

UNCLASSIFIED

FY 2003 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2002

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602747N

PROGRAM ELEMENT TITLE: Undersea 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
Undersea Warfare Applied Research									
**		75,834	71,294	72,850	73,324	71,108	71,793	CONT.	CONT.

**The Science and Technology PEs were restructured in FY 2002. FY 2001 efforts were funded in PEs 0602314N, 0602315N, and 0602633N.

A. (U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION:

(U) In countering the proliferation of quiet diesel submarines to third world countries and Russia's continued investment in submarine technology, work within this Program Element (PE) provides an enabling capability for power projection and force sustainability. This approach protects the country's capital investment in surveillance, submarine, surface ship and air Anti-Submarine Warfare (ASW) assets by exploring those high risk/high payoff technologies that promise to provide capabilities of exceptionally high military value in five to fifteen years. These technology options include research in the following areas:

- Improving reliable undersea target detection and tracking to enable on-command application of precision offensive military force. Programs include undersea sensors and arrays to provide robust shallow water surveillance and reconnaissance, and to detect undersea threats to the surface battleforce. This effort also includes Navy unique research and technology issues associated with creating a timely and intelligible tactical picture of the undersea battlespace.
- Dominating the undersea battlespace to enable timely execution of joint/combined operations and to ensure joint force sustainability. Programs include advanced sensors and arrays for both improved ASW surveillance and enhanced battleforce self-defense, ASW data fusion for better tactical control, and low frequency active sonar and rapidly deployable surveillance systems for covert/non-covert indication and warning.
- Improving reliable undersea target detection and tracking, thus enabling joint battleforce sustainability. Programs include the entire spectrum of technology development undertaken in support of the Littoral ASW (LASW) Future Naval Capability (FNC).

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- Improving undersea weapons effectiveness while reducing overall costs through improvements to current systems as well as the development of new weapons concepts. The goal of Undersea Weaponry is to produce cost effective, quick reaction intelligent weapons incorporating broadband processing with battlegroup connectivity, intelligent countermeasures, hard kill torpedo defense, improved littoral operation, and weapon flexibility. Several Science and Technology (S&T) challenges must be addressed including cluttered operating environments, multi-path acoustic propagation, low/no doppler targets, detonation physics, high density power sources, and fusing/safety/arming mechanics. The technology developed under this project will be transitioned to the acquisition community for incorporation into existing platforms. These efforts support the Littoral ASW and Platform Protection FNCs.

(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 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 funded within the Applied Research Budget Activity because it investigates technological advances with possible applications toward solutions to specific Naval problems, short of an advanced development effort.

B. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

1. (U) FY 2001 ACCOMPLISHMENTS:

- (U)(\$10,087) Wide Area Surveillance:

INITIATED:

(U) Development of signal processing algorithms for active sonar systems that remove unwanted clutter produced by sound reflecting off the ocean surface and bottom, thereby improving the ability to detect weak echoes from submarines (Funded in PE 0602314N).

(U) New Kelp design based on HYDRA technology. KELP is a bottom-moored, ultra-light, buoyant vertical line array that employs a node concept that allows autonomous processing of threat signals and transmission of detection, classification, and localization (DCL) data. HYDRA is a bottom-mounted, ultra-light sparse barrier array employing autonomous signal processing and self-repairing features (Funded in PE 0602314N).

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- (U) Development of ultra low power electronics to support advanced remote sensing devices (Funded in PE 0602314N).
- (U) Improved multi-static processing for air deployed impulsives using cepstrum analytic processing (Funded in PE 0602314N).
- (U) Depth estimation techniques for coherent echo ranging in coherent surveillance systems (Funded in PE 0602314N).
- (U) Assessment to evaluate the use of an acoustic intensity sensor as an active receiver (Funded in PE 0602314N).
- (U) Implementation of Compact Deployable Multistatic Receiver (CDMR) Processing Laboratory (Funded in PE 0602314N).
- (U) Development and demonstration of In-Buoy Signal Processing strings for CDMR (Funded in PE 0602314N).
- (U) Development of advanced technology deployable planar array (Funded in PE 0602314N).
- (U) Development of an enhanced acoustic sparker source for environmental and ASW applications including tank measurements (Funded in PE 0602314N).

