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FY 2004/2005 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET
Exhibit R-2

DATE: February 2003

BUDGET ACTIVITY: 2 PROGRAM ELEMENT: 0602782N
PROGRAM ELEMENT TITLE: Mine and Expeditionary Warfare Applied Research

COST: (Dollars in Thousands)

PROJECT NUMBER/ TITLE	FY 2002 ACTUAL	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	FY 2006 ESTIMATE	FY 2007 ESTIMATE	FY 2008 ESTIMATE	FY 2009 ESTIMATE
Mine and Expeditionary Warfare Applied Research	54,379	55,531	47,490	48,315	47,692	50,431	51,345	52,329

A. MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: This 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 Capability Objectives through the development of technologies to achieve military objectives 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 the Organic Mine Countermeasures Future Naval Capability (OMCM FNC) supporting Ship to Objective Maneuver (STOM). These include technologies for clandestine minefield surveillance and reconnaissance, organic ship 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. Within the Naval Transformation Roadmap, this investment will achieve one of three "key transformational capabilities" required by "Sea Shield" as well as technically enable the "STOM key transformational capability" within "Sea Strike".

Due to the number of efforts in this PE, the programs described herein are representative of the work included in this PE.

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B. PROGRAM CHANGE SUMMARY:

	FY 2002	FY 2003	FY 2004	FY 2005
FY 2003 President's Budget Submission:	57,158	56,813	56,354	54,599
Adjustments from FY 2003 President's Budget:				
NWCF Rate Adjustment			-105	-2
SBIR Reduction	-721			
Execution Adjustment	-1,780			
Congressional Rescissions/Adjustments/Undist Reductions	-278	-680		
Efficiencies at NWCF Activities			-614	-641
S & T Program Adjustments			-7,049	-4,599
Inflation Adjustments		-602	-1,096	-1,042
FY 2004/2005 President's Budget Submission:	54,379	55,531	47,490	48,315

PROGRAM CHANGE SUMMARY EXPLANATION:

Schedule: Not applicable
Technical: Not applicable

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PROJECT NUMBER/ TITLE	FY 2002 ACTUAL	FY2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	FY 2006 ESTIMATE	FY 2007 ESTIMATE	FY 2008 ESTIMATE	FY 2009 ESTIMATE
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Mine and Expeditionary Warfare Applied Research

54,379	55,531	47,490	48,315	47,692	50,431	51,345	52,329
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A. MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: This project 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 Capability Objectives through the development of technologies to achieve military objectives with minimal casualties and collateral damage. The project 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 effort 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 ship self-protection, organic minehunting, neutralization/breaching and clearance. The sea mining effort emphasizes technologies for future sea mines. The Naval Special Warfare and EOD technology effort concentrates on the development of technologies for near-shore mine/obstacle detection and clearance, mobility and survivability, as well as explosive ordnance disposal. Within the Naval Transformation Roadmap, this investment will achieve one of three key transformational capabilities required by "Sea Shield" as well as technically enable the "STOM key transformational capability" within "Sea Strike".

B. ACCOMPLISHMENTS/PLANNED PROGRAM:

	FY 02	FY 03	FY 04	FY 05
Mine/Obstacle Detection	33,663	34,260	32,550	31,177

Nations that threaten the US have the capability to procure, stockpile and rapidly deploy, throughout the littoral battlespace, all types of naval mines, including new generation mines that have sophisticated performance characteristics. Advanced technologies are required to rapidly detect and neutralize all mine types, from deep water to the beach. The activity 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,

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broadband, synthetic aperture, multi/hyperspectral) for rapid minefield reconnaissance and determination of the location of individual mines and obstacles.

