9.6.1 Marine Mammal System Detachment Transportation

The Mk 4 and Mk 7 can be ready to deploy on short notice.

9.6.1.1 Transportation by Air

The long-range transport of a self-contained MMS and necessary support equipment requires multiple C-141 aircraft per system. The number of aircraft may be reduced depending on the scope and magnitude of the operation. The entire detachment can be transported on various aircraft combinations listed in the TPFDD. Short-range transportation may be accomplished with MH-53, CH-53, and CH-46 helicopters, or with fixed-wing cargo aircraft. 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 operational capability. Maximum demonstrated sealift transit time is 11 days. Staggered arrival of 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.

9.6.1.2 Overland Movement

Short-distance deployments of UMCM MMS MILVANs and SEABEE shelters can be accomplished by truck. Boats require three to four trucks with an 800-lb towing capacity. The dolphins may be moved on trucks; however, it is preferable to transport them via cargo helicopters to minimize transport time. Threat, force protection, and rear area security matters should be weighed prior to any displacement and convoy movement.

9.6.2 Marine Mammal System Detachment Operating Area Support

9.6.2.1 Site Survey and Preparation

Prior to the MMS deployment to an operational area, it is necessary to conduct a site survey to determine the environmental and support conditions of the area. The following are the minimum requirements:

1. No significant environmental pollution
2. Minimum water depth of 2.5 m (8 ft) in staging area at low tide
3. Minimum water temperature of 6 °C (42 °F), maximum 33 °C (91 °F)
4. Saltwater (minimum salinity of 20 parts-per-thousand)
5. A pier, causeway, quay wall, or other stable platform for staging pens and boats
6. 190 m^2 (2,000 ft^2) of level ground for staging MILVANs and support equipment
7. Fresh water at staging area
8. Suitable area for storage of Class A explosive
9. A crane capable of lifting and positioning MILVAN and support equipment (15-ton capacity)
10. Freshwater supply
11. 220/110-volt, 60-Hz AC, 100-amp electrical service at the staging area
12. Messing and accommodations for up to 70 personnel (Mk 4 MMS has 24, Mk 7 MMS has 36; additional personnel also provide command element and maintenance support)
13. 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 DETs conducting simultaneous operations may require up to 500 gallons of MOGAS per day. A 15-day replenishment will require the following:

1. 109 kg (240 lb) 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.

9.6.2.2 Staging

MMS staging requires deployment of an advance party 24 hours before deployment of the dolphins to a remote site. This time is needed for:

1. Dolphin pen assembly

2. Preparation for transport of dolphins from landing site to staging area

3. Preparation of staging logistics

4. Preparation of navigation sites.

9.6.2.3 Marine Mammal System Detachment Replenishment

Mk 4 and Mk 7 MMS Operating System. The organic loadout contains approximately 20 to 30 days of supplies, which can be adjusted upward based on the scope of the operation.

Mammal Food. A local source for the procurement of restaurant-quality frozen fish is required for operations exceeding two weeks.

9.6.2.4 Maintenance and Repair

There are no unit-specific maintenance and repair requirements beyond those for electronic (radio) repair and boat fuel.

9.6.2.5 Sustained Deployment Support

An EOD MMS detachment deploys with sufficient assets to support 15 days of sustained operations, with the exception of MOGAS. MOGAS requirements can be up to 1,900 L (500 gal) per day, depending on scope of operations.

9.7 MINE COUNTERMEASURES COMMANDER AND STAFF

The MCS will provide berthing and office space with command and communication facilities for the MCMC and staff.

9.7.1 Berthing

The staff requires quarters for the commander plus berthing for 12 officers and 13 enlisted.

9.7.2 Office Space

The following office and work space will be required:

1. Administration and communications office (21 m^2 (225 ft^2))
2. Supply office (14 m^2 (150 ft^2))
3. Maintenance office (14 m^2 (150 ft^2))
4. Operations and plans center (58 m^2 (600 ft^2))
5. Command and control center (37 m^2 (400 ft^2)).

