

UNCLASSIFIED

FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602315N

PROGRAM ELEMENT TITLE: Mine Countermeasures, Mining and Special Warfare Technology

(U) COST: (Dollars in Thousands)

PROJECT NUMBER & TITLE	FY 1999 ESTIMATE	FY 2000 ESTIMATE	FY 2001 ESTIMATE	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	TO COMPLETE	TOTAL PROGRAM
N/A Mine Countermeasures, Mining and Special Warfare Technology	48,084	44,773	50,864	51,708	52,027	50,091	51,320	CONT.	CONT.

A. (U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: This Navy program element (PE) provides technologies for naval Mine Countermeasures (MCM), U.S. Naval sea mines, Naval Special Warfare, and Department of Defense (DOD) Explosive Ordnance Disposal (EOD). It is strongly aligned with the Joint Chiefs of Staff Joint Warfighting Capabilities through the development of technologies to achieve military objectives (Power Projection from the Sea) with minimal casualties and collateral damage. The PE supports the Joint Littoral Warfare Mission Area by focusing on technologies that will provide the Naval Force with the capability to dominate the battlespace, project power from the sea, and support forces ashore with particular emphasis on rapid MCM operations. The MCM component concentrates on the development and transition of technologies for organic mine countermeasures and Future Naval Capabilities supporting Ship to Objective Maneuver. These include technologies for clandestine minefield surveillance and reconnaissance, organic self-protection, organic minehunting, neutralization/breaching and clearance. The sea mining component emphasizes offensive sea mining capabilities. The Naval Special Warfare and EOD technology components concentrate on the development of technologies for near-shore mine/obstacle detection and clearance, mobility and survivability, as well as explosive ordnance disposal.

(U) MCM Technology: Third-world nations have the capability to procure, stockpile and rapidly deploy all types of naval mines, including new generation mines having sophisticated performance characteristics, throughout the littoral battlespace. "Desert Storm" demonstrated the U.S. Navy's needs to counter the projected third-world mine threat. Advanced technologies are required to rapidly detect and neutralize all mine types, from deep water to the beach. This task has two major thrusts: (1) Mine/obstacle detection and (2) mine/obstacle neutralization. The detection thrust includes: remote sensing techniques to survey threat mining activities and mine/obstacle field locations; advanced acoustic/non-acoustic sensors and processing technologies for rapid minefield reconnaissance and determination of the location of individual mines and obstacles. The majority of these sensors and techniques were demonstrated in FY 1997 and FY 1998 as part of the Joint Countermine Advanced Concepts Technology Demonstration (JCM ACTD). The neutralization thrust includes influence sweeping

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technologies for influence minefield clearance, explosive and non-explosive technologies for surf zone (SZ) mine/obstacle field breaching, and advanced technologies to rapidly neutralize shallow water (SW) sea mines.

(U) Mine Technology: The requirements for improved sea mine technologies has changed due to the reduced threat of the traditional modern submarines and surface ships. The elevated threats today are the third-world submarines and surface ships which may be encountered in the littoral waters of regional conflicts. Despite the diminished sophisticated threat, it is imperative that the US Navy maintain a broad-based and robust sea mining capability through advanced mine sensors, environmental characterization, and systems performance analysis technologies. Emphasis is placed on potentially high payoff advanced sensors for target detection and discrimination and on low cost, wide area sea mine system concepts, including positive command/control mechanisms and expanded weapon effectiveness for regional warfare.

(U) Special Warfare Technology: Naval Special Warfare (NSW) missions primarily support covert naval operations. The goal is to develop technology required to increase the combat range and effectiveness of Special Warfare units. A major current focus is to develop technologies to enhance the Sea-Air-Land mission of pre-invasion detection for clearance/avoidance of mines and obstacles in the very shallow water (VSW) and SZ approaches to the amphibious landing areas. Improvements to mission support equipment are needed to increase the probability of mission success, endurance and SEAL swimmer survivability.

(U) EOD Technology: Technology development for EOD needs addresses the DOD Joint Service and interagency responsibilities in EOD, including that required to counter and neutralize Weapons of Mass Destruction (WMD). The technologies developed are required for locating, rendering safe and disposing of Unexploded Explosive Ordnance (UXO). These operations typically occur in deep, poor-visibility water, in areas of high background noise, and in strategic operating areas contaminated by a variety of UXO. Advanced technologies are needed for gaining access to areas contaminated by sophisticated area-denial sensors and/or booby traps and for contending with WMD. These technologies are expected to transition to the Joint Service EOD Program, the Naval EOD Program or the DOD Technical Response Group.

(U) The Navy Science and Technology program includes projects that focus on or have attributes that enhance the affordability of warfighting systems.

