FY 2004/2005 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2003
Exhibit R-2

BUDGET ACTIVITY: 2 PROGRAM ELEMENT: 0602747N
PROGRAM ELEMENT TITLE: Undersea 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
Undersea Warfare Applied Research	72,511	84,496	62,583	66,353	63,554	64,170	65,364	66,619

A. MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: All Navy advanced technology development in undersea target detection, classification, localization, tracking and neutralization is funded through this Project Element (PE). Technologies being developed within this Project Element are aimed at enabling Sea Shield, one of the three core operational concepts detailed in the Naval Transformational Roadmap. Associated efforts focus on new anti-submarine warfare (ASW) operational concepts that promise to improve wide-area surveillance, detection, localization, tracking and attack capabilities against quiet adversary submarines operating in noisy and cluttered shallow water environments. Related efforts are aimed at leveraging technologies that will protect the country's current capital investment in surveillance, submarine, surface ship and air ASW assets.

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

B. PROGRAM CHANGE SUMMARY:

	FY 2002	FY 2003	FY 2004	FY 2005
FY 2003 President's Budget Submission:	75,834	71,294	72,850	73,324
Adjustments from FY 2003 President's Budget:				
Congressional Plus-Ups		15,150		
SBIR Reduction	-917			
Execution Adjustments	-2,152			
Congressional Rescissions/Adjustments/Undistributed Reductions	-254	-1,031		
S&T Program Adjustments			-7,835	-4,581
NWCF Rate Adjustments			-93	73
Efficiencies at NWCF Activities			-710	-701
Pay Raise/Inflation Adjustments		-917	-1,629	-1,762

FY 2004/2005 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2003
Exhibit R-2

BUDGET ACTIVITY: 2 PROGRAM ELEMENT: 0602747N
PROGRAM ELEMENT TITLE: Undersea Warfare Applied Research

FY 2004/2005 President's Budget Submission:	72,511	84,496	62,583	66,353

PROGRAM CHANGE SUMMARY EXPLANATION:
Schedule: Not applicable.
Technical: Not Applicable.

FY 2004/2005 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2003
Exhibit R-2a

BUDGET ACTIVITY: 2 PROGRAM ELEMENT: 0602747N Project Title: Undersea
PROGRAM ELEMENT TITLE: Undersea Warfare Applied Research 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
Undersea Warfare Applied Research	72,511	84,496	62,583	66,353	63,554	64,170	65,364	66,619

A. MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: All Navy advanced technology development in undersea target detection, classification, localization, tracking and neutralization is funded through this project. Technologies being developed within this program are aimed at enabling Sea Shield, one of the three core operational concepts detailed in the Naval Transformational Roadmap. Associated efforts focus on new anti-submarine warfare (ASW) operational concepts that promise to improve wide-area surveillance, detection, localization, tracking and attack capabilities against quiet adversary submarines operating in noisy and cluttered shallow water environments. Related efforts are aimed at leveraging technologies that will protect the country's current capital investment in surveillance, submarine, surface ship and air ASW assets.

B. ACCOMPLISHMENTS/PLANNED PROGRAM:

	FY02	FY03	FY04	FY05
Wide Area Anti-Submarine (ASW) Surveillance	13,323	18,016	17,663	18,072

Wide Area ASW Surveillance is focused on dramatically improving the capability to sanitize large areas relative to the capabilities of legacy ASW sensors. Efforts include the development of affordable off-board systems with associated processing and robust, high bandwidth communications links. The cornerstone of Wide Area Surveillance is the ability to rapidly distribute acoustic and non-acoustic sensors from air, surface and sub-surface platforms as well as to develop long-endurance sensors and unmanned ASW vehicles. This program area represents a shift from traditional fixed surveillance systems to autonomous, networked-components, multi-static operation, and supported by passive/active signal processing all with the objective of increased detection capabilities.

FY 2002 ACCOMPLISHMENTS:

- **Non-Acoustic ASW/Data Fusion Technology**

  Initiated:

  - Project to miniaturize Deployable Autonomous Distributed System (DADS) sensor and control nodes by a factor of 10 with equal or better performance for littoral ASW applications.

  Continued:

  - Development of ultra-low power electronics to support ASW advanced maritime remote sensing devices.

- **Active Undersea Signal Processing**

Initiated:
- Performance evaluation of a multistatic sonar system using air-deployed explosive sound sources and sonobuoys based on an operational concept called "non-traditional scattering".

