FY 2003 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2002

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602782N
PROGRAM ELEMENT TITLE: Mine and Expeditionary Warfare Applied Research

(U) COST: (Dollars in Thousands)

PROJECT NUMBER & TITLE	FY 2001 ACTUAL	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	FY 2006 ESTIMATE	FY 2007 ESTIMATE	TO COMPLETE	TOTAL PROGRAM
Mine and Expeditionary Warfare Applied Research									
	**	57,158	56,813	56,354	54,599	53,284	56,306	CONT.	CONT.

**The Science and Technology PEs were restructured in FY 2002. FY 2001 efforts were funded in PE 0602315N.

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 thrusts concentrate 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 thrust emphasizes technologies for future sea mines. The Naval Special Warfare and EOD technology thrust concentrates 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: Nations that threaten the US 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. 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 (e.g. biomimetic, broadband, synthetic aperture) for rapid minefield reconnaissance and determination of the location of individual mines and obstacles. The neutralization thrust includes influence sweeping technologies for influence minefield clearance, explosive and non-explosive

technologies for mine/obstacle field breaching, and advanced technologies to rapidly neutralize shallow water (SW) sea mines. The overall goal of the MCM technology thrust is the reduction of MCM tactical timelines and increased standoff.

(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 maintains 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 surf zone (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) Due to the number of efforts in the PE, the programs described are representative of the work included in the PE.

(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.

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B. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

1. (U) FY 2001 ACCOMPLISHMENTS:

- (U) ($30,310) MINE/OBSTACLE DETECTION: (FY 01 accomplishments were funded in PE 0602315N)

(U) Acoustic Sensor: Completed analysis of synthetic aperture sonar (SAS) Fleet Battle Experiment Hotel demonstration results showing good agreement with predicted resolution and excellent clutter rejection. Completed field-testing of broadband, low frequency synthetic aperture sonar (SAS) projector technology and integration into SAS testbed. Completed laboratory testing of small acoustic sensors. Began integration of acoustic sensors on small autonomous underwater vehicles, focusing on networking and adaptive sampling. Demonstrated the use of autonomous underwater vehicles (AUVs) technologies for bottom mapping and mine hunting in Kernal Blitz 2001, a 3rd Fleet training exercise.

(U) Electro-Optic Sensors: Initiated development of sensor and predictive model for on-scene assessment of diver visibility. Continued development of advanced, multi-spectral mine identification sensor focusing on collection of multi-spectral, mine identification data. Collected electro-optic mine ID sensor data for development and assessment of automated mine ID algorithms.

(U) Electro-magnetic Sensors: Completed laboratory testing of thin film, low temperature superconducting gradiometer. Completed documentation of test results quantifying expected performance in high speed, surface vessel operations.

(U) Image Processing, Classification Algorithms, and Data Fusion: Continued development of broad band processing techniques/algorithm focusing on the application of Hidden Markov techniques to process spectral information. Continued development of environmentally adaptive processing techniques to extend detection/classification range of existing and emerging sensor systems. Continued development of data fusion techniques/algorithms focusing on fusion of multi-platform, multi-sensor data. Initiated transition of CAD/CAC algorithms to AQS-20 airborne mine countermeasures program. Initiated the development of mine burial prediction algorithms focusing on the development of a more accurate hydrodynamic model for the prediction of impact mine burial. Completed mine burial prediction field drop experiments focusing on the hydrodynamics of falling mines.

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- (U)($8,600) MINE/OBSTACLE NEUTRALIZATION: (FY01 accomplishments were funded in PE 0602315N)
  (U) SZ Mine Neutralization: Demonstrated performance of High-Energy Low-Pressure explosive technology against tilt rod mines. Initiated study of vulnerability of magnetic influence mines obtained from Program Manager Naval Sea Systems Command (PMS-490). Developed estimates of these mines interactions with shock and bubble loading and provide pre-test predictions in support of Distributed Explosive Technology/Shallow Water Assault Breaching (DET/SABRE) tests. Continued nondeterministic modeling of mine vulnerability, extending the modeling to include chemical and reactive dart lethality.

  (U) Obstacle Breaching: Investigated innovative concepts for clearance and burial of SZ and beach obstacles. Developed supporting technologies that are critical to accurate and affordable delivery of high explosive packages from over the horizon. Developed 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. Completed assessments of sequential and simultaneous bomb detonations for obstacle clearance. Began development of segmented rod warhead concept for obstacle clearance on land.

  (U) Sea Mine Neutralization: Began development of mine jamming concepts using ship-degaussing coils. Began development of precise positional reference system using fixed land and sea beacon nodes.

- (U) ($3,000) SEA MINING: (FY01 accomplishments were funded in PE 0602315N)
  (U) Continued demonstrations of mine network concept for Distributed Autonomous Detection System (DADS) weapon. Completed field-testing of guidance sensors and signal processing algorithms. Completed documentation of field-test results. Initiated field test of command and control of DADS weapon. Continued development of command and control hardware/software for minefield control.