(U) Due to the sheer volume of efforts included in this PE, the programs described in the Accomplishments and Plans sections are representative selections of the work included in this PE.

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(U) JUSTIFICATION FOR BUDGET ACTIVITY: This program is budgeted within the APPLIED RESEARCH Budget Activity because it investigates technological advances with possible applications toward solution of specific Naval problems, short of a major development effort.

(U) PROGRAM ACCOMPLISHMENTS AND PLANS:

1. (U) FY 1999 ACCOMPLISHMENTS:

- (U) MINE/OBSTACLE DETECTION:
 - (U) Acoustic Sensors: Completed analysis of performance and effectiveness of Toroidal Volume Search Sonar (TVSS), demonstrated during JCM ACTD. Demonstrated Synthetic Aperture Sonar (SAS) technology during Fleet Battle Experiment (FBE) Echo (Kernal Blitz), Mine Readiness and Effectiveness Measurement (MIREM) 9, and GOMEX99 (Gulf of Mexico Experiment). Initiated development of broadband sonar transmitter for SAS application to enhance detection/classification probabilities, area search rate, and environmental adaptability.
 - (U) Electro-Optic Sensors: Demonstrated laser line scan electro-optic identification sensor during FBE-Echo (Kernal Blitz), MIREM9, and GOMEX99. Initiated development of scene classification algorithms based on target optical properties. Begin feasibility studies to define the characteristics of an advanced electro-optic identification sensor that measures the spectral properties of mine-like objects and the surrounding scene.
 - (U) Electro-Magnetic Sensors: Completed development of thin film, High Tc superconducting gradiometer for field demonstration to investigate motion induced noise characteristics.
 - (U) Image Processing and Classification Algorithms: Completed assessment of effectiveness of multi-sensor data fusion techniques demonstrated during JCM ACTD and initiated development of improvements indicated by the assessment. Initiated development of broadband acoustic signal processing algorithms and techniques for SAS application to provide increased coverage rate, increased target image resolution, and extended sonar range. Initiated environmentally adaptive processing techniques to maintain high detection probabilities under varying and adverse environmental conditions.
- (U) MINE/OBSTACLE NEUTRALIZATION:
 - (U) Shallow Water (SW) Mine Neutralization: Initiated effort to develop technology to sweep pressure influence mines by focusing on the characterization of pressure signatures of surface ships in ocean swell.
 - (U) Surf Zone (SZ) Mine Neutralization: Expanded mine vulnerability data base to include neutralization criteria for recently developed threat mines with potential for use in the SZ and beach environments. Investigated innovative concepts for energetic neutralization of SZ mines.

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- (U) Obstacle Breaching: Determined effects of directed energy warheads against light/medium obstacles in water and air. Investigated innovative concepts for clearance or burial of SZ obstacles.
- (U) SEA MINING:
 - (U) Intelligent Mine Network: Developed hardware/software to demonstrate feasibility of Distributed Autonomous Deployed System (DADS)-weapon concept.
 - (U) Sea Mine Sensors: Completed testing of guidance sensors and signal processing for DADS-weapon in the laboratory.
 - (U) Minefield Command and Control: Completed assessment of concept for command and control of DADS weapon through simulation.
 - (U) SW Bottom Mines: Completed assessment of applicability of command and control concepts developed in prior years to SW bottom mines.
- (U) SPECIAL WARFARE/EOD:
 - (U) Mission Mobility Technology: Transitioned low signature diver propulsion technology. Develop NSW signature reduction technologies. Continued development of NSW life support equipment technologies.
 - (U) Mission Support Technology: Began integration of sensors into a diver-portable multi-sensor buried minehunter prototype. Initiated development of advanced portable real-time intelligence/sensor/marker technologies.
 - (U) Clearance of UXO: Investigated the use of broad band transmissions to jam or neutralize the electronic components of electronic safe and armed fuses. Expanded inverse scattering sensing capability of time domain electro-magnetic induction sensors to allow identification of individual buried UXO. Demonstrated a 10,000 element acoustic array that provides a 1 centimeter resolution image of an underwater target at 20 frames per second.
 - (U) Response to WMD incidents: Conducted testing of a catalyst/sensor array technique for the detection and localization of a WMD in a marine environment.
 - (U) Extending the Littoral Battlespace (ELB): Initiated development of modeling and simulation of ELB component technologies. Developed ELB Measures of Effectiveness and Measures of Performance supporting military utility assessment. Conducted integrated feasibility demonstrations.