FY 2002 ACCOMPLISHMENTS:

- **Acoustic Sensors:** Demonstrated the employment of reconnaissance and mine hunting autonomous underwater vehicles (AUVs) from a High Speed Vessel and mine countermeasures ship as part of spiral development for Fleet Battle Experiment Juliet. Demonstrated reacquisition of AUV detected contacts by a mine countermeasures ship sonar. Demonstrated reconnaissance and mine hunting autonomous underwater vehicles (AUVs) from a High Speed Vessel during Fleet Battle Experiment Joliet, demonstrating long endurance (15 hours) autonomous operation. Initiated development of forward looking sonar for AUV obstacle avoidance. Conducted low frequency, broadband synthetic aperture sonar (SAS) field tests to acquire data for concept assessment and development of processing algorithms. Initiated development of long range SAS motion compensation and beamforming. Began integration of low frequency, broadband SAS hardware onto an Autonomous Underwater Vehicle (AUV). Initiated development of buried mine classification sensor.
- **Electro-optic Sensors:** Initiated collection/characterization of active/passive electro-optic mine signature data in coastal marine environments. Initiated real-time processing for airborne laser ranging/multi-spectral minefield detection (LIDAR). Completed development of high pulse rate laser for minefield detection. Refined optical performance predictive model for on-scene assessment of diver visibility. Began transition of sensor and predictive model for on-scene assessment of diver visibility.
- **Image Processing, Classification Algorithms, and Data Fusion:** Initiated transition of automated mine identification algorithms to AQS-20A airborne mine countermeasures program. Continued development and refinement of automated mine identification algorithms. Initiated development of environmental tactical decision aids. Continued development of environmentally adaptive processing techniques to extend detection/classification range of existing and emerging sensor systems. Refined broad band processing techniques/algorithms using at sea data acquired from low frequency, broadband SAS field-testing. Continued development of mine burial prediction algorithms, focusing on scour modeling and the incorporation of oceanographic data. Conducted mine burial prediction field experiment focusing on burial by wave induced scour. Developed a threat evaluation software module to accurately estimate the threat posed to transiting ships by multiple threat mine types in multiple lanes. Initiated development of an automated deconfliction manager for use during ship to shore mission planning.

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FY 2003 PLANS:

- **Acoustic Sensors:** Demonstrate autonomous reconnaissance and mine hunting technologies, during Fleet exercise such as Transparent Hunter 2003, focusing on multiple cooperating vehicles. Continue development of obstacle avoidance sonar for AUVs. Complete development and assess performance of long range SAS motion compensation and beamforming techniques using existing SAS field data. Complete integration of low frequency, broadband SAS hardware onto AUV. Conduct at sea testing to quantify performance and collect data to refine low frequency, broadband-processing techniques. Continue development of buried mine classification sensor. Begin to address AUV integration issues for buried mine classification sensor.
- **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. Complete and validate electro-optic identification (EOID) system performance models.
- **Image Processing, Classification Algorithms, and Data Fusion:** Complete refinement of automated mine identification algorithms. Complete the transition of automated mine identification algorithms to AQS-20A airborne mine countermeasures program. Begin long-range, automated target recognition physics-based algorithms for Synthetic Aperture Sonar. Begin integration of mine burial predictive models into expert system tactical decision aid and demonstrate model in large experiment.

FY 2004 PLANS:

- **Acoustic Sensors:** Continue development and demonstration of autonomous reconnaissance and mine hunting technologies focusing on multiple cooperating vehicles. Complete development of obstacle avoidance sonar for AUVs. Complete SAS algorithm development for long-range, multi-path environment. Continue data collection to refine low frequency broadband processing techniques. Continue development of obstacle avoidance sonar and real-time path planning algorithms. Begin development of compact low frequency, broadband projector, improved low frequency, broadband synthetic aperture receiver and post mission analysis tool for AUV system integration. Begin integration of buried mine classification sensor into an AUV.
- **Electro-optic Sensors:** Demonstrate validity and utility of EOID system performance models and diver visibility models during a fleet exercise. Continue the development of active/passive electro-optic image processing and modeling to support Rapid Overt Airborne Reconnaissance - including factoring in results of the previous phenomenology studies in the Surf Zone (SZ) and Beach Zone (BZ).
- **Image Processing, Classification Algorithms, and Data Fusion:** Continue development of SAS physics-based algorithms for automated target recognition at long ranges. Complete the incorporation of mine burial model code into expert system and Mine Warfare Decision Aids Library (MEDAL); conduct major burial experiments at Martha's Vineyard.