CONTINUED:

- (U) Development of acoustic signal processing Detection, Classification, and Localization techniques for autonomous undersea applications (Funded in PE 0602314N).
- (U) Refurbishment and fabrication of T-Size X-Glider to demonstrate standoff ASW surveillance concept development and evaluation (Funded in PE 0602314N).
- (U) Development of a family of ultra-lightweight, ultra-low power air-, surface ship- or submarine-deployable, Matched Field Tracking Arrays to be used for barrier (Hydra) or area (Kelp) surveillance or as organic off-board sensors for submarines (Funded in PE 0602314N).
- (U) Development of improved off-board, acoustic multi-static source components, processing algorithms, and performance predictive tools (Funded in PE 0602314N).
- (U) Multi-static ASW Capabilities Enhancement (MACE) multi-static processing development (Funded in PE 0602314N).
- (U) At sea testing and data analysis for multi-static processing algorithm development (Funded in PE 0602314N).
- (U) Transition of a suite of processing techniques to the Air Deployable Active Receiver project for use with undersea surveillance in-buoy processing (Funded in PE 0602314N).
- (U) Development of Telesonar acoustic communications system for use with deployable, autonomous systems—Telesonar networks consist of modulators/demodulators (modems) used for communicating acoustic data among undersea sensing components. (Funded in PE 0602314N).

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- (U) Phase conjugation algorithm development and evaluation (Funded in PE 0602314N).
- (U) Development of large aperture, bottom-mounted array/signal processing (Funded in PE 0602314N).
- (U) Assessment and report on ASW performance of Hydra during RDS-3 (Rapidly Deployable Systems) experiment (Sep/Oct 2000) (Funded in PE 0602314N).
- (U) Deployable Autonomous Distributed System (DADS) sensor/signal processing development for autonomous detection/classification of submarines using magnetic matched field processing (Funded in PE 0602314N).
- (U) The development of a signal processing system for a new multistatic sonar system using air-deployed explosive sound sources and air-deployed sonobuoys based on an operational concept called "non-traditional scattering" of sound off of submarines (Funded in PE 0602314N).
- (U) Assessment of initial sea test data using over-the-side multi-static sources. Detections were obtained at tactically significant ranges against a small submarine in a littoral environment. (Funded in PE 0602314N).
- (U) Advanced compact multi-static Air Deployed Active Receiver with active & passive in-buoy signal processing design trade studies (Funded in PE 0602314N).

• (U)(\$30,796) Battlegroup ASW Defense:

INITIATED:

- (U) Development of a suite of signal processing improvements for "coherent" active sonar systems, thereby improving the ability to detect, classify and locate small, slow moving submarines in shallow water environments (Funded in PE 0602314N).
- (U) Development of structural magneto-restrictive materials for ruggedized acoustic transducer. The development of these materials will enable more rugged transducer designs thus extending the reliability and service life of acoustic transducers under explosive shock conditions. (Funded in PE 0602314N).
- (U) Development of Lead Zirconate Titanate (PZT) materials for high field direct current (DC) biased operation to permit high power operation of acoustic transducers as means to double acoustic output (Funded in PE 0602314N).
- (U) Design of Magnetostrictive Piezoelectric Transducer (MPT) for High Frequency (HF) broadband (2+ octave) use in the submarine conformal array program (Funded in PE 0602314N).
- (U) Development of outboard power electronics for HF conformal array program requiring electronics coincident with the conformal array (Funded in 0602314N).
- (U) Development of HF broadband panel projector array for HF conformal program utilizing feedback to maintain control over array behavior over a frequency range of 2+ octaves (Funded in PE 0602314N).
- (U) Evaluate Fishline fiber optic sensor designs for submarine, surface ship & air deployed ASW arrays (This effort was reported previously under Cooperative ASW) (Funded in PE 0602314N).

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(U) Demonstration of Environmentally Adaptive Sonar Technology (EAST) signal processing techniques in a Fleet operational effort (Funded in PE 0602314N).

(U) Design/integration of Ultra-Low Frequency (ULF) and Extremely Low Frequency (ELF) Electromagnetic (EM) sensors signal processing and environmental noise cancellation techniques for submarine detection onto the Vertical Take-off Unmanned Air Vehicle (VTUAV) (Funded in PE 0602314N).

(U) Sea tests of optical standoff sensor systems (Funded in PE 0602314N).

CONTINUED:

(U) Environmentally adaptive processing development for non-Gaussian background noise (Funded in PE 0602314N).

(U) Wideband transmit waveform investigations for reduced reverberation and improved detection (Funded in PE 0602314N).

(U) Development of Integrated Bow Conformal (IBC), Low Frequency Hull Array (LFHA), and Volumetric towed arrays (Funded in PE 0602314N).

(U) EAST: Development of technical approaches for automating the operational configuration of sonar systems in response to real-time analysis of the acoustic field and relevant (measured) environmental parameters to reduce operator workload, enable reduced manning, and improve performance in the littoral environments (Funded in PE 0602314N).

(U) Development of broadband hybrid transducer array for SSBN applications to replace the aging bathymetry transducer. (Funded in PE 0602314N).