9.8 PERSONNEL AND ADMINISTRATIVE SUPPORT

The MCS must provide the capabilities normally provided to the MCM units by their homeport support facilities, including:

1. Medical and dental
2. Disbursing
3. Postal
4. Messing and berthing
5. Laundry.

9.9 COMMUNICATIONS

Communication support should include a message center capable of transmitting and receiving general message traffic and providing periodic encryption updates for portable secure voice radios.

9.10 EMERGENCY SUPPORT

Due to the dangers of diving and working with ordnance, an emergency support plan must be developed to allow for rapid SAR and MEDEVAC. In the event of hostilities, OPAREA security must be provided in and around isolated dive and beach sites.

9.10.1 Medical Officer

The services of a diving medical officer should be available.

9.10.2 MEDEVAC Helicopters

Detailed arrangements should be made for the availability and use of MEDEVAC helicopters.

9.11 OTHER SUPPORT FACILITIES

9.11.1 Floating Magazine

MCM operations require substantial quantities of explosives. To reduce the storage and handling requirements aboard the MCM platforms and provide a safe and accessible alternative, the use of a barge or offshore structure should be considered.

9.11.2 Towing and Salvage Capability

Ships, including SMCM, may incur mobility damage from adversary actions. A powerful tug capable of towing the larger combatants should be available. Due regard must be applied to the remaining mine threat. Dispatching a tug with a large magnetic signature may cause its loss. Using an MCM ship is an alternative to be used only in emergencies for short tows.

Damaged ships can be saved through the application of timely, proper salvage procedures. Salvage teams using air-transportable equipment can be taken to a distressed ship on short notice. These teams can be used even before the ship is removed from the minefield when warranted. More comprehensive measures involving fire fighting, pumping, and emergency repair can be applied later by Navy or commercial assets. The available resources in the OPAREA such as ocean salvage tugs and oilfield service vessels should be cataloged and preliminary contingency arrangements made for their use.

9.11.3 Portable Acoustic Degaussing Range

The U.S. Navy has no portable ranges to service MCM ships. Some allied or otherwise friendly nations do have this capability. In the absence of portable ranges, the use of fixed facilities reasonably near the OPAREA may be feasible.

9.11.4 Support Craft (Contracted Vessels)

In the past, non-U.S. Navy craft of opportunity have proven to be well suited to support EOD MCM. Commercial ocean-going tugs make excellent platforms because of their large open deck space located aft and low freeboard. Some limitations that must be addressed before committing to this type of vessel are:

1. Lack of precise navigation
2. Lack of secure voice communications
3. Incompatible electrical requirements (e.g., many foreign vessels operate with 50-Hz systems).

9.12 SITE SURVEY

When forward area MCM operations are planned, a reconnaissance survey should be performed to evaluate potential shore sites.

LIST OF ACRONYMS AND ABBREVIATIONS

AAAV	advanced amphibious assault vehicle (NWP 1-02)
AAW	antiair warfare (JP 1-02)
ADCON	administrative control (JP 1-02)
AE	assault echelon (JP 1-02)
AF	audio frequency (NWP 1-02)
AFOE	assault follow-on echelon (JP 1-02)
AIMD	aircraft intermediate maintenance department (JP 1-02)
ALMDS	Airborne Laser Mine Detection System
AMC	Air Mobility Command (JP 1-02)
AMCM	airborne mine countermeasures (JP 1-02)
AMNS	Airborne Mine Neutralization System
AMW	amphibious warfare (JP 1-02)
AOA	amphibious objective area (JP 1-02)
AOR	area of responsibility (JP 1-02)
APC	acoustic power cable
ARG	amphibious ready group (JP 1-02)
A-S	antispoofing
ASD	area search detachment
ASW	antisubmarine warfare (JP 1-02)
ASWC	antisubmarine warfare commander (JP 1-02)
ATF	amphibious task force (JP 1-02)
AW	air warfare (JP 1-02)
AWNIS	Allied Wartime Navigational Information Service (AAP-15)
BG	battle group
BSP	battlespace profiler