- (U) ($10,450) SPECIAL WARFARE/EOD: (FY01 accomplishments were funded in PE 0602315N)
  (U) Mission Mobility: Continued development of life support equipment technologies. Transitioned enhanced Stirling cycle engine technology to PMS-EOD for use in Very Shallow Water/Mine Countermeasures Detachment (VSWMCM DET). Initiated efforts to develop Diver Propulsion Vehicle subsystems with lower magnetic signature. Initiated investigation of technology options for Swimmer Delivery Vehicle (EOD) heating system. Continued autonomous search vehicle (EOD) development activities. Continued development of coordinated

behavior and mission execution by Unmanned Underwater Vehicles (UUVs) demonstrating hydrographic reconnaissance and mine hunting during Fleet Battle Experiment Hotel.

(U) Mission Support: Continued development of UUV technologies to support Naval Special Warfare reconnaissance and mine clearance missions. Transitioned underwater photo-curable adhesive technology to PMS-EOD. Continued development of broadband sonar technologies for diver and UUV deployment. Initiated development of advanced conformal side-looking acoustic sensors for diver and UUV deployment. Completed field tests and evaluation of buried mine hunting sonar.

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

(U) FY 2001 Congressional Plus-ups: Not applicable

2. (U) FY 2002 PLAN:

- (U)($35,658) MINE/OBSTACLE DETECTION:

(U) Acoustic Sensors: Initiate development of long range SAS motion compensation and beamforming. Conduct low frequency, broadband SAS field tests to acquire data for concept assessment and development of processing algorithms. Begin integration of low frequency, broadband SAS hardware onto an Autonomous Underwater Vehicle (AUV). Demonstrate the employment of reconnaissance and mine hunting autonomous underwater vehicles from a High Speed Vessel during Fleet Battle Experiment-Juliet.

(U) Electro-optic Sensors: Initiate real-time processing for airborne LIDAR/multi-spectral minefield detection. Initiate collection/characterization of active/passive electro-optic mine signature data in coastal marine environments. Complete development of high pulse rate laser for minefield detection. Refine optical performance predictive model for on-scene assessment of diver visibility. Begin transition of sensor and predictive model for on-scene assessment of diver visibility.

(U) Image Processing, Classification Algorithms, and Data Fusion: Initiate development of environmental tactical decision aids. Initiate modeling and simulation for adaptive planning of amphibious operations. Continue development of environmentally adaptive processing techniques to extend detection/classification range of existing and emerging sensor systems. Continue development and refinement of automated mine identification algorithms. Initiate transition of automated mine identification algorithms to AQS-20/X airborne mine countermeasures program. Complete the transition of CAD/CAC algorithms to AQS-20 airborne mine countermeasures program. Refine broad band processing techniques/algorithms using at sea data acquired from low frequency, broadband SAS field-testing. Continue development of mine burial prediction algorithms, focusing on scour modeling and the incorporation of oceanographic data. Conduct mine burial prediction field experiment focusing on burial by wave induced scour.

- (U) ($9,900) MINE/OBSTACLE NEUTRALIZATION:
  (U) SZ Mine Neutralization: Extend mine vulnerability database to include damage from reactive and chemical darts for beach zone mines. Initiate development of computational tools to be used to predict the performance of dart dispenser mechanisms. Initiate development of a sand penetration model to be used to predict the performance of darts and fragments against buried mines. Initiate assessment of chemical and reactive dart lethality against common SZ and beach zone (BZ) mines.

  (U) Obstacle Breaching: Complete the assessment of explosive channeling as a mechanism for clearing mines and obstacles in the surf zone. Complete the development of the Surface Neutralization Bomblets (SNUBs) concept for obstacle clearance. Conduct initial analysis of the effectiveness of segmented rod warhead against light and beach obstacles. Initiate development of a fragmenting warhead concept for mine and obstacle clearance.

  (U) Sea Mine Neutralization: Initiate development of advanced laser targeting for Rapid Airborne Mine Clearance System (RAMICS). Conduct field test to determine accuracy, required self-survey time, and temporal stability of precise positional reference system using fixed land and sea beacon nodes. Conduct field demonstration and initiate assessment of mine jamming concepts utilizing ship-degaussing coils.

- (U) ($1,200) SEA MINING:
  (U) Complete analysis/documentation of guidance sensors and signal processing field tests.

Complete development of command and control hardware/software for minefield control. Field-test the command and control of DADS weapon.

- (U)($10,400) SPECIAL WARFARE/EOD

(U) Mission Mobility: Continue development of life support equipment technologies.

(U) Mission Support: Initiate development of hyperspectral polarometer prototype. Continue development of UUV technologies to support VSW reconnaissance missions. Continue development of virtual environment-based training aid and tactical decision aids for NSW missions. Complete field tests of synthetic aperture sonar integrated on a UUV. Begin development of onboard synthetic aperture sonar processing for AUV integration. Complete field tests of diver portable high frequency imaging sonar.

(U) Clearance of UXO: Continue development of technologies to enable coordinated behavior and mission execution by unmanned underwater vehicles. Complete development of robotic manipulators and actuators based on artificial muscle materials. Continue development of technologies to remotely jam or disable the functioning of Electronic Safed Armed fused devices.

