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## MODULAR SEA MINE (MSM) and PILL BOX PROGRAMS

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A paper submitted to the Faculty of the Naval War College in partial satisfaction of the requirements of the Gravely Research Group.

The contents of this paper reflect my own personal views and are not endorsed by the Naval War College or the Department of the Navy.

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## **1 Introduction**

A minefield is a significant physical and psychological threat that can cause severe damage and destruction of ships and submarines or limit movements by forcing delays and diversions because of real and exaggerated perceptions and fears. Any potential minefield must be treated as a danger, forcing a commander to make decisions without complete information of the threat, courses of action and possible consequences. The US Navy has had a proud tradition in mine warfare, but let this invaluable capability slowly atrophy since WWII and has focused only on Mine Countermeasures (MCM). The US Navy's reduction in mining capabilities has given potential adversaries the advantage of continuing to develop new mines while ignoring MCM investments in research and development and ships. A resurgence in the US Navy's mining capability is required to reverse this trend. The Modular Sea Mine Program and the Pill Box concept will allow the US Navy to develop an inventory of modern naval mines, build a credible mining capability and demonstrate to potential adversaries the resolve of the US Navy to use naval mines.

## **2 Current Situation**

The US Navy's policy on mining is clear. It states the US forces will "conduct offensive, defensive, and protective mining as necessary" (Joint Forces Command 2011). Mines are to be used to "reduce the enemy threat by destruction and disruption of their operations, to interdict the enemy SLOCs and designated ports in order to neutralize or destroy combatant and merchant ships, and to defend US and allied shipping" (Joint Forces Command 2011). The only problem

is US mining capability is unable meet this policy and has been steadily decreasing since World War II.

The current U.S. inventory of naval mines consists of just two types of mines; the Quickstrike and Submarine Launched Mobile Mine (SLMM). The Quickstrike mine is a family of air-delivered bottom mines based on US general-purpose bombs using a variable-influence sensor. These mines are capable of being deployed by aircraft up to a depth of 300 feet. The MK-62 utilizes a 500 lb. bomb, the MK-63 a 1000 lb. bomb, and MK-65 2000 lb. bomb. All mines have arming-delay, sterilization, self-destruct, and other operational settings. To be effective, a significant number of mines are needed to cover the possible transit paths available to the threat platforms. This is a manpower intensive and challenging task. Aircraft must fly low and slow to properly drop the mines making them vulnerable to enemy fire and pilot error. Work has been done to increase the standoff range of the Quickstrike mines through the use of JDAM wing kits. Testing has indicated that standoff range can be increased to as much as 45 miles while providing precise targeting.

The SLMM MK-67 is a submarine launched mine based on the Mk 37 torpedo with a mine warhead. This mine can be clandestinely delivered from standoff ranges or into an area not normally accessible by mines. The SLMM is a multiple-influence bottom mine with a capability that permits it to be covertly propelled to a predetermined location to restrict ship and submarine traffic. Although it's still in the current Navy inventory, the 1950's technology in the SLMM is for all practical purposes obsolete. An Improved SLMM program was proposed to replace the MK-67 by converting MK-48 torpedoes into dual warhead mobile mines, but the program never gained traction.



**Figure 1: Air Deployable Quickstrike Mine**

### **3 A Brief History**

From its earliest years, the U.S. Navy has had a distinguished history with sea mines. David Bushnell invented the first successful sea mine in 1776. This simple device consisted of a wooden keg filled with gunpowder fitted with a crude contact fuse. These mines were a successful psychological deterrent to British naval operations in harbors and rivers in spite of spotty reliability.

During the Civil War, the South was much more innovative in using a variety of naval mines than the Union Navy. Confederate Lieutenant Hunter Davidson developed a remote controlled electrically detonated naval mine. The Confederates also invented the "Singer" mine which used a percussion cap to detonate the main explosive. This mine was also one of the first designed with a safety mechanism to prevent accidental explosions during placement. The Confederate Navy used mines, quite extensively during the war and sank approximately 27 Union vessels and damaged many more. By comparison, only nine Federal vessels were sunk by gunfire (Hartshorn 2012).

A major development in mine technology was the invention of the Hertz horn in 1866. This simple device allowed for the development of reliable contact mines. Strategic mining was employed effectively by both the Japanese and Russians in the Russo Japanese War. The effectiveness demonstrated by both sides in the war prompted the US Navy to ask Congress for funds for a mine depot ship. The old cruiser USS San Francisco was converted in 1912 and became the first mine warfare ship in the US Navy.

Sea mines played a significant role in World War I, particularly in the Dardanelles-Gallipoli campaign and the North Sea. Allied forces attempting to breach Turkish defenses met with mines laid in the Dardanelles Strait. Four ships were lost or damaged, effectively ending the campaign. In the North Sea, the Allies laid over 70,000 mines in the northern portion of the English Channel to limit German access to the Atlantic Ocean. Smaller fields were planted in the southern part of the channel. By the end of the war, the naval mine had proven to be a highly effective weapon that dramatically changed the character of naval warfare.