COMPLETED:

(U) Development of signal processing methods that enable improved target localization estimates and differentiation between man-made and natural transient noises (Funded in PE 0602314N).

(U) Development of signal processing algorithms for submarine towed arrays that provide improved target localization estimates (Funded in PE 0602314N).

(U) Ultra-wide waveform target strength model-based measurements and modeling (Funded in PE 0602314N).

Assessment of environmental and system factors on processing performance (Funded in PE 0602314N).

(U) Affordable towed array construction, demonstration and transition to Twinline Towed Array (TB-29) for SSNs (Funded in PE 0602314N).

(U) Development of a mid-frequency broadband panel projector utilizing active feedback for a towed acoustic source application with very small tow bodies (Funded in PE 0602314N).

(U) Development of low frequency, low profile cymbal transducers to be unobtrusively mounted on unmanned vehicles for mine-hunting applications (Funded in PE 0602314N).

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(U) Evaluation of piezocomposites as broadband projector materials (Funded in PE 0602314N).

(U) Extremely Low Frequency Emissions (ELFE) technology through data analysis/final report of demonstrations and algorithm development (Funded in PE 0602314N).

(U) Development of a fully bistatic, broadband ocean surface scattering strength model and provided the model to the Navy Ocean and Atmospheric Master Library (OAML). Completed validation of multistatic active system performance models using experimental data. Completed fabrication of a threat submarine physical scale model. Completed validation of statistical models that characterize the non-gaussian (non-normal statistical distribution) properties of clutter for low frequency/mid frequency active sonar systems. Developed a simulation capability for forward scatter echo detection system concepts (Funded in PE 0602314N).

(U) Development of an interrogation system for a 96-channel optical array to be used for testing in a joint United States/United Kingdom (US/UK) program in FY 2002. Demonstrated a 30dB increase in response over previous coatings for a new polymer coated fiber sensor. Developed cross-frequency correlation and time-frequency filtering algorithms that reject false targets associated with surface shipping. Provided an improved surface shipping source spectra model to Space and Naval Warfare Systems Command (Funded in PE 0602314N).

(U) Demonstration of a preliminary application of Hidden Markov Models to identify/classify environmental clutter mechanisms encountered by active sonar systems. Hidden Markov Models are algorithms used to extract signals that are otherwise hidden by noise (Funded in PE 0602314N).

- (U) Cooperative ASW: The effort previously reported under this area (Cooperative ASW) is now included under Wide Area Surveillance (Funded in PE 0602314N).

- (U)(\$28,770) Neutralization:

INITIATED:

(U) Development of Stealth Torpedo Homing Concepts needed to demonstrate the operational utility of stealthy weapon sensors. The effort includes developing associated combat control algorithms needed for effective weapon employment as well as autonomous weapon guidance algorithms (Funded in PE 0602633N).

(U) Development of technologies to enable a Heavyweight torpedo and its host platform to be effectively employed as a fully linked on-board and off-board sensor system (Funded in PE 0602633N).

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(U) Development of Undersea Weapon Design and Optimization (UWDO) tools using physics based models, computational techniques, and codes to optimize undersea weapon system designs with respect to cost and performance requirements (Funded in PE 0602633N).

(U) Development of broadband signal processing and intelligent torpedo control advancements (including waveforms, algorithms, etc.) that will dramatically improve single- and multi-ping detection, classification and localization of threat targets (Funded in PE 0602633N).

(U) Development of signal processing algorithms aimed at passively Detecting, Classifying and Localizing threat torpedoes and torpedo countermeasures for close-in waterborne/underwater threats and high-speed weapons (Funded in PE 0602633N).

(U) Development of Torpedo Noise Modeling and Control concepts that support development of long-range quiet weapons; including reduction of radiated noise of current and next generation torpedoes to minimize target alertment and classification of the launch platform (Funded in PE 0602633N).

(U) Development of concepts and design tools for undersea weaponry warhead fuzing, detonation processes and target interactions, and enhanced kill mechanisms. Development of these tools will permit the elimination of several iterations of empiricism's in the design and testing cycle with significant cost and time savings. Development of these advanced concepts will permit the development of enhanced performance torpedo warheads in reduced volumes (Funded in PE 0602633N).

(U) Development of active-passive vibration mount concepts to reduce weapon machinery vibration and noise radiation (Funded in PE 0602633N).

(U) Research on high power propulsion technologies and integrated hybrid power systems for advanced undersea weapons that reduce life-cycle costs, increase power and energy densities, and enhance stealth. Efforts include hybrid propulsion system modeling, high power rechargeable batteries, micro-turbines, and hydroreactive materials (Funded in PE 0602633N).