Continued:
- Development of signal processing algorithms that reduce the number of clutter-generated false alerts, thereby improving the ability to detect weak submarine echoes.
- Development of signal processing techniques for detection, classification, and localization of threat submarines using coherent sources in a multistatic sonar system.
- Development of improved signal processing techniques for use with multistatic sonar systems that employ explosive sound sources.

- **Passive Undersea Signal Processing**

Completed:
- Development of acoustic signal processing detection, classification, and localization techniques for autonomous undersea applications.
- 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.

- **Air and Deployable ASW Sensors/Systems**

Continued:
- An assessment exploring the feasibility of using acoustic intensity sensors as active receivers for ASW applications.
- Development of an enhanced acoustic sparker source for environmental sensing and air-deployed ASW sensor applications.
- Development of system components that enable ultra-lightweight, ultra-low power air-, surface ship- or submarine-deployable, Matched Field Tracking Arrays to be used for barrier or area surveillance.
- Development of the technology to enable Telesonar acoustic communications for deployable systems.

Completed:
- In-air technical feasibility demonstrations of an X-Glider Unmanned Autonomous Vehicle (UAV) to remotely deploy multiple ASW sensors to predetermined locations.
- Assessment and final report of the technical feasibility of a partial-aperture Matched Field Tracking Array following in-water testing.

- **Multistatic ASW (Component of LASW Future Naval Capability (FNC))**

Initiated:
- Development of small, cheaper low frequency active sonar transducers for use in Navy multistatic sonar systems.
- Development and at-sea testing of Compact Deployable Multistatic Receiver (CDMR) hardware and software.
- Analysis of FY 02 multi-static source sea-test data.

Continued:

- At-sea testing of a low-frequency, submarine deployed autonomous source.
- Development and testing of signal processing software for the Compact Deployable Multistatic Receiver. Each software "build" incrementally increases the amount of processing performed in the sonobuoy and decreases the amount of data that needs to be transmitted to the command center.
- Development of threat target scattering databases using scale model submarines to enable the continuing development of forward scattering echo detection algorithms.
- Extension of Hidden Markov Model techniques to identify/classify submarine-like targets and additional environmental factors that produce scattering. Incorporated acoustic waveguide effects into the Hidden Markov Model algorithms.

Completed:
- Initial demonstration of a multistatic sonar signal processing system for submarines using a towed array to receive signals and a moored low frequency acoustic source to transmit signals.
- Development of large-aperture planar arrays and technologies for packaging them in deployable systems.
- Development of low-frequency, submarine, off-board, multi-static source hardware, signal processing algorithms, and performance prediction tools.
- Assembly of a laboratory test bed to test end-to-end performance of Compact Deployable Multistatic Receiver signal processing software.

FY 2003 PLANS:

- **Non-Acoustic ASW/Data Fusion Technology**

  Continue:
  - Development of ultra-low power electronics to support ASW advanced maritime remote sensing devices.
  - Project to miniaturize DADS sensor and control nodes by a factor of 10 with equal or better performance for littoral ASW applications.
- **Active Undersea Signal Processing**

  Continue:
  - Performance evaluation of a multistatic sonar system using air-deployed explosive sound sources and sonobuoys based on an operational concept called "non-traditional scattering".
  - Development of signal processing algorithms that reduce the number of clutter-generated false alerts, thereby improving the ability to detect weak submarine echoes.
  - Development of signal processing techniques for detection, classification and localization of threat submarines using coherent sources in a multistatic sonar system.
  - Development of improved signal processing techniques for use with multistatic sonar systems that employ explosive sound sources.
- **Air and Deployable ASW Sensors/Systems**

  Initiate:

- Development of computational intelligence algorithms aimed at efficiently and effectively activating a multistatic field of air-deployed sources and receivers.
- Development of volumetric arrays for deployables capable of tactically significant gains.

Continue:
- An assessment exploring the feasibility of using acoustic intensity sensors as active receivers for ASW applications.
- Development of the technology to enable Telesonar acoustic communications for deployable systems.

Complete:
- Development of system components that enable ultra-lightweight, ultra-low power air-, surface ship- or submarine-deployable, Matched Field Tracking Arrays to be used for barrier or area surveillance.
- Development of an enhanced acoustic sparker source for environmental sensing and air-deployed ASW sensor applications.

- **Multistatic ASW (Component of LASW FNC)**

Initiate:
- Development of "field-level" processing that combines data provided by many Compact Deployable Multistatic Receivers distributed across a large ocean region, and produces tracks of submarines moving through the region.
- Transducer, power source and power amplifier development for the new aircraft-deployable Compact Deployable Multistatic Acoustic Sound Source.