In World War II the use of naval mines came of age and brought about a new and expanded role. Increasingly mines were looked upon as an offensive weapon as well as a defensive weapon. The development and use of acoustic and magnetic influence mines and the first use of aerial mine laying increased the effectiveness of and deployment of sea mines. Germany's Baltic Sea mine campaign successfully sealed the Russian fleet in port for the duration of the war and United States' Operation Starvation dropped over 11,000 mines in Japanese harbors and shipping routes, resulting in the destruction or disablement of most of the Japanese merchant marine fleet sealing off critical SLOCs to and from Japan.

Post-World War II naval warfare saw increased use of mines by underdeveloped nations in conflicts reflecting the asymmetric value of mine warfare. In the Korean War, mining by

communist forces immobilized the U.S. fleet for more than a week during the landing at Wonsan. Three thousand Russian-made contact and magnetic mines delayed the US landing force while minesweepers tried to sweep a clear channel through the minefield.

During the Cold War, the US Navy only used mines on two occasions. The first was the 1972 mining of North Vietnamese ports to force the North back to the Paris Peace Talks and the second was the mining the Persian Gulf during Desert Storm to block Iraqi naval craft from leaving their home ports.

#### **4 Benefits of Mines**

Naval mines have many benefits and provide unique capabilities. Naval mines are a force multiplier. With the inevitable drawdown of naval forces, mines provide the ability of the Navy to create static defenses such as blockades, antisubmarine barriers, access denial to ports with minimal manpower. Ships and submarines are then free to perform other more pressing matters. Naval mines can remain in place for the duration of hostilities and require no monitoring once deployed. Mines from World War II and the Korean War have been found to be fully operational.

Naval mines are cost effective. They are the IEDs of the sea, cheap and deadly. Many mines are commercially available for prices which range from a few thousand dollars to a few million dollars, depending on the technology employed. When compared to the price of a ship, mines are a cost effective deterrent (Faith 2014).

Naval mines allow commanders to shape the battlespace. Mines can be delivered by air, surface ship, submarine or using Unmanned Underwater Systems (UUS). The use of overt or covert methods of mining allows commanders to deny the enemy access to preferred

transportation routes harassing and slowing an enemy. Finding and destroying mines is dangerous and time-consuming. These delays further frustrate the enemy's plans. Preemptive clandestine mining or quick reaction mining reduces the ability of the enemy to understand the situation clearly, and a forces him to be reactive instead of proactive taking away the initiative.

Mines are easy to use. Mine deployment can be as simple as sailing to a specified point and dropping mines over the side. Once in the water, they can create chaos exponentially larger than their actual effect.

Mines produce a dramatic psychological effect in adversaries. Nothing will sober the crew of a ship more than seeing the destruction of a fellow ship hitting a mine or just watching mines fall from an aircraft into their intended path. Once mines are discovered either through a hit or through the discovery of a minefield through an overt deployment of mines, crew stress will rise exponentially and diminish shipboard efficiency (Bray 2001).

Naval mines provide a low-risk option to policymakers and commanders. Naval mines can be delivered quickly anywhere, anytime with limited risk to friendly personnel. Mines keep sailors out of harm's way reducing the risk of casualties. Personnel losses tend to lead to public pressure for withdrawal and a consequent failure to achieve the national objectives that initially motivated US involvement. Naval mines can prove useful to U.S. diplomatic objectives by enforcing sanctions without initiating open conflict. Rapid response mining in limited contingencies, such as shutting down shipping or barricading potentially hostile naval units demonstrates US diplomatic resolve. As a tool of diplomacy, mines may contribute to achieving objectives without actually striking enemy target. Overt mine laying or warning of mines may cause belligerents to take pause and reconsider actions.

An active mine development program will develop US Navy expertise in mine design, MCM, and mining tactics. This expanded knowledge can then be used to better understand the design, manufacture and operation of foreign mines and mining operations. US mines and MCM expertise can then be made available to allies through foreign military sales and cooperative agreements.

Critics of mine warfare point out their drawbacks. Mines can remain active and in place indefinitely. International law concerning mines requires them to be cleared or rendered inert after the end of hostilities. Modern technology enabling precision deployment and remote control of mines alleviates much of this concern. Another concern is that mines are effective but not really efficient. A quick look at the number of mines deployed in WWI and WWII and the number of ships destroyed or damaged seems to confirm this point. However, one must remember that the mines used during the world wars were contact or bottom mines. These types of mines required ships to either make direct contact with a mine or move within 10 - 50 yards of the mine to be effective. A modern encapsulated torpedo mine has the ability to engage targets in excess of 15 miles away.