(U) Development of High-Speed Supercavitating torpedo vehicle control and homing sensor technologies. Continue conduct of experiments and tests on vehicle control concepts and homing sensors (Funded in PE 0602633N).

(U) Development of MicroElectroMechanical Systems (MEMs) Safing and Arming (S&A) technology (less Inertial Measurement Unit (IMU)) (Funded in PE 0602633N).

(U) Development of technologies to support connectivity between a torpedo and a fixed sensor. Includes: generation of a fire control quality track by the fixed sensor, communication between a torpedo at speed and a fixed sensor node, guidance of the torpedo by the fixed sensor in the face of countermeasures and evasive maneuvers by the target (Funded in PE 0602315N).

COMPLETED:

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(U) Concept development of Feature Based Navigation and Mapping that offer underwater vehicle navigation methods that allow the potential of achieving bounded errors for long-duration missions and offering a method to avoid the need for acoustic beacons or surfacing for external position fixing and resets (Funded in PE 0602633N).

(U) Dual-mode warhead concept development for torpedo counterweapon(s) (Funded in PE 0602633N).

(U) FY2001 Congressional Plus-ups:

- (U) (\$871) Lithium Carbon Monofluoride Coin Cells for Battery Application Technology Provides low toxicity electrolytes and safer, higher energy CFx cathode material than present lithium batteries. This battery technology could double the mission time of naval mines and surveillance systems over that provided by the use of existing lithium batteries. (Funded in PE 0602314N).
- (U) (1,931) Continued Undersea Warfare MEMS. This will permit reduction of size and cost of future torpedo S&A systems by up to 90%. (Funded in PE 0602633N).

2. (U) FY 2002 PLAN:

- (U)(\$13,206) Wide Area Surveillance:

INITIATE:

(U) Project to miniaturize DADS sensor/control nodes by a factor of 10 with equal or better performance for littoral applications

(U) Development of improved low frequency active source transducers to reduce their size and cost

(U) Compact multi-static Air Deployed Active Receiver with active and passive In Buoy Signal Processing—design Experimental Super Air Deployed Active Receiver at-sea data collection and demonstrate buoy based on FY01 design trade-off studies

(U) Performance evaluation of a new multistatic sonar system using air-deployed explosives and air-deployed sonobuoys based on an operational concept called "non-traditional scattering" of sound off of submarines

CONTINUE:

(U) Development of signal processing algorithms for active sonar systems that remove unwanted clutter produced by sound reflecting off the ocean surface and bottom, thereby improving the ability to detect weak echoes from submarines

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- (U) Development of a family of ultra-lightweight, ultra-low power air-, surface ship- or submarine-deployable, Matched Field Tracking Arrays to be used for barrier (Hydra) or area (Kelp) surveillance or as organic off-board sensors for submarines
- (U) Development of ultra low power electronics to support advanced remote sensing devices
- (U) At sea testing in support of algorithm development, source reliability, and system component demonstrations using multiple multi-static sources
- (U) Development of improved off-board, acoustic multi-static source components, processing algorithms, and performance predictive tools
- (U) Transition of a suite of signal processing techniques to the Super- Air Deployed Active Receiver undersea surveillance sonobuoy effort
- (U) Assessment to evaluate the use of an acoustic Intensity sensor as an active receiver
- (U) Development of an enhanced acoustic sparker source for environmental and ASW applications
- (U) Implementation of CDMR Development laboratory to provide end-to-end development and test capability for the CDMR processing string
- (U) Progressive development of the CDMR processing string through builds 2 and 3
- (U) Telesonar acoustic communications system for deployable systems

COMPLETE:

- (U) Development of acoustic signal processing detection, classification, and localization techniques for autonomous undersea applications
- (U) Improved signal processing for multistatic sonar systems employing explosive sound sources based upon a signal processing method called "cepstrum-processing"
- (U) Assessment and report on partial aperture Hydra acoustic ASW performance during Seaweb technical feasibility demonstrations in September 2001. Seaweb refers to collection of Telesonar modems.
- (U) Design/integration of ULF/ELF EM submarine detection system mounted on VUAVs
- (U) Demonstration of a full-scale X-Glider deployment gliding over a prescribed course
- (U) Initial demonstration of multi-static processing
- (U) Development of advanced technology deployable planar array. Complete investigation of technologies for packaging larger array apertures in expendable systems.
- (U) Demonstration of first Build of CDMR In-Buoy processing String to demonstrate the initial reduction in required link bandwidth.

