

# UNCLASSIFIED

FY 2000 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 1999

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 1998 ACTUAL	FY 1999 ESTIMATE	FY 2000 ESTIMATE	FY 2001 ESTIMATE	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	TO COMPLETE	TOT PROG
00000	35,221	45,496	45,022	51,008	52,104	53,285	54,542	55,837	CONT.	CON

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 of 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) 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.

(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 (ACTD). The neutralization thrust includes influence sweeping 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.

R-1 Line Item 13

Budget Item Justification  
(Exhibit R-2, page 1 of 9)

# UNCLASSIFIED

# UNCLASSIFIED

FY 2000 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

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BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602315N

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

(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 will be 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, with 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 (SEAL) 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) 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 1998 ACCOMPLISHMENTS:

- (U) (\$18,756) MINE/OBSTACLE DETECTION:
  - (U) Acoustic Sensors: Completed integration of Toroidal Volume Search Sonar (TVSS) and Synthetic Aperture Sonar (SAS) acoustic minehunting sensor modules into remote underwater sensor platform for Joint Countermine (JCM)

R-1 Line Item 13

Budget Item Justification  
(Exhibit R-2, page 2 of 9)

# UNCLASSIFIED

# UNCLASSIFIED

FY 2000 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 1999

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602315N

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

ACTD demonstration of sea mine detection, classification, and identification. Conducted at-sea testing of TVSS and SAS integrated sensor modules. Demonstrated acoustic sensors during the JCM ACTD as part of MARCOT98/Unified Spirit (combined Canadian/NATO exercise). Continued development of advanced SAS and Side Looking Sonar beamforming techniques focusing on phase compensation for motion and environmentally induced errors.

- (U) Electro-Optic Sensors: Completed sensor performance prediction model for optical mine identification system that included the spectral characteristics of mine-like targets. Completed integration of Laser Line Scan mine identification sensor into Remote underwater platform for demonstration during the Joint Countermine ACTD. Successfully deployed laser line scan and synthetic aperture sonar sensors during SwissAir crash site investigation, providing identification of sonar contacts of interest. Continued development of fluorescence imaging for mine identification focusing on the characterization of target/background spectral content.
- (U) Electro-Magnetic Sensors: Completed development of thin film, single channel Low Temperature Critical(Tc) superconducting gradiometer test article. Completed investigation of motion-induced noise and radio frequency immunity. Continued to develop thin film, High Tc superconducting gradiometer fabrication technology to a level of maturity comparable to the thin film, Low Tc counterpart.
- (U) Image Processing and Classification Algorithms: Developed improved multi-sensor data fusion and compression techniques to provide real-time processing and data transmission from the remote underwater sensor platform to the "mother ship" for information assimilation and display. Completed integration of real-time processing algorithms on embedded processor and demonstrated as part of the JCM ACTD, real-time mine detection, classification, and identification.
- (U) (\$6,180) MINE/OBSTACLE NEUTRALIZATION:
  - (U) SW Mine Neutralization: Transitioned anti-mine projectile for the Rapid Airborne Mine Clearance System concept to an Advanced Technology Transition Project (PE 0603792N).
  - (U) SZ Mine Neutralization: Established through precise tests and measurements the importance of relative flow between sand and mine-like targets on shock transmission and mine kill predictions in the SZ environment. Continued expanding database of mine neutralization criteria (pressure, impulse, energy) for threat mines through testing and analysis.
  - (U) Obstacle Breaching: Developed an analytical model from parametric studies with the finite concrete model which will allow tradeoffs of warhead size, shape, and standoff required to defeat various target shapes and configurations. Improved obstacle clearance models by incorporating results of simultaneous and sequential detonation testing. Initiated development of technologies required for precise standoff bomb delivery for mine and obstacle clearance.
- (U) (\$2,860) SEA MINING:

R-1 Line Item 13

Budget Item Justification  
(Exhibit R-2, page 3 of 9)