## **5 Types of Mines**

Naval mines are classified in three ways. These classifications include the method of delivery, position of the mine in the water column, and method of target detection (National Research Council 2000).

### **5.1 Methods of Delivery**

Mines can be deployed by aircraft, submarine, surface ship or Large Diameter Unmanned Underwater Vehicle (LDUUV). Air-laid mines are dropped over an area, similar to a bomb.

Submarine laid mines are used for clandestine mining and are usually launched from the torpedo tubes. The US Navy currently has no dedicated mine laying ships however any surface ship is capable of deploying mines. Even mines specifically designed for aircraft and submarine delivery can be modified to allow planting by surface craft.

Aircraft are the primary means of US mine delivery capability. The Navy's F/A-18 and P-3C and the Air Force B-52H, B-1B and B-2 bombers are capable of delivering the Quickstrike family of mines. The P-8 which is replacing the P-3C is also capable of mine delivery; however testing has not been conducted. Aircraft can quickly deliver a large quantity of mines for offensive mining operations; replenishing minefields or mining enemy-held inland waterways. Most air-laid mines use a parachute pack and release gear to decrease water-impact velocity. As the mine strikes the water, or submerges to a given depth, the release gear frees the mine case from the parachute, after which the parachute and mine then sink free from each other.



**Figure 2: B-52H Dropping Quickstrike Mines**

Current US attack submarines can deliver the SLMM MK-67 mines clandestinely from their torpedo tubes. Although submarines can carry mines great distances from home ports, they are not conducive to carrying large payloads. In addition, each mine carried reduces the submarine's ability to carry torpedoes. This has been resolved by some navies by the use of mine belts which allow external carrying of mines on submarines. Although, the limited number of mines that a submarine can carry is a disadvantage, the secrecy with which a submarine can deliver mines to an enemy port or operating area at great distances from friendly bases provides an overwhelming tactical advantage. Submarines can be highly effective in the mine laying role as they are capable of clandestine operations, permitting them to enter waters normally denied to surface ships or aircraft because of enemy forces, bad weather, or ice.

The LDUUV offers the ability to provide clandestine mine deployment without the use of submarines. Two methods of deployment are feasible. First, the LDUUV can deliver mines in a similar fashion as a submarine would and then return to its base ship. The second option would be to have the LDUUV deliver encapsulated torpedoes to a desired location and then sit and wait. When a suitable target is identified, the LDUUV would deploy its payload. Once the LDUUV has expended its weapons or the battery life reaches a predetermined level, the LDUUV would return to its base ship or port.



**Figure 3: Large Diameter Unmanned Underwater Vehicle (LDUUV)**

Almost all air and submarine laid mines can be adapted for deployment from ships. Delivery of mines from a modified cargo ship, fishing vessel or barge can be quickly accomplished in a semi-clandestine manner under the cover of darkness. Surface ship mining is the most economical method of delivery because of the large number of mines that can be carried.



**Figure 4: Chinese Ships Laying Mines**

## **5.2 Position in the Water**

Mines are classified according to where they are placed in the water column. Each type of mine has benefits and drawbacks.