- (U)(\$40,390) Battlegroup ASW Defense:

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INITIATE:

- (U) Passive Acoustic array test-bed design and installation to support future passive sonar system designs
- (U) Development, demonstration, and transition of signal processing algorithms designed to detect and classify acoustic signatures of threat submarines
- (U) Planning for advanced Counter-Torpedo DCL (CTDCL) development for surface ship defense in complex salvo scenarios.
- (U) Development of compact, broadband, high frequency cymbal arrays for conformal array applications that will provide greater than one octave transmit capability above 10 kHz for conformal array applications
- (U) Evaluate Reduced Diameter towed arrays
- (U) Pre-track fusion for shipboard coherent echo ranging systems
- (U) Development of environmental adaptive track formation techniques for coherent echo ranging
- (U) Assessment of Naval Sea Systems Command (NAVSEA) AN/WSQ-11()/Tripwire design and performance documentation
- (U) Assessment of Tripwire performance requirements in complex salvo and background acoustic scenarios
- (U) Improvement of Tripwire system HF sensor acoustic signal loss for salvo data collection risk reduction
- (U) Initiate research to design high frequency, high dynamic-range fiber optic acoustic arrays for the IBC system. Initiate research to develop the virtual sonar array concept for any hull-mounted sonar (e.g., submarine, autonomous underwater vehicle, torpedo).

CONTINUE:

- (U) Development of a suite of signal processing improvements for "coherent" active sonar systems, thereby improving the ability to detect, classify and locate small, slow moving submarines in shallow water environments
- (U) Development of IBC, and Volumetric towed arrays
- (U) Development of outboard power electronics and controls for conformal arrays that are highly reliable and of a low profile design
- (U) Development of structural magnetostrictive materials to enable more rugged acoustic transducer designs capable of explosive shock survivability and useable as structural members in innovative transducers.
- (U) Development of PZT materials for high field DC biased operation to permit high power operation of acoustic transducers.
- (U) Development of Fishline fiber optic sensor designs for submarine, surface ship & air deployed ASW arrays
- (U) EAST: Development of technical approaches for automating the operational configuration of sonar systems in response to real-time analysis of the acoustic field and relevant (measured) environmental parameters to reduce operator workload, enable reduced manning, and improve performance in littoral environments.

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- (U) Demonstrate EAST signal processing techniques in a Fleet operational effort
- (U) Improved multi-static processing for light weight sound system (LWSS) and air deployed impulsives
- (U) Sea tests of optical standoff sensor systems
- (U) Design/integration of ULF/ELF EM submarine detection system mounted on VTUAVs
- (U) Collection measurement data in support of developing the forward scatter echo detection concept. Continue to develop threat target scattering databases using physical scale model submarines. Continue investigations into the application of time-reversal acoustic techniques applicable to active sonar systems.
- (U) Determination of factors that limit the resolvability of individual noise sources by large aperture acoustic arrays in the littoral environments. Fabricate and test the response of long sections of polymer coated fibers
- (U) Extension of Hidden Markov Model techniques to identify/classify submarine-like targets and additional environmental factors that produce scattering. Incorporate acoustic waveguide effects into the Hidden Markov Model algorithms.

COMPLETE:

- (U) Transition of ultra-wide waveform target strength model-based measurements and modeling to related investigations
- (U) Transition of environmentally adaptive processing development for non-Gaussian background noise
- (U) Development of the MPT array for the HF conformal program that can deliver high power over a 2+ octave frequency band.
- (U) Development of HF broadband panel projector array for the HF conformal array program with the capability of velocity control over the entire frequency band of operation
- (U) Development of broadband hybrid transducer array for the SSBN program. Complete a demonstration on an SSBN test platform of this more reliable, modern replacement transducer array.
- (U) Development and validation of bistatic, broadband boundary and volume scattering strength models. Complete development of physics-based active classification algorithms that extract specific signal components from a target echo.

- (U) Cooperative ASW: Efforts previously reported under this area (Cooperative ASW) are now included under Wide Area Surveillance

- (U)(\$22,238) Neutralization:

INITIATE:

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- (U) A Dual Use S&T (DUS&T) low noise integrated motor propulsor project entitled LAMPrEy (Low Acoustic signature Motor/Propulsor for Electrically powered undersea vehicles) to further enhance the Torpedo Stealth project.
- (U) Development of an Active Noise Control technology that reduces vehicle shell vibration and noise radiation using Active Fiber Composite materials.
- (U) Development of adaptive broadband processing algorithms that will dramatically improve single- and multi-ping detection, classification and localization of threat targets.
- (U) Development of directed energy concept proof of principle for enhanced performance undersea warhead.