# UNCLASSIFIED

# UNCLASSIFIED

FY 2000 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 1999

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602315N

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

- (U) Intelligent Mine Network: Developed Distributed Autonomous Deployed System (DADS) mobile shallow water mine (DADS-weapon) concept. Develop covert deployment concept based upon Submarine Launched Mobile Mine. Developed concepts for "restart" of deployed mobile mine for target attack, communications with DADS during target attack mode, and terminal guidance.
- (U) Sea Mine Sensors: Initiated development of guidance sensors and signal processing for DADS mobile shallow water mines.
- (U) Minefield Command and Control: Initiated development of concept for command and control of DADS weapons. Conducted assessment of minefield command and control incorporating prior year developments of Indication Friend or Foe and Remote Control into DADS. Initiated development of concept for intra-field guidance of DADS weapon after launch using node and weapon sensors.
- (U) (\$7,425) SPECIAL WARFARE/Explosive Ordnance Disposal (EOD):
  - (U) Mission Mobility Technology: Completed development of components of low signature diver propulsion system; integrated, tested and evaluated prototype. Transitioned technology for incorporating micro Phase Change Materials into dive suits for passive, thermal protection. Developed NSW life support equipment technologies. Options for life support equipment technologies include passive in-water chemical detectors, advanced Carbon Dioxide scrubbing technology, diver internal monitoring/biofeedback, field oxygen supply technologies.
  - (U) Mission Support Technology: Fabricated, evaluated and demonstrated prototype of passive multispectral optical parametric amplification laser imager. Conducted field tests of sensors for use in a diver-portable multi-sensor buried minehunter; developed algorithms to process and display signals. Transitioned clandestine ultra-short range gate laser technology for underwater obstacle localization/identification.
  - (U) Clearance of UXO: Demonstrated a capability to determine the status of electronic safe and armed fuses from a standoff distance due to unintentional or stimulated emissions from the firing train components. Demonstrated a small, autonomous, untethered underwater vehicle controls and sensors for identification of naval threats hosted on a composite vehicle built by Lockheed-Martin under Independent Research & Development funding.

2. (U) FY 1999 PLAN:

- (U) (\$21,486) MINE/OBSTACLE DETECTION:
  - (U) Acoustic Sensors: Complete analysis of performance and effectiveness of TVSS and SAS, demonstrated during JCM ACTD, for detection and classification of sea mines. Initiate development of broadband sonar transmitter for SAS application to enhance detection/classification probabilities, area search rate, and environmental adaptability.
  - (U) Electro-Optic Sensors: Initiate 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.

R-1 Line Item 13

Budget Item Justification  
(Exhibit R-2, page 4 of 9)

# UNCLASSIFIED

# UNCLASSIFIED

FY 2000 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 1999

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602315N

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

- (U) Electro-Magnetic Sensors: Complete development of thin film, High Tc superconducting gradiometer for field demonstration to investigate motion induced noise characteristics.
- (U) Image Processing and Classification Algorithms: Assess effectiveness of multi-sensor data fusion techniques demonstrated during JCM ACTD and initiate development of improvements indicated by the assessment. Initiate 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. Initiate environmentally adaptive processing techniques to maintain high detection/classification probabilities under varying and adverse environmental conditions.
- (U) (\$7,548) MINE/OBSTACLE NEUTRALIZATION:
  - (U) SW Mine Neutralization: Initiate effort to develop technology to sweep pressure influence mines by focusing on the characterization of pressure signatures of surface ships in ocean swell.
  - (U) SZ Mine Neutralization: Expand mine vulnerability data base to include neutralization criteria for recently developed threat mines with potential for use in the SZ and beach environments. Investigate innovative concepts for energetic neutralization of SZ mines.
  - (U) Obstacle Breaching: Determine effects of directed energy warheads against light/medium obstacles in water and air. Investigate innovative concepts for clearance or burial of SZ obstacles.
- (U) (\$2,975) SEA MINING:
  - (U) Intelligent Mine Network: Develop hardware/software to demonstrate feasibility of DADS-weapon concept.
  - (U) Sea Mine Sensors: Test guidance sensors and signal processing for DADS-weapon in the laboratory.
  - (U) Minefield Command and Control: Test concept for command and control of DADS weapon through simulation.
  - (U) SW Bottom Mines: Assess application of sensors and command and control concepts developed in prior years to SW bottom mines.
- (U) (\$12,854) SPECIAL WARFARE/EOD:
  - (U) Mission Mobility Technology: Transition low signature diver propulsion technology. Develop NSW signature reduction technologies. Continue development of NSW life support equipment technologies.
  - (U) Mission Support Technology: Integrate sensors into a diver-portable multi-sensor buried minehunter prototype and evaluate/demonstrate under realistic field conditions. Transition multispectral optical parametric amplification laser imaging technology. Develop advanced portable real-time intelligence/sensor/marker technologies. Options for intelligence/sensor technology developments include passive millimeter wave sensor, infrared polarimetry, sonar classification using echo back scatter, sensor fusion/processing, etc.
  - (U) Clearance of UXO: Investigate the use of broad band transmissions to jam or neutralize the electronic components of electronic safe and armed fuses. Expand the inverse scattering sensing capability of time domain