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FY 2005 PLANS:

- **Acoustic Sensors:** Complete data collection to refine low frequency broadband processing techniques. Complete development of obstacle avoidance sonar and real-time path planning algorithms for UUVs. Complete development of compact broadband projector, improved broadband synthetic aperture receiver and post mission analysis tool for AUV system integration. Demonstrate autonomous reconnaissance and minehunting technologies, specifically broadband low frequency sonar, during fleet exercise. Initiate multi-static AUV-based minehunting system development integrating navigation, communication and sensor elements. Complete integration of buried mine classification sensor into AUV. Begin field trials of buried mine classification.
- **Electro-optic Sensors:** Transition of EOID system performance models and sensors and models for on-scene assessment of diver visibility. Continue development of systems and algorithms for airborne detection of buried land minefields in anticipation of a major demonstration in FY 07.
- **Image Processing, Classification Algorithms, and Data Fusion:** Continue development of SAS physics-based algorithms for automated target recognition at long ranges. Initiate effort to fuse data from magnetic and acoustic sensors to enhance probability of classification (Pc) and reduce false alarm rate for buried minehunting. Transition mine burial expert system to the Naval Oceanographic Office.

	FY 02	FY 03	FY 04	FY 05
Mine/Obstacle Neutralization	9,539	9,398	4,200	5,800

This activity 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 these first two activities is to reduce mine countermeasures (MCM) tactical timelines and increase standoff.

FY 2002 ACCOMPLISHMENTS:

- **Surf Zone (SZ) Mine Neutralization:** Initiated development of computational tools to be used to predict the performance of dart dispenser mechanisms. Initiated development of a sand penetration model to be used to predict the performance of darts and fragments against buried mines. Extended mine vulnerability database to include damage from reactive and chemical darts for beach zone mines. Initiated assessment of chemical and reactive dart lethality against common SZ and beach zone (BZ) mines. Began analysis of assault lane navigation system by conducting field test to determine accuracy, required self-survey time, and temporal stability using fixed land and sea beacon nodes.
- **Obstacle Breaching:** Completed the assessment of explosive channeling as a mechanism for clearing mines and obstacles in the surf zone. Continued the development of the Surface Neutralization

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Bomblets (SNUBs) concept for obstacle clearance. Conducted initial analysis of the effectiveness of segmented rod warhead against light and beach obstacles. Initiated development of a fragmenting warhead concept for mine and obstacle clearance.

- Sea Mine Neutralization: Initiated mine jamming concept utilizing ship-degaussing coils. Conducted field demonstration and initiated assessment of mine jamming concepts utilizing mine countermeasures vessel (MCMV) ship-degaussing coils during a NATO exercise.

FY 2003 PLANS:

- SZ Mine Neutralization: Continue development of computational tools to be used to predict the performance of dart dispenser mechanisms. Continue development of dart and fragment sand penetration model. Continue to expand mine vulnerability database to include damage from reactive and chemical darts against surf zone mines. Continue assessment of dart lethality against SZ and BZ mines with an emphasis on chemical, reactive, and explosive fills. Continue assault lane navigation system analysis and perform feasibility demonstration of precise positional reference system using fixed land and sea beacon nodes. Assess advanced standoff mine neutralization technologies.
- Obstacle Breaching: Continue analysis of the effectiveness of segmented rod warhead against light and medium beach obstacles. Continue development of a fragmenting warhead concept for mine and obstacle clearance. Continue assessment of advanced obstacle breaching technologies.
- Sea Mine Neutralization: Complete assessment of mine jamming concepts utilizing MCMV ship-degaussing coils.