BT	bathythermograph (JP 1-02)
C2	command and control (JP 1-02)
C3	command, control, and communications (JP 1-02)
C4I	command, control, communications, computers, and intelligence (JP 1-02)
CATF	commander, amphibious task force (JP 1-02)
CC	component command (NATO) (JP 1-02)
CFCP	COTS fleet communications package
CIC	combat information center (JP 1-02)
CJCS	Chairman of the Joint Chiefs of Staff (JP 1-02)
CJTF	commander, joint task force (JP 1-02)
CLF	commander, landing force (JP 1-02)
CLZ	craft landing zone (JP 1-02)
COA	course of action (JP 1-02)
COMCMRON	commander, MCM squadron
COMINEWARCOM	Commander, Mine Warfare Command (JP 1-02)
COMLANTFLT	Commander, U.S. Atlantic Fleet
COMOMAG	Commander, Mobile Mine Assembly Group
COMPACFLT	Commander, U.S. Pacific Fleet
COMPLAN	communications plan (JP 1-02)
COMSECONDFLT	Commander, U.S. Second Fleet
COMTECHREP	comprehensive technical report
COMTHIRDFLT	Commander, U.S. Third Fleet
COMUSMARDEZLANT	Commander, U.S. Maritime Defense Zone, Atlantic
COMUSMARDEZPAC	Commander, U.S. Maritime Defense Zone, Pacific
COMUSNAVEUR	Commander, U.S. Naval Forces, Europe
CONUS	continental United States (JP 1-02)
COP	common operational picture (JP 1-02)
COSAL	consolidated ship's allowance list

COTS	commercial off-the-shelf (JP 1-02)
CPP	controllable pitch propellers
CRRC	combat rubber raiding craft (JP 1-02)
CSS	Coastal Systems Station
CTU	commander, task unit
CUDIXS	Common User Digital User Information Exchange System (NWP 1-02)
CV	aircraft carrier (JP 1-02)
CVN	aircraft carrier, nuclear (JP 1-02)
CWC	composite warfare commander (JP 1-02)
DETECHREP	detailed technical report
DEU	diver evaluation unit
DMA	Defense mapping Agency
DRMS	distance root-mean-square (JP 1-02)
ED/AD	ratio of electrical depth to actual depth
EEI	essential elements of information (AAP-15)
EHF	extremely high frequency (JP 1-02)
ELF	extreme low frequency
EMCON	emission control (JP 1-02)
EOD	explosive ordnance disposal (JP 1-02)
EODMU	EOD mobile unit (NWP 1-02)
EODWG	EOD working group
ET	exercise and training
EXTAC	experimental tactic (NWP 1-02)
FADL	fly away diving locker
FARC	fly away recompression chamber
FDNF	forward deployed naval forces
FFG	guided missile frigate (JP 1-02)
FLIR	forward-looking infrared (JP 1-02)

FLS	forward-looking sonar
FSA	fire support area (JP 1-02)
GCCS-M	Global Command and Control System — Maritime (JP 1-02)
GDOP	geometric dilution of precision
GPS	global positioning system (JP 1-02)
GRP	glass reinforced plastic (AAP-15)
HAB	height above bottom
HDOP	horizontal dilution of precision
HEC	helicopter element coordinator (JP 1-02)
HF	high frequency (JP 1-02)
HFSP	High Frequency Sonar Program
HM	helicopter mine countermeasures squadron
HOD	head of delegation (JP 1-02)
HWM	high water mark (JP 1-02)
ICDP	intercount dormant period
IEA	information exchange agreement
ILDP	interlook dormant period (NWP 1-02)
INSS	Integrated Navigation Sonar System
IOC	initial operational capability (JP 1-02)
JSRC	joint subregional command (NATO) (JP 1-02)
JWICS	Joint Worldwide Intelligence Communications System (JP 1-02)
LAMPS	Light Airborne Multipurpose System (helicopter) (JP 1-02)
LCAC	landing craft air cushion (JP 1-02)
LD	line of departure (JP 1-02)
LEO	law enforcement operations
LF	low frequency (JP 1-02)
LHA	amphibious assault ship (general purpose) (JP 1-02)
LLPM	light load propulsion motors