# Naval Mine Types

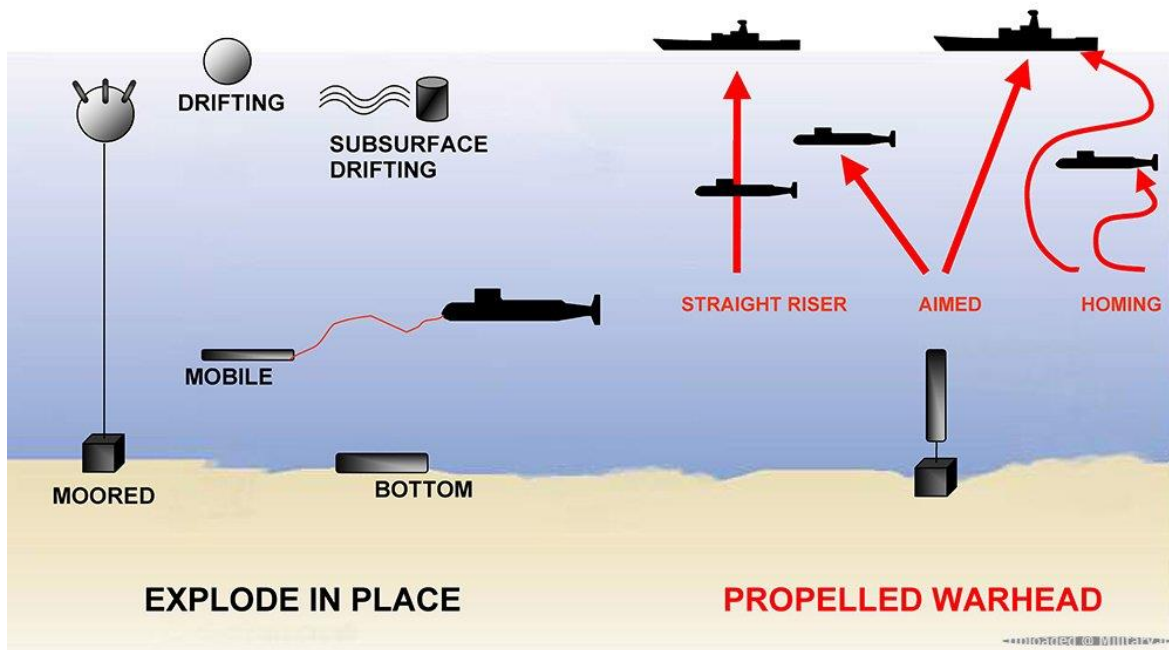


Figure 5: Types of Mines

Bottom mines sit on the floor or below of the seabed and have many advantages. They are easy and safe to deploy. Delay fuses allow the safe handling of mines on board unspecialized vessels by an unskilled crew. Mine deployment is as simple as sailing to a specified point and dropping mines over the side. They can be deployed by submarines, LDUUV, aircraft or surface ship (Slade 2010).

Moored mines are by far the most common naval mine. Moored mines are designed for medium to deep water depths. The deployment of moored mines is more complex than bottom mines, but still within the ability of lightly trained crews. The weight of most moored mines requires deployment by large aircraft, LDUUV or surface ships.

The rising mine is a special type of moored mine for use in very deep water or a soft seabed. These mines lie on or under the sea floor. Rising mines utilize a passive acoustic sensor to listen for ship or submarine traffic. The mine switches to an active mode upon contact with a target, floats upward and explodes. An improved version of the rising mine fires a torpedo or projectile rather than just floating upwards.

Floating mines are mines which float on or just below the surface and detonate upon contact with surface vessels. These mines have been banned by treaty but they are still being manufactured and sold by various countries.

### **5.3 Target Detection Methods**

#### **5.3.1 Magnetic Mines**

Magnetic mines sit on the ocean floor and are limited to relatively shallow water. These mines are designed to detect the rate of change of a magnetic field. Increasing magnetic field strength followed by a decreasing field strength causes detonation. The rise and fall of the magnetic field ensure the mine will explode as the ship passes under the propellers rather than under the bows increasing damage. Magnetic bottom mines are designed and built simply and inexpensively. Defenses against magnetic mines include reducing the magnetic signature of the intended targets through the use of non-magnetic materials and degaussing.

#### **5.3.2 Acoustic Mines**

Acoustic mines exploit the principle that all ships and submarines have a unique acoustic signature. This signature is the result of many factors including the engine, machinery, hull design and the propellers. Delay features allow mines to remain inert (and thus unsweepable) for a set number of days. Ship counters are used to delay mine detonation until a predetermined

number of contacts are detected. These features require a mine sweeper to make many passes over a suspected field to ensure that all the mines are identified.

Acoustic mines can be set to work in either broadband or narrow band modes. Broadband mines work on the volume of noise emissions across all frequencies. The fusing system is relatively simple and mines of this type can be swept using simple noise generators. Mines of this type are very widespread and are produced extensively. They do, however, require a degree of electronic sophistication in the fusing making them more expensive and time-consuming to produce.

Narrow band acoustic mines discriminate and classify targets by identifying distinctive frequencies generated by ships or submarines. These frequencies may be the drone of a diesel engine, the cavitation caused by a propeller design or the whine of a gas turbine. One Russian narrow band acoustic mine, for example, can be set to listen specifically for the LM-2500 gas turbine and ignore other powerplants (Slade 2010). This makes sweeping these mines exceptionally difficult. MCM devices must accurately reproduce the sound profile of a target in order to detonate the mine. The match has to be nearly exact since errors are detected and used to filter out the sweeping attempts. The design of these TDDs requires sophisticated hydro-acoustic expertise and is produced only by major naval powers. Narrow-band acoustic mine design require extensive non-recurring engineering and development costs and are produced in smaller batch sizes resulting in increased cost.

### **5.3.3 Magnetic-Acoustic Mines**

Acoustic mines require electrical power to detect acoustic signatures. This electrical power requirement limits the useable life of the mine. The introduction of a simple magnetic switch similar to those used in the original magnetic mines resolves the energy conservation problem.

This switch activates the acoustic portion of the fuse when there is a large change in the magnetic field. If a suitable target is identified, the mine will explode; otherwise it turns off after a few minutes. This magnetic switch does not require energy, so it is not life limited. The acoustic switch is off most of the time, conserving battery power and limiting detectability. Any attempt to sweep the mine must combine magnetic and acoustic generators in a carefully integrated and phased sequence. This combination of magnetic and acoustic fusing integrates the simplicity and long life of a magnetic mine with the discrimination of a narrow-band acoustic mine and while increasing the lethality and survivability of the system.