FY 2004 PLANS:

- SZ Mine Neutralization: Continue assessment of dart dispenser concepts using advanced computational tools and engineering level models. Complete development of a penetration model for projectiles and fragments - emphasis on sand. Continue development of mine vulnerability database - emphasis on kinetic damage, shock, blast and thermal effects. Continue assessment of advanced mine neutralization technologies - emphasis on standoff weapons. Initiate development of mine vulnerability code for surf zone (SZ) and beach zone (BZ) mines.
- Obstacle Breaching: Complete development of segmented rod warhead for light and medium obstacles. Continue development of computational tools for the assessment of advanced obstacle breaching technologies - emphasis on standoff weapons e.g. continuous rod warhead (CRW) and guided bombs. Initiate development of advanced computational model to simulate guided bombs in the surf zone against light and medium obstacles.

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- Sea Mine Neutralization: Begin application of mine jamming concepts utilizing ship-degaussing coils to steel hulled vessels.

FY 2005 PLANS:

- SZ Mine Neutralization: Continue development of the mine vulnerability database for kinetic damage, shock, blast and thermal effects. Continue assessment of advanced standoff mine neutralization technologies. Continue development of a mine vulnerability code for surf zone (SZ) and beach zone (BZ) mines.
- Obstacle Breaching: Continue development of advanced computational tools to explore continuous rod warhead (CRW) and guided bomb technologies. Complete development of an advanced computational model to simulate guided bombs in the surf zone against light and medium obstacles. Continue assessment of advanced standoff obstacle breaching technologies.
- Sea Mine Neutralization: Initiate development of advanced laser targeting and advanced fire control algorithms for Rapid Airborne Mine Clearance System (RAMICS), focusing on deeply submerged targets of interest. Conduct demonstration and assessment of mine jamming utilizing ship-degaussing coils during a fleet exercise.

	FY 02	FY 03	FY 04	FY 05
Mine Technology:	1,156	200	200	200

The requirement for improved sea mine technologies stems from a threat from third world submarines and surface ships, which may be encountered in the littoral waters. 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.

FY 2002 ACCOMPLISHMENTS:

- Completed analysis/documentation of guidance sensors and signal processing field tests. Completed development of command and control hardware/software for minefield control. Field-tested the command and control of Distributed Advanced Deployable System (DADS) weapon.

FY 2003 PLANS:

- Initiate and complete development of mining assessment tools. Initiate assessment of advanced sea mine technologies focusing on remote control and warhead concepts for increased effectiveness.

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FY 2004 PLANS:

- Continue assessment of advanced sea mine technologies focusing on remote control and warhead concepts for increased effectiveness.

FY 2005 PLANS:

- Initiate assessment of advanced sea mine technologies focusing on target classification, tracking and fire control from networked, distributed mine sensors.

	FY 02	FY 03	FY 04	FY 05
Special Warfare/EOD	10,021	11,673	10,540	11,138

Naval Special Warfare (NSW) missions primarily support covert near-shore 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. Technology developments for Explosive Ordnance Disposal (EOD) address DOD Joint Service and interagency responsibilities. The technologies are required for locating, rendering safe and disposing of Unexploded Explosive Ordnance (UXO) and those required to counter and neutralize Weapons of Mass Destruction (WMD). EOD 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. These technologies are expected to transition to the Joint Service EOD Program, the Naval EOD Program or the DOD Technical Response Group.

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FY 2002 ACCOMPLISHMENTS:

- NSW/EOD Sensor Technology: Completed fabrication of diver portable dual frequency lens sonar. Continued development of hyperspectral polarometer prototype. Continued development of small synthetic aperture sonar for UUV deployment. Continued development of digital beamformer architecture for high frequency imaging sonar. Continued development of shallow water real time imaging polarometer. Completed development of technologies to remotely jam or disable the functioning of Electronic Safed Armed fused devices. Continued development of short range sensors for UUV reconnaissance of surf zone. Continued development of a pulsed elemental analysis with neutrons system for identification of filler material in improvised explosive devices.
- NSW/EOD Mission Support Technology: Completed analysis of mass transfer characteristics for catalyst free CO2 scrubber. Continued development of life support equipment technologies. Initiated development of miniature CO2 sensor. Initiated development of passively controlled rebreather. 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. Continued development of virtual environment-based training aid and tactical decision aids for NSW missions. Continued development of unmanned underwater vehicle (UUV) technologies to support VSW and SZ reconnaissance missions. Began investigation of methods to increase service lifetime of underwater adhesives.