CONTINUE:

- (U) Development of UWDO tools using physics based models, computational techniques, and codes to optimize undersea weapon system designs with respect to cost and performance requirements.
- (U) Development of innovative adaptive broadband signal processing algorithms that will improve a torpedo's single ping detection, classification and localization performance. This initiative will leverage single processing advances made in the radar community.
- (U) Development of signal processing algorithms aimed at Detecting, Classifying and Localizing threat torpedoes and torpedo countermeasures for close-in waterborne/underwater threats and high-speed weapons.
- (U) Transition of counter-torpedo technologies to NAVSEA (PMS-415) Tripwire Torpedo Defense System (AN/WSQ-11).
- (U) Research on high power propulsion technologies and integrated hybrid power systems for advanced undersea weapons that reduce life-cycle costs, increase power and energy densities, and enhance stealth. Efforts include models for hybrid propulsion systems, high power rechargeable batteries, micro-turbines, and hydroreactive materials.
- (U) Development of concepts and design tools for enhanced kill mechanisms of Undersea Warheads. Development of these tools will permit the elimination of several iterations of empiricism's in the design and testing cycle with significant cost and time savings. Development of these advanced concepts will permit the development of enhanced performance torpedo warheads in reduced volumes.
- (U) Development of Stealth Torpedo Homing Concepts needed to demonstrate the operational utility of stealthy weapon sensors. The effort includes developing combat control algorithms needed for effective weapon employment as well as autonomous weapon guidance algorithms.
- (U) Development of technologies to enable a Heavyweight torpedo and a shooting platform to be effectively employed as a fully linked on-board and off-board sensor system.
- (U) Development of active-passive mount technologies for reducing weapon machinery noise by conducting laboratory experiments and demonstrations.

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(U) Development of High-Speed Supercavitating torpedo vehicle control and homing sensor. Continue to conduct experiments and tests on vehicle control concepts and homing sensors.

(U) Development of technologies to support connectivity between a torpedo and a fixed sensor. Includes: generation of a fire control quality track by the fixed sensor, communication between a torpedo at speed and a fixed sensor node, guidance of the torpedo by the fixed sensor in the face of countermeasures and evasive maneuvers by the target

COMPLETE:

(U) Development of torpedo noise modeling development and incorporate it into the UWDO design toolbox.

(U) Development of underwater explosive effects hydro code that provides computational methods to accurately evaluate the effects of damage resulting from underwater explosions.

(U) Development of MEMs S&A technology (less IMU). This capability permits reduction of size and cost of future torpedo S&A systems by up to 90%. Insertion of an IMU into the S&A permits the reduction of the safe standoff distance required for a quick reaction weapon without any own-ship safety compromise.

(U) FY2002 Congressional Plus-ups:

- (U) Semi-Autonomous Underwater Vehicle for Intervention Missions (SAUVIM): The objective of this project is to develop and demonstrate the control methodologies and algorithms necessary to perform complex tasks using a robotic arm attached to an underwater vehicle. The problem is enhanced by strong underwater currents, force feedback, object recognition, and object dimensioning. (Appropriated in PE 0602633N, \$1,685)

3. (U) FY 2003 PLAN:

- (U)(\$16,418) Wide Area Surveillance:

INITIATE:

(U) Hydra adaptations for use as an off-board sensor for submarines

(U) Investigation of a new surveillance concept based on an underwater acoustic theory called "time-reversal echo ranging"

(U) Development of improvements for off-board multi-static source components to reduce cost and increase reliability

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CONTINUE:

- (U) Development of a family of ultra-lightweight, ultra-low power air-, surface ship- or submarine-deployable, Matched Field Tracking Arrays to be used for barrier (Hydra) or area (Kelp) surveillance or as organic off-board sensors for submarines
- (U) Performance evaluation of a new multistatic sonar system using air-deployed explosives and air-deployed sonobuoys based on an operational concept called "non-traditional scattering" of sound off of submarines
- (U) Development of ultra low power electronics to support advanced remote sensing devices
- (U) Project to miniaturize DADS sensor/control nodes by a factor of 10 with equal or better performance for littoral applications
- (U) Development of improved off-board, acoustic multi-static source components, processing algorithms, and performance predictive tools
- (U) Development of low frequency active source transducers
- (U) Sea tests of optical standoff sensor systems
- (U) Telesonar acoustic communications system for deployable systems
- (U) Assessment to evaluate the use of an acoustic Intensity sensor as an active receiver
- (U) Design, fabrication and shakedown testing of Experimental Super Air Deployed Active Receiver
- (U) Progressive development of the CDMR processing string through builds 3 and 4
- (U) Telesonar acoustic communications system for deployable systems (This effort was reported previously under Cooperative ASW)

COMPLETE:

- (U) Assessment and report on Hydra performance during RDS-4 (Rapidly Deployable Systems) testing scheduled for September 2002
- (U) Transition of a suite of signal processing algorithms to Super Air Deployed Active Receiver undersea surveillance sonobuoy processing effort
- (U) Analysis of FY 02 multi-static source sea-test data
- (U) Demonstration of Build 2 of CDMR In-buoy processing string. Complete further reduction of link bandwidth over build 1.