3. (U) FY 2003 PLAN:

- (U)($38,113) MINE/OBSTACLE DETECTION

(U) Acoustic Sensors: Complete integration of low frequency, broadband SAS hardware onto AUV. Conduct initial at sea testing to quantify performance and collect data to refine low frequency, broadband-processing techniques. Complete development and assess performance of long range SAS motion compensation and beamforming techniques using existing SAS field data. Begin development of obstacle avoidance sonar for AUVs. Demonstrate autonomous reconnaissance and mine hunting technologies during Fleet exercise such as Kernal Blitz 2003.

(U) Electro-optic Sensors: Complete the collection and characterization of active/passive electro-optic mine signature data in coastal marine sediments. Refine real-time processing algorithms for airborne LIDAR/multi-spectral minefield detection utilizing active/passive signature data. Demonstrate day/night airborne reconnaissance of minefields during a fleet exercise such as Kernal Blitz 2003. Complete transition of optical sensor and predictive model for on-scene assessment of diver visibility.

(U) Image Processing, Classification Algorithms, and Data Fusion: Complete the transition of automated mine identification algorithms to AQS-20/X airborne mine countermeasures program. Complete refinement of automated mine identification algorithms. Continue development of environmental tactical decision aids, focusing on the near shore environment. Continue modeling and simulation for adaptive planning of amphibious operations. Begin integration of mine burial predictive models into expert system tactical decision aid.

- (U)($9,100) MINE/OBSTACLE NEUTRALIZATION
  (U) SZ Mine Neutralization: Complete model development of shock interaction and propagation through the seabed. Complete assessment of chemical dart lethality against common SZ and BZ mines. Complete development of computational tools to be used to predict the performance of dart dispenser mechanisms. Begin assessment of performance of dart dispenser mechanisms. Complete development of dart and fragment sand penetration model. Expand mine vulnerability database to include damage from reactive and chemical darts against surf zone mines.

  (U) Obstacle Breaching: Complete analysis of the effectiveness of segmented rod warhead against light and medium beach obstacles. Complete development of a fragmenting warhead concept for mine and obstacle clearance. Continue assessment of advanced obstacle breaching technologies.

  (U) Sea Mine Neutralization: Continue development of advanced laser targeting and initiate development of advanced fire control algorithms for (RAMICS). Complete development of precise positional reference system using fixed land and sea beacon nodes. Complete assessment of mine jamming concepts utilizing ship-degaussing coils.

- (U)($1,100) SEA MINING
  (U) Initiate development of advanced sea mine concepts. Initiate technology assessment of advanced target detection and tracking sensors and algorithms.

- (U)($8,500) SPECIAL WARFARE/EOD
  (U) Mission Mobility: Continue development of life support equipment technologies.

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(U) Mission Support: Continue development of hyperspectral polarometer prototype. Begin development of optimized search strategies for multiple, cooperating AUVs for reconnaissance. Continue development of AUV sensing, communications, and navigation technologies to support VSW reconnaissance missions. Begin integration of embedded synthetic aperture processing into AUV to communicate target information to a control authority. Complete development of virtual environment-based training aid and tactical decision aids for NSW missions.

(U) Clearance of UXO: Continue development of technologies to enable coordinated behavior and mission execution by unmanned underwater vehicles. Begin development of advanced robotic mobility actuators. . Initiate advanced robotic search strategies. Complete development of technologies to remotely jam or disable the functioning of Electronic Safed Armed fused devices.

C. (U) PROGRAM CHANGE SUMMARY:

	FY 2001	FY 2002	FY 2003
FY 2002 President's Budget	**	57,668	
Adjustments from FY 02 PRESBUDG:			
Section 8123 Management Reform Initiative		-510	
FY 2003 President's Budget Request:	**	57,158	56,813

**The Science and Technology PEs were restructured in FY 2002. FY 2001 efforts were funded in PE 0602315N.

(U) PROGRAM CHANGE SUMMARY EXPLANATION:

(U) Schedule: Not Applicable
(U) Technical: Not Applicable

D. (U) OTHER PROGRAM FUNDING SUMMARY:

(U) RELATED RDT&E:

(U) NAVY RELATED RDT&E:
(U) PE 0601153N (Defense Research Sciences)

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(U) PE 0602131M (Marine Corps Landing Force Technology)
(U) PE 0602435N (Ocean Warfighting Environment Applied Research)
(U) PE 0603502N (Surface and Shallow Water Mine Countermeasures)
(U) PE 0603654N (Joint Service Explosive Ordnance Development)
(U) PE 0603782N (Mine and Expeditionary Warfare Advanced Technology)
(U) PE 0604654N (Joint Service Explosive Ordnance Development)
(U) PE 0603640M (Marine Corps Advanced Technology Demo)

(U) NON NAVY RELATED RDT&E:
(U) PE 0602712A (Countermine Systems)
(U) PE 0603606A (Landmine WF and Barrier Advanced Technology)
(U) PE 1160401BB (Special Operations Technology Development)
(U) PE 1160402BB (Special Operations Advanced Technology Development)

E. (U) SCHEDULE PROFILE: not applicable