FY 2003 PLANS:

- NSW/EOD Sensor Technology: Complete development of shallow water real time imaging polarometer. Complete development of small synthetic aperture sonar for UUV deployment. Complete development of hyperspectral polarometer prototype. Continue development of digital beamformer architecture for high frequency imaging sonar. Perform field tests on dual frequency lens sonar. Continue development of short range sensors for UUV reconnaissance of surf zone. Continue development of a pulsed elemental analysis with neutrons system for identification of filler material in improvised explosive devices. Initiate development of standoff detection and classification sensors for surface and buried UXO using multi-dimensional electro-magnetic (EM) methods.
- NSW/EOD Mission Support Technology: Continue development of robotic manipulators and actuators based on artificial muscle materials. Continue development of life support equipment technologies. Continue development of miniature CO2 sensor. Continue development of passively controlled rebreather. Continue development of virtual environment-based training aid and tactical decision aids for NSW missions. Continue development of UUV technologies to support VSW reconnaissance missions. Complete development of technologies to enable coordinated behavior and mission execution

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by unmanned underwater vehicles. Proceed with development of extended lifetime underwater adhesives. Begin investigation of technology alternatives for next generation Seal Delivery Vehicle.

FY 2004 PLANS:

- NSW/EOD Sensor Technology: Complete development of digital beamformer architecture for high frequency imaging sonar. Continue development of short range sensors for UUV reconnaissance of surf zone. Complete development of a pulsed elemental analysis with neutrons system for identification of filler material in improvised explosive devices. Continue development of standoff detection and classification sensors for surface and buried UXO using multi-dimensional EM methods. Begin development of buried ordnance identification sensor.
- NSW/EOD Mission Support Technology: Complete development of robotic manipulators and actuators based on artificial muscle materials. Complete analysis of low order detonation phenomena. Complete development of miniature CO2 sensor. Complete development of passively controlled rebreather. Complete development of virtual environment-based training aid and tactical decision aids for NSW missions. Continue development of UUV technologies to support VSW reconnaissance missions. Continue development of extended lifetime underwater adhesives. Develop design alternatives for next generation Seal Delivery Vehicle. Begin development of technology to provide blast mitigation for detonations in congested areas. Begin development of Ultra High Velocity Shaped Charge for neutralizing improvised explosive devices.

FY 2005 PLANS:

- NSW/EOD Sensor Technology: Complete development of short range sensors for UUV reconnaissance of surf zone. Continue development of standoff detection and classification sensors for surface and buried UXO using multi-dimensional EM methods. Continue development of buried ordnance identification sensor. Begin development of sensor to detect radioactive material underwater.
- NSW/EOD Mission Support Technology: Continue development of technology to provide blast mitigation of explosions in congested areas. Continue development of Ultra High Velocity Shaped Charge for neutralizing improvised explosive devices. Begin development of low signature materials for application to NSW and EOD tools and clothing.

C. OTHER PROGRAM FUNDING SUMMARY:

NAVY RELATED RDT&E:

PE 0601153N (Defense Research Sciences)

PE 0602131M (Marine Corps Landing Force Technology)

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

NON-NAVY RELATED RDT&E:

PE 0602712A (Countermining Systems)
PE 0603606A (Landmine WF and Barrier Advanced Technology)
PE 1160401BB (Special Operations Technology Development)
PE 1160402BB (Special Operations Advanced Technology Development)

D. ACQUISITION STRATEGY: Not Applicable

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