LMRS	Long-Term Mine Reconnaissance System
LO/LO	lift-on/lift-off (JP 1-02)
LORAN	long-range aid to navigation (JP 1-02)
LOS	line of sight (JP 1-02)
LOTS	logistics over-the-shore (JP 1-02)
LPA	littoral penetration area
LPD	amphibious transport dock (JP 1-02)
LPH	amphibious assault ship, landing platform helicopter (JP 1-02)
LPP	littoral penetration point
LPS	littoral penetration site
LPZ	littoral penetration zone
LSS	life support skid
MAL	mine actuation level (AAP-15)
MAST	mobile ashore support terminal (JP 1-02)
MCC	maritime component commander (JP 1-02)
MCCM	mine counter-countermeasures
MCD	mobile communications detachment
MCM	mine countermeasures (JP 1-02)
MCM OPDIR	mine countermeasures operational directive
MCM SITREP	mine countermeasures situation report
MCMC	mine countermeasures commander
MCMRON	mine countermeasures squadron
MCS	MCM command and support ship
MDA	mine danger area (NWP 1-02)
MDZ	maritime defense zone (JP 1-02)
MEDAL	Mine Warfare Environmental Decision Aid Library
MEDEVAC	medical evacuation (JP 1-02)
MEUG	MCM Expert User Group

MFPF	minefield planning folder (JP 1-02)
MHC	minehunter, coastal (NWP 1-02)
MICFAC	mobile integrated command facility
MILC	minelike contact
MINEDETREP	mine detection report
MINEREP	mine report
MIO	maritime interception operations (JP 1-02)
MIUW	mobile inshore undersea warfare (JP 1-02)
MIW	mine warfare (AAP-15)
MM	multinational manual
MMF	mobile maintenance facility (NWP 1-02)
MMGTG	marine minesweeping gas turbine generator
MMS	marine mammal system (NWP 1-02)
MNS	Mine Neutralization System (USN) (JP 1-02)
MNV	mine neutralization vehicle
MOC	mobile operations center
MOE	measure of effectiveness (JP 1-02)
MOGAS	motor gasoline (JP 1-02)
MOMAG	mobile mine assembly group (NWP 1-02)
MOMAU	mobile mine assembly unit
MOP	magnetic orange pipe
MP	mission package
MPC	multi-purpose crane
MPSRON	maritime pre-positioning ships squadron (JP 1-02)
MSC	Military Sealift Command (JP 1-02)
MSF	magnetic silencing facility
MSO	mine sweeper ocean
MTOW	major theaters of war

MTRANSIT	mine countermeasures transit instructions
MTWG	maritime tactical working group
MWC	mine warfare commander
MWES	mine warfare environmental survey
MWP	mine warfare pilot
MWRG	Mine Warfare Readiness Group
MWTC	Mine Warfare Training Center
MWWG	mine warfare working group
NATO	North Atlantic Treaty Organization (JP 1-02)
NAVOCEANO	Naval Oceanographic Office (JP 1-02)
NCS	navigation communication system
NG	naval group
NIDTS	NATO Initial Data Common User Transfer System (AAP-15)
NIPRNET	Non-Secure Internet Transfer Protocol Router Network (JP 1-02)
NMMWG	NATO maritime mine warfare conference
NOMBO	nonmine, minelike bottom object (NWP 1-02)
NOME	non-minelike echo (AAP-15)
NRD	nominal recognition differential
NRF	naval reserve force (NWP 1-02)
NSCT1	Naval Special Clearance Team One
NSW	naval special warfare (JP 1-02)
NSWC	Naval Surface Warfare Center
NTF	naval task force
NTTP	Navy Tactics, Techniques, and Procedures
NVD	night vision device (JP 1-02)
NWP	Naval Warfare Publication
OASIS	Organic Airborne Surface Influence Sweep
OCA	operational control authority (JP 1-02)