#### **5.3.4 Pressure Mines**

Pressure mines are bottom mines that measure the change in water pressure associated with the hull of a ship passing over the mine. Pressure mines are for shallow-water applications. As with acoustic mines, pressure mines incorporate time delay and ship count features. Many amphibious warfare vessels have high pressure signatures and are very vulnerable to such mines. There is no current method to sweep pressure mines, but do have a significant weakness. Shallow draft vessels can cross most pressure minefields unscathed.

#### **5.3.5 Contact Mines**

Contact mines are the most common mine in use today and detonate when a ship strikes the mine. Contact with a vessel bends the malleable outside horns protruding from the mine, breaking glass cylinders of acid igniting the detonator. Contact mines are easily swept and destroyed. The design of contact mines limits their use to anti-ship warfare. The design and manufacture of such mines is simple resulting in a procurement cost of only several thousand dollars per mine. The low cost and widespread use of contact mines makes these weapons impossible to ignore or to dismiss as obsolescent.

Two variations of contact mines are the antenna mine and the string mine. The antenna mine is designed to explode under submarines damaging or breaching the submarine's pressure hull. The antenna mine is a moored mine on a short cable with a long copper wire stretched upwards by a float. If any steel object touches the wire, an electrical potential is generated which detonates the mine. These mines are set to sit deep in the water with their detonation antennas set to a predetermined depth under the surface. This design allows surface ships to sail over the wires safely while presenting a danger to submarines. Antenna mines require detonation within about 100 feet of the hull of the submarine if significant damage is to be achieved.

String mines are a modification of the antenna mine which features tiers of explosive charges which may be either contact or antenna activated. The explosion of one mine will detonate the remainder as a result of sympathetic detonation. The assembly is cumbersome and looks like a large to spider web but can be effective as an asset protection or anti-access system.

## **6 Geographical Considerations**

Geography determines the suitability, selection and deployment of mines. Mines are the maritime equivalent of roadside bombs. Maritime traffic has preferred and common routes; however there is almost always an alternate route. Mining is most useful in highly traveled, narrow waterways such as the Strait of Hormuz. At its narrowest point, this waterway is just 21 miles wide. The sheer size of the Pacific Ocean presents a tougher problem. One of the Western Pacific's narrowest chokepoints, the gap between South Korea and Japan, has two channels each greater than 21 miles across. Taiwan and the Japanese Islands are 700 miles apart, linked by the loose chain of the Ryukyu Islands. The distance from Taiwan to the Philippines is approximately 275 miles, but the Philippines consist of many islands with many channels, offering many

potential detours around a minefield. The Strait of Malacca, through which most of East Asia's oil flows, is only 1.7 miles across. Mining this would cut the most direct route from the Persian Gulf to Asia. Traffic could still detour around Sumatra, Java, and Timor and head north. This route would increase the time and cost, but it would hardly cripple seaborne commerce (Freedberg 2015).



Figure 6: Trade Straits in the Pacific Ocean

## **7 Other Considerations**

### **7.1 Dummy Mines**

Not every mine-like object is a mine. Domestic trash, sunken buoys, errant intermodal containers, oddly-shaped rocks, and other debris cover the ocean floor. Clearing mines require the identification of all mine-like objects and the elimination of all objects deemed suspicious. The laying of cheap dummy mines in conjunction with genuine mines will bring the mine clearance process to a congested halt. Cheap resin mine casings filled with concrete and painted with the correct markings can be quickly and cheaply manufactured. Each dummy mine must be treated as a live mine until proven otherwise diverting manpower and assets and slowing naval operations. (Slade, 2010)

### **7.2 Information Warfare**

Information warfare can play a prominent part of developing a credible offensive mining capability. Briefs and acquisition plans for mine development must be prominently featured in magazines, websites and even on social media. Telegraphing our intentions to both potential adversaries and allies will plant the seed that the US is getting serious about offensive mining.

Mine-laying exercises with allies needs to be announced and performed on a regular basis. This will increase fleet proficiency and continue the credibility of US offensive mining. All methods of mine delivery need to be incorporated into the exercises. These activities can then be followed by MCM exercises to improve the proficiency of mine hunting and sweeping.

All US Navy ships should be equipped for mine laying and each ships inventory needs to include a set number of mines. Shipboard training must also include proper mine laying procedures. Once again this will increase the credibility of US mining operations with the net

effect that mine warfare is a credible threat to our adversaries diverting their R&D assets into MCM and sweeping.