2. (U) FY 2000 PLAN

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- (U) MINE/OBSTACLE DETECTION:
 - (U) Acoustic Sensors: Complete development of broadband sonar projector for synthetic aperture sonar to enhance detection/classification probabilities, area search rate and environmental adaptability. Integrate broadband source on existing SAS testbed for field testing. Begin field test of broadband synthetic aperture technology. Begin development of small acoustic sensors for integration on small autonomous vehicles.
 - (U) Electro-optic Sensors: Continue development of scene classification algorithms based on target optical properties. Complete feasibility studies defining characteristics of advanced, multi-spectral mine identification sensor. Initiate development of advanced electro-optic mine identification sensor.
 - (U) Electro-magnetic Sensors: Initiate field testing of thin film, high temperature superconducting gradiometer focusing on motion induced noise characterization.
 - (U) Image Processing, Classification Algorithms, and Data Fusion: Continue development of broad band processing techniques/algorithm development efforts. Continue development of environmentally adaptive processing techniques to extend detection/classification range of existing and emerging sensor systems. Initiate data fusion effort focusing on fusion of multi-platform, multi-sensor data (with initial emphasis on fusion of in-service and developmental organic sensors).
- (U) MINE/OBSTACLE NEUTRALIZATION:
 - (U) SZ Mine Neutralization: Continue development and evaluation of High Energy Low Pressure (HELP) explosive technology to promote pressure-impulse characteristics of explosives for more efficient coupling into tilt-rod mines. Transition completed mine kill criteria for new threat mines to PMS-407 in support of Distributed Explosive Technology/Shallow Water Breaching (DET/SABRE) programs. Initiate nondeterministic modeling of mine vulnerability. Initial efforts will be development of a nondeterministic model for a single mine.
 - (U) Obstacle Breaching: Initiate development of linear shaped charge array anti-obstacle technology for breaching of obstacles on the beach and in the surf. Continue development and evaluation of small unmanned bottom robotic platforms to provide reconnaissance and targeting data for mine and obstacle clearance systems. Continue developing data base for damage characteristics of obstacles on land and in the water when subjected to simultaneous and sequenced multiple bomb detonations.
- (U) SEA MINING:
 - (U) Intelligent Mine Network: Complete development of hardware/software to demonstrate feasibility of DADS weapon concept. Begin demonstration of mine network concept.
 - (U) Sea Mine Sensors: Initiate field tests of guidance sensors and signal processing for DADS weapon.

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- (U) Minefield Command and Control: Initiate development of command and control hardware/software for feasibility demonstration of minefield command and control.
- (U) SPECIAL WARFARE/EOD
 - (U) Mission Mobility: Continue development of life-support equipment technologies. Major focus will be thermal protection for extremities. Initiate effort to increase Stirling engine performance from 500 to 2000 watts. Investigate materials and methodologies to enable non-magnetic valve and actuator systems on NSW diver propulsion vehicle systems.
 - (U) Mission Support: Continue development of unmanned underwater vehicle (UUV) technologies to support VSW reconnaissance missions. Initiate development of broadband sonar technology for diver and UUV deployment. Initiate development of scannerless range imaging system for underwater applications. Continue development of underwater adhesive technologies. Initiate development of deployable virtual environment based training aid and tactical decision aid for NSW missions.
 - (U) Clearance of UXO: Initiate underwater vehicle coordination task to provide enabling technologies for heterogeneous systems of small UUVs to provide detection, classification, and identification of underwater explosive ordnance. Initiate development of robotic actuators and manipulators based on artificial muscle materials. Investigate and implement neural techniques for visual image processing and object recognition.
 - (U) Response to WMD Incidents: Evaluate concepts for detecting radiation interaction with water as a means of detecting the primary source of radiation.
 - (U) ELB: Conduct and assess integrated feasibility demonstrations of ELB technologies. Develop enhancements to battlespace network to enable real-time, seamless sensor to shooter functions. Initiate development of technologies to support near real-time operations/intelligence integration.

3.(U) FY 2001 PLAN

- (U) MINE/OBSTACLE DETECTION
 - (U) Acoustic Sensor: Complete field testing of broadband SAS technology. Document results and begin transition to PE 0603502N (Remote Minehunting System). Complete development of small acoustic sensors for integration on small autonomous vehicles. Complete laboratory testing of small acoustic sensors. Begin integration of acoustic sensors on small autonomous underwater vehicles, focusing on networking and adaptive sampling.
 - (U) Electro-Optic Sensors: Complete development of advanced, multi-spectral mine identification sensor. Initiate field testing of advanced mine identification sensor.