OCD	ordnance clearance detachment
OCONUS	outside the continental United States (JP 1-02)
OMFTS	operational maneuver from the sea
OOB	order of battle (JP 1-02)
OP	overpressure charge
OPAREA	operating area (NWP 1-02)
OPCON	operational control (JP 1-02)
OPGEN	operational general matter (JP 1-02)
OPORD	operation order (JP 1-02)
OPTASK	operation tasking (JP 1-02)
OTCIXS	Officer in Tactical Command Information Exchange System (NWP 1-02)
OTH	over-the-horizon (JP 1-02)
PAC	probability actuation circuit
PEOMUW	Program Executive Office for Mine and Undersea Warfare
PFP	Partnership for Peace (NATO) (JP 1-02)
PG	project group (AAP-15)
PINS	precise integrated navigation system (JP 1-02)
PMS	planned maintenance system
PNS	Precise Navigation System
POL	petroleum, oils, and lubricants (JP 1-02)
PPS	precision positioning service (JP 1-02)
PRETECHREP	preliminary technical report
PSE	prevention of stripping equipment
RAMICS	Rapid Airborne Mine Countermeasures System
RC	regional command (NATO) (AAP-15)
RFOC	rapid follow-on clearance
RHIB	rigid hull inflatable boat (JP 1-02)
RMAST	reserve mobile ashore support terminal

RMS	Remote Minehunting System
RMV	remote minehunting vehicle
RO/RO	roll-on/roll-off (JP 1-02)
ROE	rules of engagement (JP 1-02)
ROV	remotely operated vehicle (NWP 1-02)
RSP	render-safe procedure (AAP-15)
S/A	selective availability
SAR	search and rescue (JP 1-02)
SATCOM	satellite communications(JP 1-02)
SC	strategic command (NATO) (AAP-15)
SCUBA	self-contained underwater breathing apparatus
SEAL	Sea-air-land team (JP 1-02)
SG	sub-group
SHAPE	Supreme Headquarters Allied Powers, Europe (JP 1-02)
SIPRNET	SECRET Internet Protocol Router Network (JP 1-02)
SIT	simple initial threat
SITREP	situation report (JP 1-02)
SLMM	Submarine-Launched Mobile Mine (NWP 1-02)
SLOC	sea line of communications (JP 1-02)
SMCM	surface mine countermeasures (JP 1-02)
SOA	speed of advance (JP 1-02)
SSN	attack submarine, nuclear (JP 1-02)
ST	specialist team
STOM	ship-to-objective maneuver
STRIKFLTLANT	Strike Fleet Atlantic
STWC	strike warfare commander (JP 1-02)
SUBACLANT	Submarine Force Allied Command Atlantic
SUW	surface warfare (JP 1-02)

SVP	sound velocity profile (NWP 1-02)
SW	shallow water
SWMCM	shallow water MCM
SZ	surf zone (JP 1-02)
TARLOC	target localization
TD	time delay
TDA	tactical decision aid (NWP 1-02)
TDD	target detecting device (NWP 1-02)
TECHREP	technical report
TLAM	Tomahawk land-attack missile (JP 1-02)
TPFDD	time-phased force and deployment data (JP 1-02)
TPO	technical project office
UBA	underwater breathing apparatus
UCHS	umbilical cable handling system
UDWG	underwater diving working group
UEP	underwater electric potential (NWP 1-02)
UMCM	underwater mine countermeasures
UMPM	Uncountered Minefield Planning Model
USMC	United States Marine Corps (JP 1-02)
USMTF	United States message text format (JP 1-02)
UUV	unmanned underwater vehicle (JP 1-02)
VDS	variable depth sonar (NWP 1-02)
VEMS	Versatile Exercise Mine System
VHS	vehicle handling system
VSW	very shallow water (NWP 1-02)
VSW MCM WG	very shallow water MCM working group

VTS	vessel traffic service (JP 1-02)
WG	working group
WGS	World Geodetic System (JP 1-02)

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