## **8 Modular Sea Mine Program**

Naval mines have the ability shape the battlespace at a low cost. A program to develop a state of the art mine capability for the US Navy is required. The program will allow the Navy to take advantage of benefits of mines while avoiding the pitfalls. The goal of Modular Sea Mine (MSM) Program is to develop new family of naval mines which can incorporate multiple kinetic and non-kinetic payloads and is coupled to a common state of the art Target Detection Device (TDD) or networked of TDDs.

### **8.1 Modular Sea Mine (MSM) Program Key Requirements**

In a declining military budget environment cost becomes a major consideration of any weapons program. The MSM program will adopt a technology mix which will keep unit costs low and provide a cost effective deterrent to adversaries. Commercial-off-the Shelf (COTS) and Non-Developmental Items (NDI) will be leveraged along with technologies currently under development by DARPA to provide increased value and a Pre-Programmed Product Improvement (P3I) for the MSM.

A method of remote activation/deactivation will be incorporated into the MSM to allow mines to be strategically placed during Phase 0 or Phase 1 operations and activated when desired. Extremely Low Frequency (ELF) signals offer a near term solution. In addition, work being performed by the Hydra and Upward Falling Payload programs by DARPA should offer improved capabilities in the future.

A state of the art common TDD is another key requirement of the MSM program. This TDD can be designed with common interfaces to allow its use across the entire MSM family of mines. Incorporation of commercial of the shelf (COTS) and non-developmental components will help to ensure the TDD is both reliable and affordable.

Another consideration in the design of the MSM is to incorporate anti-tamper features. These features are designed to prolong the clearing process or destroy the Remote Operated Vehicles (ROVs) used in mine clearing. MCM ships rely on a small number of ROVs in the mine sweeping process. Any damage or destruction of these tools will significantly impede MCM efforts. Mines specifically targeting ROVs can be intermixed in mine fields or moored encapsulated torpedo mines can be designed to be triggered or explode upon cutting the mine's chain. These features would help to frustrate and prolong mine clearing.

Other requirements include intuitively designing mines to allow safe deployment with minimal training and the ability to programming targets at the lowest technical level; the ability to deploy from by aircraft, submarines, LDUUV and surface vessels and capable of being used in all depths of water up to 10,000 feet. Kinetic and non-kinetic payloads should be explored to determine the feasibility of the MSM disrupting sea operations in a covert manner and exploring stealth design concepts to camouflage mines and slow MCM operations.