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- (U) Electro-magnetic Sensors: Complete field testing of thin film, low temperature superconducting gradiometer. Complete documentation of test results and begin transition of PE 0603502N (Shallow Water Mine Countermeasures).
- (U) Image Processing, Classification Algorithms, and Data Fusion: Complete development of broad band processing techniques/algorithm development efforts. Complete development of environmentally adaptive processing techniques to extend detection/classification range of existing and emerging sensor systems. Assess performance of environmentally adaptive processing techniques during mine training exercise and document results. Begin transition of environmentally adaptive techniques/algorithms to PE 0603502N (Remote Minehunting System) and AQS-20/X airborne minehunting acquisition program. Continue development of data fusion techniques/algorithms focusing on fusion of multi-platform, multi-sensor data.
- (U) MINE/OBSTACLE NEUTRALIZATION
 - (U) SZ Mine Neutralization: Demonstrate performance of HELP charge against tilt rod mines. Initiate study of vulnerability of magnetic influence mines obtained from Program Manager Naval Sea Command code SEA 407(PMS-407). Develop estimates of these mines interactions with shock and bubble loading and provide pre-test predictions in support of DET/SABRE tests. Continue nondeterministic modeling of mine vulnerability. Transition completed mine kill criteria for new threat mines to PE 0603502N in support of DET/SABRE programs.
 - (U) Obstacle Breaching: Investigate innovative concepts for clearance and burial of SZ and beach obstacles. Develop supporting technologies that are critical to accurate and affordable delivery of high explosive packages from over the horizon. Develop a methodology that will provide a reliable prediction of explosive channeling effects produced by using arrays of bombs to provide a clear path in the surf and beach and craft landing zones.
- (U) SEA MINING
 - (U) Intelligent Mine Network: Complete demonstration of mine network concept for DADS weapon.
 - (U) Sea Mine Sensors: Complete field testing of guidance sensors and signal processing algorithms. Complete documentation of field test results.
 - (U) Minefield Command and Control: Conduct field test of command and control of DADS weapon.
- (U) SPECIAL WARFARE/EOD
 - (U) Mission Mobility: Continue development of life support equipment technologies. Transition enhanced Stirling cycle engine technology to PMS-EOD for use in VSWMCM DET. Initiate efforts to develop Diver Propulsion Vehicle subsystems with lower magnetic signature.
 - (U) Mission Support: Continue development of UUV technologies to support NSW reconnaissance and mine clearance missions. Transition underwater adhesive technology to PMS-EOD. Continue development of broadband sonar

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technologies for diver and UUV deployment. Initiate development of advanced conformal side-looking acoustic sensors for diver and UUV deployment.

- (U) Clearance of UXO: Continue development of technologies to enable coordinated behavior and mission execution by unmanned underwater vehicles. Continue development of robotic manipulators and actuators based on artificial muscle materials. Initiate development of technologies to remotely jam or disable the functioning of Electronic Safed Armed fused devices.
- (U) Response to WMD Incidents: Evaluate promising techniques for detection of underwater radiation in a laboratory setting.

B. (U) PROGRAM CHANGE SUMMARY:

	FY 1999	FY 2000	FY 2001
(U) FY 2000 President's Budget:	45,496	45,022	51,008
(U) Appropriated Value:		45,022	
(U) Adjustments from FY00 PRESBUDG:			
(U) Congressional Recissions:		-249	
(U) SBIR/STTR Transfer:	-716		
(U) Various Rate Adjustments:			-144
(U) Inflation Adjustments:	-208		
(U) Execution Adjustments:	3,512		
(U) FY 2001 PRESBUDG Submission:	48,084	44,773	50,864

(U) Schedule: Not applicable.

(U) Technical: Not Applicable.

C. (U) OTHER PROGRAM FUNDING SUMMARY: Not applicable.

(U) RELATED RDT&E:

- (U) This program has strong ties to the PE's listed below:
- (U) PE 0601153N (Defense Research Sciences)
- (U) PE 0602131M (Marine Corps Landing Force Technology)

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- (U) PE 0602233N (Human Systems Technology)
- (U) PE 0602314N (Undersea Warfare Surveillance Technology)
- (U) PE 0602435N (Oceanographic and Atmospheric Technology)
- (U) PE 0602633N (Undersea Warfare Weapons Technology)
- (U) PE 0603502N (Undersea Warfare and MCM Development)
- (U) PE 0603555N (Sea Control and Littoral Warfare Technology Demonstration)
- (U) PE 0603654N (Joint Service EOD Development)
- (U) PE 0603782N (Mine and Expeditionary Warfare Advanced Technology)
- (U) PE 0604654N (Joint Service EOD Development)
- (U) PE 0603640M (Marine Corps Advanced Technology Demo)
- (U) PE 0602712A (Countermine Systems)
- (U) PE 0603606A (Landmine WF and Barrier Advanced Technology)
- (U) PE 1160401BB (Special Operation Technology Development)
- (U) PE 1160402BB (Special Operation Advanced Technology Development)

(U) This program adheres to Tri-Service Reliance Agreements on EOD with coordination provided by the Joint Directors of Laboratories.

D. (U) SCHEDULE PROFILE: Not applicable.

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