Continue:
- Development and at-sea testing of Compact Deployable Multistatic Receiver hardware and software.
- Development and testing of signal processing software for the Compact Deployable Multistatic Receiver. Each software "build" incrementally increases the amount of processing performed in the sonobuoy and decreases the amount of data that needs to be transmitted to the command center.
- Development of small, cheaper low-frequency active source transducers for use in Navy multistatic sonar systems.
- Development and at-sea testing of Compact Deployable Multistatic Receiver hardware and software.
- Extension of Hidden Markov Model techniques to identify/classify submarine-like targets and additional environmental factors that produce scattering. Incorporated acoustic waveguide effects into the Hidden Markov Model algorithms.

Complete:
- At-sea testing of a low frequency, submarine-deployed autonomous acoustic source.
- Analysis of FY 02 multi-static source sea-test data.
- Integration of Hidden Markov Model techniques with traditional submarine tracking algorithms and evaluate overall effectiveness for in shallow water ASW applications.
- Transition to Naval Air Systems Command (NAVAIR) Extended Echo Ranging (EER) 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.

FY 2004 PLANS:

- **Non-Acoustic ASW/Data Fusion Technology**
  Continue:
  - Project to miniaturize DADS sensor and control nodes by a factor of 10 with equal or better performance for littoral ASW applications.
  Complete:
  - Development of ultra-low power electronics to support advanced ASW maritime remote sensing devices.
- **Active Undersea Signal Processing**
  Initiate:
  - Development of signal processing algorithms for multistatic sonar systems that have controllable transmit waveform type and ping schedule leading to improved detection and tracking of submarine targets.
  Continue:
  - Development of signal processing algorithms that reduce the number of clutter-generated false alerts, thereby improving the ability to detect weak submarine echoes.
  - Development of signal processing techniques for detection, classification and localization of threat submarines using coherent sources in a multistatic sonar system.
  - Development of improved signal processing techniques for use with multistatic sonar systems that employ explosive sound sources.
  Complete:
  - Performance evaluation of a multistatic sonar system using air-deployed explosive sound sources and sonobuoys based on an operational concept called “non-traditional scattering”.
- **Air and Deployable ASW Sensors/Systems**
  Initiate:
  - Development of encoded Low Probability of Intercept (LPI) transmit acoustic waveforms for use with multistatic active sources. The intent is to ensure enemy submarines remain unaware they are operating inside a multistatic sensor field.
  Continue:
  - Development of computational intelligence algorithms aimed at efficiently and effectively activating a multistatic field of air-deployed sources and receivers.
  - Development of the technology to enable Telesonar acoustic communications for deployable systems.
  Complete:
  - An assessment exploring the feasibility of using acoustic intensity sensors as active receivers for ASW applications.
  - Development of volumetric arrays for deployables capable of tactically significant gains.
- **Multistatic ASW (Component of LASW FNC)**
  Initiate:

- At-sea testing of the integrated multistatic sonar system, comprised of the signal processing software, "field-level" processing, the Compact Deployable Multistatic Receiver and the Compact Deployable Multistatic Source.

Continue:

- Development and testing of signal processing software for the Compact Deployable Multistatic Receiver. Each software "build" incrementally increases the amount of processing performed in the sonobuoy and decreases the amount of data that needs to be transmitted to the command center.
- Development of small, cheaper low-frequency active source transducers for use in Navy multistatic sonar systems.
- Development of "field-level" processing that combines data provided by many Compact Deployable Multistatic Receivers distributed across a large ocean region, and produce tracks of submarines moving through the region.
- Research to optimize in-situ multi-static active sonar performance based on broadband, physics-based scattering models and environmental feedback algorithms.

Complete:

- Transducer, power source and power amplifier development and integration for the new aircraft-deployable Compact Deployable Multistatic Source.
- Development and at-sea testing of Compact Deployable Multistatic Receiver hardware and software.

FY 2005 PLANS:

- **Non-Acoustic ASW/Data Fusion Technology**

Initiate:

- Development of an advanced mobile node design for DARWIN (DADS Advanced Research for Wireless Instrumented Networks) ASW applications.

Continue:

- Project to miniaturize DADS sensor and control nodes by a factor of 10 with equal or better performance for littoral ASW applications.

Complete:

- Design of a prototype node that will resist damage from trawling/fishing equipment.

- **Active Undersea Signal Processing**

Continue:

- Development of signal processing algorithms for multistatic sonar systems that have controllable transmit waveform type and ping schedule leading to improved detection and tracking of submarine targets.
- Development of signal processing algorithms that reduce the number clutter-generated false alerts, thereby improving the ability to detect weak submarine echoes.