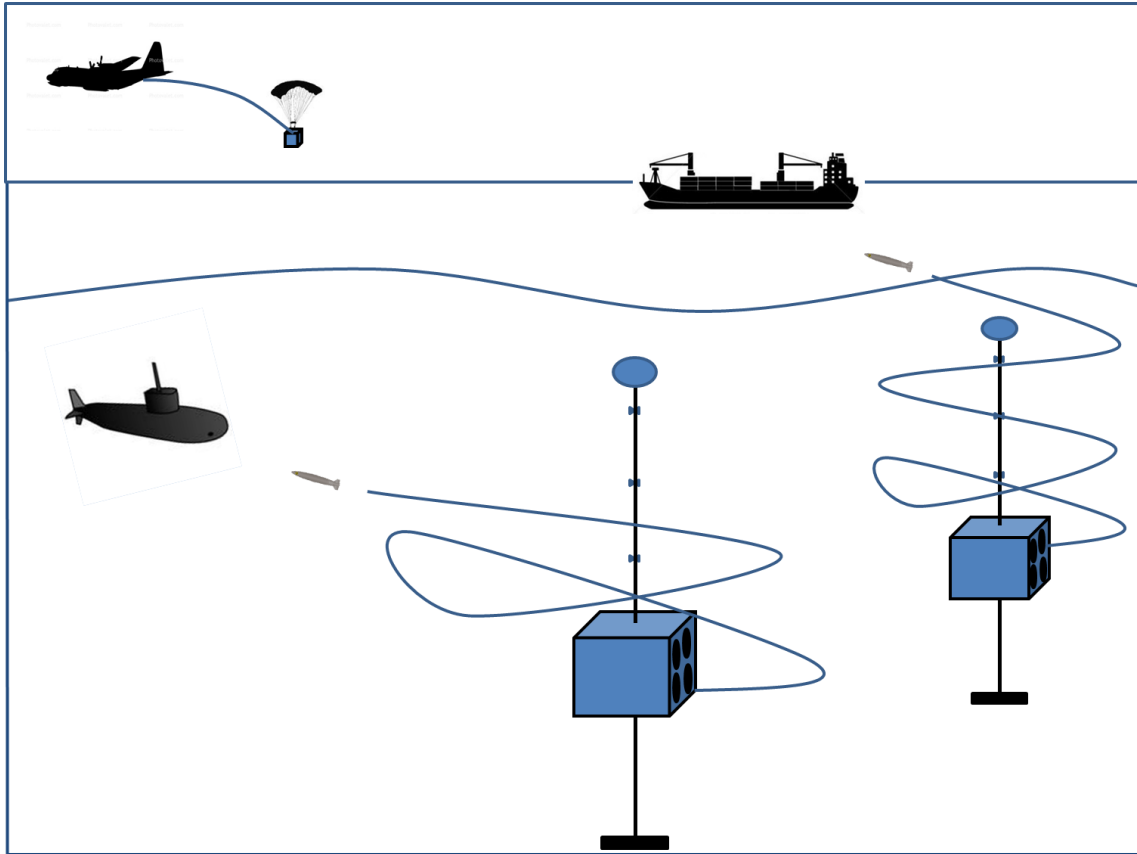
## **9 The Pill Box Concept**

The Pill Box concept is a possible deployment concept of the mines developed under the MSM program. The Pill Box is a scalable concept to provide a battery of encapsulated torpedo mines in a 463L airdrop compatible, 20 foot or 40 foot intermodal container form factors. The Pill Box will contain anywhere between eight to twenty four encapsulated torpedoes. A common

self-deployable vertical TDD sensor array will be used for all versions. A COTS Bluefin battery pack will provide power to the Pill Box allowing for a five year life in sleep mode and a two year life while activated. Anti-tamper features will ensure the integrity of the systems so they are available when needed. It is anticipated that this program will be developed in a minimum of two phases. The first phase will use current technology and MSM components to develop a suitable system which can be fielded within the next 3 - 5 years. The second phase of the program will make use of technology from DARPA's Hydra and Upward Falling Payload programs to leverage networking of vertical TDD sensor arrays, allow remote power recharging of power sources to extend useful life and develop improved communications with the Pill Box.

During Phase 0 and Phase 1 operations, it is anticipated that the Pill Box will be airdropped, rolled off a cargo ship under the cover of darkness or clandestinely dropped by LDUUVs in desired locations. The deployed containers will deploy the mooring weight and shed the parachute (if equipped). The container itself will lie in the water column and wait for a signal to activate. When desired, an ELF signal will activate the Pill Box and deploy the vertical TDD sensor array. The sensor array will use multiple influences to determine when a potential target is approaching. The sensor will then activate the acoustic sensor. The narrow band acoustic sensor will listen to the approaching vessel and determine if it is a desired target by comparing its sound profile to the preprogrammed target profiles in its database. If the vessels profile matches a preprogrammed target profile then the Pill Box will launch an encapsulated torpedo. The torpedo will perform a circular search pattern to target and destroy the enemy vessel. Upon the destruction of the vessel, the acoustic sensor will listen for any additional targets and then power off to wait for the next potential target. Attempts to sweep the Pill Box by cutting the

mooring chain or approaching the container with an ROV will cause the Pill Box to sequentially fire any remaining torpedoes.



**Figure 7: Pill Box Concept of Operations**

The Pill Box concept encompasses some distinct advantages with respect to current US mine technology. The first is its ease of delivery. The size and weight of the Pill Box allows it to be deployed by multiple methods including air, LDUUV or surface ship. The Pill Box also reduces the time required to lay mines. Instead of delivering multiple mines, the Pill Box allows an arsenal of mines to be deployed in a single container in a clandestine or semi-clandestine manner. This limits activity in the target area reducing suspicious behavior.

The ability of the Pill Box to be turned on at the start of hostilities means it can be deployed during Phase 0 operations and wait until it is needed. The ability to shut off the Pill Box at the

end of hostilities eliminates the tedious and time consuming task of locating and rendering mines inert.

The Pill Box's narrow band acoustic TDD sensor array will allow friendly ships to pass through mined areas unscathed while only posing a threat to preprogrammed targets. The use of encapsulated torpedoes allows targets to be acquired and destroyed from distances of up to two miles as compared to 50 yards in Quickstrike mines. This distance will grow as networked TDD sensor arrays are perfected. This will allow the deployment of two or three Pill Boxes along critical waterways to completely block enemy access.