- (U)(\$34,703) Battlegroup ASW Defense:

INITIATE:

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- (U) Improved techniques to distinguish submarine echoes from echoes produced by ocean bottom features using detailed surveys of the ocean bottom and its geologic properties
- (U) Design of shipboard coherent sonar systems based on low probability of intercept waveform investigations
- (U) Final design and subsequent fabrication of a partial HF conformal transducer array for concept demonstration. The design will be selected from candidate designs developed earlier in this program.
- (U) Development of single crystal piezoelectric composite materials with the goal of adapting the materials to a viable transducer design capable of operating at a broad bandwidth and producing 5 times the power output over conventional piezoelectric materials.
- (U) Research to optimize in-situ multi-static active sonar performance based on broadband, physics-based scattering models and environmental feedback algorithms
- (U) Assembly and laboratory measurements of a large aperture virtual sonar array. Initiate research to determine the underwater channel capacity limits for high frequency acoustic communications in support of autonomous operations.
- (U) Development of a geo-acoustic inversion capability for submarines that uses data from the submarine's passive towed array

CONTINUE:

- (U) Passive acoustic array test-bed design and installation to support future passive sonar system designs
- (U) Development, demonstration, and transition of signal processing algorithms designed to detect and classify acoustic signatures of threat submarines
- (U) Testing of IBC, and Volumetric towed arrays
- (U) Testing of Fishline fiber optic sensor designs for submarine, surface ship, and air deployed ASW arrays (This effort was reported previously under Cooperative ASW)
- (U) Development of Reduced Diameter towed arrays
- (U) Development of PZT materials (known as Galfenol) under high field DC biased operation as a means to improve high power performance and linearity under high power operation with at least double the power output of ordinary piezoelectric materials.
- (U) Development of structural magnetostrictive materials for transducer applications requiring non-brittle components with the goal of producing a structurally strong and rugged magneto-active material for acoustic transducer applications
- (U) Development of compact, high frequency cymbal transducer (a Class V flexensional transducer) for inclusion into a thin conformal array less than one-half inch thick

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(U) Development of a suite of signal processing improvements for "coherent" active sonar systems, thereby improving the ability to detect, classify and locate small, slow moving submarines in shallow water environments

(U) Development of a new torpedo defense system for surface ships, including performance assessment, data collection, data analysis, and algorithm development

(U) EAST: Development of technical approaches for automating the operational configuration of sonar systems in response to real-time analysis of the acoustic field and relevant (measured) environmental parameter

(U) Demonstration of EAST signal processing techniques in multiple Fleet operational effort

(U) Development of advanced technology deployable planar array

(U) Development of outboard power electronics for high power, broadband conformal arrays including power amplifiers, tuning (and receive circuitry, if required), and pressure tolerant components

(U) Optical standoff sensors platform installation and performance testing

(U) Design/integration of ULF/ELF EM submarine detection system mounted on VTUAVs

(U) Development of acoustic time reversal techniques for active sonar systems through simulation studies and planning for at-sea testing

(U) Fabrication and field testing of the performance of a complete polymer coated fiber array. Continue fabrication and calibration of individual high frequency fiber optic sensors. Continue assembly and conduct laboratory measurements of a large aperture virtual sonar array.

(U) Integration of Hidden Markov Model techniques with traditional submarine tracking algorithms and evaluate overall effectiveness for in shallow water ASW applications.

COMPLETE:

(U) Current EAST development.

(U) Sea tests of optical standoff sensor systems

(U) Transition to Naval Air Systems Command (NAVAIR) EER (Extended Echo Ranging) the forward scattering echo detection algorithms. Complete acquisition of scale-model threat target scattering databases and assess robustness of target scattering features to environmental distortion.

• (U)(\$20,173). Neutralization:

INITIATE:

(U) Development of a Weapon Design and Optimization capability in a virtual environment using results of FY01 and FY02 efforts.

(U) Validation of torpedo vulnerability assessment methodology and codes.