R-1 Line Item 13

Budget Item Justification  
(Exhibit R-2, page 5 of 9)

# UNCLASSIFIED

# UNCLASSIFIED

FY 2000 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 1999

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602315N

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

electro-magnetic induction sensors to allow identification of individual buried UXO. Demonstrate 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: Perform 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): Initiate development of modeling and simulation of ELB component technologies. Develop ELB Measures of Effectiveness and Measures of Performance supporting military utility assessment. Conduct and assess integrated feasibility demonstrations.
- (U) (\$633) Portion of extramural program reserved for Small Business Innovation Research assessment in accordance with 15 USC 638.

3. (U) FY 2000 PLAN

•(U) (\$21,107) 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) (\$7,650) MINE/OBSTACLE NEUTRALIZATION:
    - (U) SZ Mine Neutralization: Continue development and evaluation of HELP (High Energy Low Pressure) 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

R-1 Line Item 13

Budget Item Justification  
(Exhibit R-2, page 6 of 9)

# UNCLASSIFIED

# UNCLASSIFIED

FY 2000 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 1999

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602315N

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

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) (\$3,000) 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.
  - (U) Minefield Command and Control: Initiate development of command and control hardware/software for feasibility demonstration of minefield command and control.
  
- (U) (\$13,265) 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.

B. (U) PROGRAM CHANGE SUMMARY:

R-1 Line Item 13

Budget Item Justification  
(Exhibit R-2, page 7 of 9)

# UNCLASSIFIED

# UNCLASSIFIED

FY 2000 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 1999

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602315N

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

	FY 1998	FY 1999	FY 2000
(U) FY 1999 President's Budget:	41,451	45,928	45,264
(U) Appropriated Value:		45,928	
(U) Adjustments from FY 1999 PRESBUDG:	-6230	- 432	- 242
(U) FY 2000 President's Submission:	35,221	45,496	45,022

(U) CHANGE SUMMARY EXPLANATION:

(U) Funding: The FY 1998 reduction consists of Small Business Innovation Research (-1,415), and Actual Execution Update(-4,815). The FY 1999 reduction consists of Revised Economic Assumptions (-106), Civilian Personnel Underexecution (-51), Contract Advisory and Assistance (-221),and FFRDC Distribution (-54). The FY 2000 reflects NWCF Adjustment of (+265), CIVPERS (+144) and Non Pay Inflation (-651).

(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)

(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 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.

R-1 Line Item 13

Budget Item Justification  
(Exhibit R-2, page 8 of 9)

# UNCLASSIFIED

# UNCLASSIFIED

FY 2000 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 1999

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602315N

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

D. (U) SCHEDULE PROFILE: Not applicable.

R-1 Line Item 13

Budget Item Justification  
(Exhibit R-2, page 9 of 9)

# UNCLASSIFIED