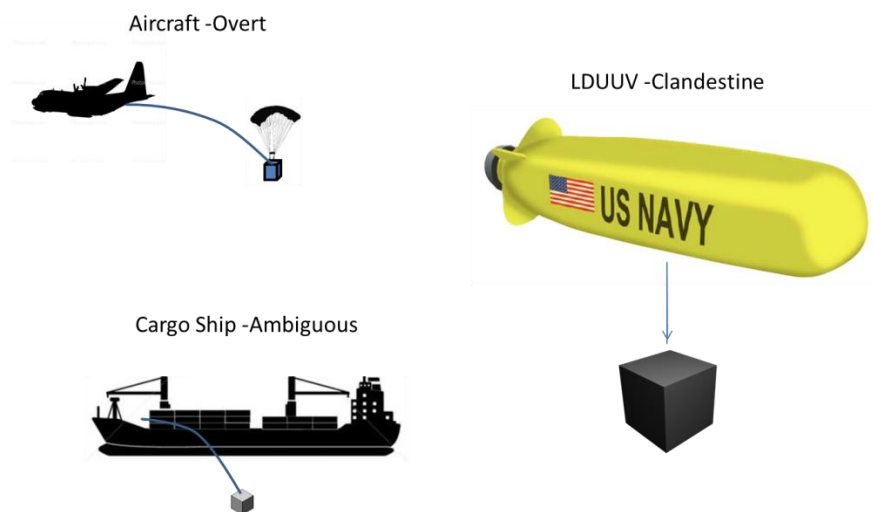
### **9.1 Airdrop Capable Pill Box Mine**

The Airdrop Capable (ADC) Pill Box is designed to allow precision deployment utilizing the Joint Precision Airdrop System (PADS 10K). Airdrop compatibility requires a maximum weight of 10,000 pounds and a form factor of approximately 108" x 88" x 96". This will allow the airdrop compatible Pill Box to be compatible with the standard 463L cargo pallet allowing transportation in any military cargo aircraft and capable of deployment in the C-130, C-17, and C-5.



**Figure 8: Joint Precision Airdrop System - 10K**

In addition, these containers may be delivered via cargo ship or LDUUV. Preliminary design of the ADC Pill Box enclosure indicates the ability to fit 6 – 8 MK-44, MK-46 or MK-54 encapsulated torpedoes. Initially the Pill Box will utilize battery packs of multiple COTS Bluefin Batteries (15.1” x 5.2” x 8.2”). Technology from the DARPA Hydra and Upward Falling Payload programs will allow for underwater recharging of batteries extending useful life indefinitely.



**Figure 9: ADC Pill Box Methods of Deployment**

## 9.2 20 foot/40 foot Pill Box

The 20 foot/40 foot Pill Box is similar to the ADC Pill Box only scaled to a larger size. These concepts utilize a 20 foot (20' x 8' x 8.5') or 40 foot (40' x 8' x 8.5') intermodal container form factor. The size and weight of these containers necessitate roll-off cargo ship deployment or possibly the use of an extra-large underwater unmanned vehicle. The 20 foot form factor is the same size as the containers being developed under the Hydra program, therefore any deployment options developed under Hydra would be compatible. Preliminary design of these systems indicates 8 - 16 MK-48 ADCAP encapsulated torpedoes or 16 to 24 MK-54 encapsulated torpedoes can be packaged in these Pill Boxes. Unfortunately, current vertical TDD sensor arrays do not have the necessary range to justify the development of MK-48 ADCAP encapsulated torpedoes. Sensor networking currently under development by the Hydra and Upward Falling Payload programs should allow for networking of sensors allowing the full use of MK-48 ADCAP torpedo range.



Figure 10: Intermodal Container (typical)

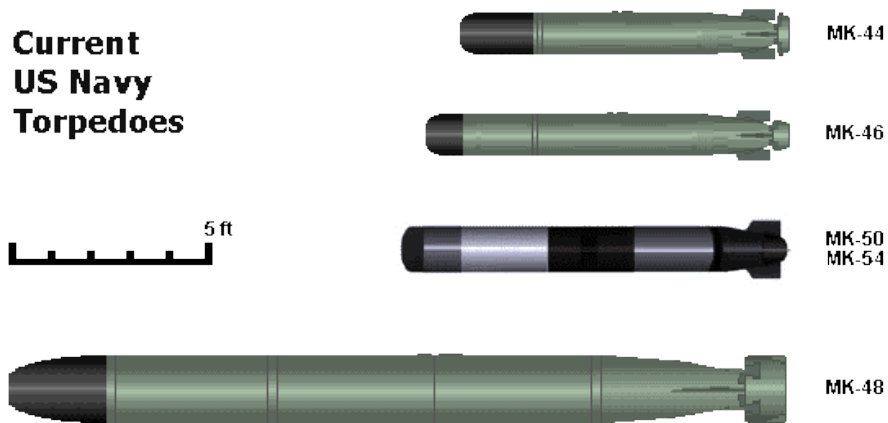


Figure 11: Current US Torpedoes

## 10 Conclusion and Recommendations

Since World War II, the US Navy's capability to perform offensive mining has dropped dramatically. Mining choices today revolve around the inefficient Quickstrike mine or the nearly obsolete SLMM. A reinvigoration of mine technology is needed. The first step in this revival is the MSM program and the Pill Box concept. These programs will allow the development of an inventory of modern naval mines and begin to build a credible US mining capability. No longer will adversaries be allowed to ignore MCM investments in research and development and ships while building and developing new mines.

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