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CONTINUE:

- (U) Implementation of Multidisciplinary Design Optimization (MDO) in weapon design. Continue optimization of undersea weapon system designs with respect to cost and performance requirements.
- (U) Development of a DUS&T low noise integrated motor propulsor project entitled LAMPReY to further enhance the Torpedo Stealth project.
- (U) Development of High-Speed Supercavitating torpedo vehicle control and homing sensor. Continue to conduct experiments and tests on vehicle control concepts and homing sensors.
- (U) Research on high power propulsion technologies and integrated hybrid power systems for advanced undersea weapons that reduce life-cycle costs, increase power and energy densities, and enhance stealth. Efforts include models for hybrid propulsion systems, high power rechargeable batteries, micro-turbines, and hydroreactive materials.
- (U) Development of Stealth Torpedo Homing Concepts needed to demonstrate the operational utility of stealthy weapon sensors. The effort includes developing combat control algorithms needed for effective weapon employment as well as autonomous weapon guidance algorithms.
- (U) Development of technologies to enable a Heavyweight torpedo and a shooting platform to be effectively employed as a fully linked on-board and off-board sensor system.
- (U) Development of directed energy concept proof of principle to substantially enhance the performance of undersea warheads.
- (U) Development of concepts and design tools for enhanced kill mechanisms for Undersea Warheads. Development of these tools will permit the elimination of several iterations of empiricism's in the design and testing cycle with significant cost and time savings. Development of these advanced concepts will permit the development of enhanced performance torpedo warheads in reduced volumes.
- (U) Development of innovative adaptive broadband processing algorithms that will improve a torpedo's single ping detection, classification and localization performance. This initiative will leverage signal-processing advances made in the radar community.
- (U) Development of signal processing algorithms aimed at Detecting, Classifying and Localizing threat torpedoes and torpedo countermeasures for close-in waterborne/underwater threats and high-speed weapons.
- (U) Development of technologies to support connectivity between a torpedo and a fixed sensor. Includes: generation of a fire control quality track by the fixed sensor, communication between a torpedo at speed and a fixed sensor node, guidance of the torpedo by the fixed sensor in the face of countermeasures and evasive maneuvers by the target.

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COMPLETE:

- (U) Development of active-passive mounts for reducing weapon machinery noise; commence demonstration of active-passive mount technologies with in-water torpedo testing.
- (U) Complete in-water demonstration of Smart Skin for torpedo noise radiation control concepts. Active controller hardware will be implemented in Active Fiber Composites project.
- (U) Development of broadband signal processing and intelligent torpedo control for dramatically improved single- and multi-ping detection of broadband signal processing and intelligent torpedo control advancements (including waveforms, algorithms, etc.) that will dramatically improve single- and multi-ping detection, classification and localization transition to MK-48 CBASS Program (PE 0205632N).

C. (U) PROGRAM CHANGE SUMMARY:

	FY 2001	FY 2002	FY 2003
FY 2002 President's Budget	**	76,510	
Adjustments from FY 2002 President's Budget:			
Section 8123 Mgmt Reform Initiative		-676	
FY 2003 President's Budget Submission	**	75,834	71,294

**The Science and Technology PEs were restructured in FY 2002. FY 2001 efforts were funded in PEs 0602314N, 0602315N, and 0602633N.

(U) CHANGE SUMMARY EXPLANATION:

- (U) Funding: Not Applicable.
- (U) Schedule: Not Applicable.

D. (U) OTHER PROGRAM FUNDING SUMMARY:

(U) NAVY RELATED RDT&E:

- (U) PE 0601153N (Defense Research Sciences)
- (U) PE 0602114N (Power Projection Applied Research)
- (U) PE 0602123N (Force Protection Applied Research)
- (U) PE 0602435N (Ocean Warfighting Environment Applied Research)
- (U) PE 0602782N (Mine and Expeditionary Warfare Applied Research)

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PROGRAM ELEMENT: 0602747N

PROGRAM ELEMENT TITLE: Undersea Warfare Applied Research

- (U) PE 0603114N (Power Projection Advanced Technology)
- (U) PE 0603123N (Force Protection Advanced Technology)
- (U) PE 0603506N (Surface Ship Torpedo Defense)
- (U) PE 0603553N (Surface ASW)
- (U) PE 0603747N (Undersea Warfare Advanced Technology)
- (U) PE 0603758N (Navy Warfighting Experiments and Demonstrations)
- (U) PE 0604221N (P-3 Modernization Program)
- (U) PE 0604261N (Acoustic Search Sensors (ENG))
- (U) PE 0604784N (Distributed Surveillance Systems)

(U) NON NAVY RELATED RDT&E:

- (U) PE 0603763E (Marine Technology)
- (U) PE 0603739E (Advanced Electronics Technologies)
- (U) PE 0602702E (Tactical Technology)
- (U) PE 0602173C (Support Technologies - Applied Research)

E. (U) SCHEDULE PROFILE: Not applicable.

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