- Development of signal processing techniques for detection, classification and localization of threat submarines using coherent sources in a multistatic sonar system.

Continue:

- Development of improved signal processing techniques for use with multistatic sonar systems that employ explosive sound sources.

- **Air and Deployable ASW Sensors/Systems**

Continue:

- Development of encoded LPI transmit acoustic waveforms for use with multistatic active sources. The intent is to ensure enemy submarines remain unaware they are operating inside a multistatic sensor field.
- Development of the technology to enable Telesonar acoustic communications for deployable systems.
- Development of computational intelligence algorithms aimed at efficiently and effectively activating a multistatic field of air-deployed sources and receivers.

- **Multistatic ASW (Component of LASW FNC)**

Continue:

- At-sea testing of the integrated multistatic sonar system, comprised of the signal processing software, "field-level" processing, the Compact Deployable Multistatic Receiver and the Compact Deployable Multistatic Source.
- Research to optimize in-situ multi-static active sonar performance based on broadband, physics-based scattering models and environmental feedback algorithms.

Complete:

- Development and testing of signal processing software for the Compact Deployable Multistatic Receiver. Each software "build" incrementally increases the amount of processing performed in the sonobuoy and decreases the amount of data that needs to be radioed back to the command center.
- Development of improved, small-size, less expensive, low-frequency, active source transducers for use in Navy multistatic sonar systems. Development of "field-level" processing that combines data provided by many the outputs of a Compact Deployable Multistatic Receivers distributed across a large ocean region, and produce tracks of submarines moving through the region.

	FY02	FY03	FY04	FY05
Battlegroup Anti-Submarine Warfare (ASW) Defense	30,356	26,545	26,161	27,850

Battlegroup ASW Defense technology focuses on the development of platform-based sources and receivers aimed at denying submarines the ability to target grey ships. This technology area is primarily concerned with detections inside 10 nm. Battlegroup ASW Defense integrates next-generation technologies, automatic target recognition, sensors that adjust to complex acoustic environments, and environmentally adaptive processing techniques. Battlegroup ASW Defense will enable smaller, lighter, and cheaper acoustic/non-acoustic arrays, large multi-line arrays, and submarine flank arrays all with environmental adaptation capabilities.

FY 2002 ACCOMPLISHMENTS:

- **Non-Acoustic ASW and Data Fusion Technology**

  Continued:
  - Sea tests of optical standoff sensor systems.
  - Design and integration of an Ultra Low Frequency/Extremely Low Frequency (ULF/ELF) Electromagnetic (EM) submarine Multi-Mode Magnetic Detection System (MMMDS) mounted on Vertical Take-off Unmanned Autonomous Vehicles (VTUAVs).

- **Active Undersea Signal Processing**

  Initiated:
  - Development of signal processing techniques that combine multiple waveforms from echo returns before tracks are formed. This effort has the potential to improve detection performance and holding times for surface ship sonar systems.

  Continued:
  - Development of signal processing improvements for coherent tactical active sonar systems aimed at improving the ability to detect, classify and locate small, slow moving submarines in shallow water environments.
  - Investigation of synthetic aperture sonar techniques for improving target and clutter classification performance in tactical ASW sonar systems operating in shallow water environments.
  - Investigations into time-reversal techniques that exploit the diversity of the shallow water underwater acoustic channel to improve the performance of active sonar systems.

  Completed:
  - Ultra-wide waveform target strength model-based measurements and associated modeling.

- **Platform Sensors and Arrays**

  Initiated:
  - Evaluation of Reduced Diameter fiber optic sensors to improve towed array reliability.
  - Development of sensors and algorithms to address degradation of towed array performance during operational maneuvers and turns.
  - Research to design high frequency, high dynamic-range fiber optic acoustic sensors.
  - Research to develop the virtual sonar array concept for any hull-mounted sonar (e.g., submarine, autonomous underwater vehicle, torpedo).

  Continued:
  - Development of conformal hull array designs of significantly greater aperture and reduced volume and weight for application to the high frequency sail array designs for 688- and Virginia-class submarines.
  - Development of low cost Fishline fiber optic array for platform-deployed ASW-sensors.
  - Fabricated and tested the response of long sections of polymer coated fibers.

  Completed:

- Development of Volumetric (multi-line) towed array aperture control; multi-line array transitioned the Advanced Systems Technology Office (ASTO), SEA-93, P.E. 0603561N.

- **Acoustic Sources and Materials**

  Initiated:
  - Development of compact, broadband, high frequency cymbal arrays that will provide greater than one octave transmit capability above 10 kHz for conformal array applications.

  Continued:
  - 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.

- **High Frequency Broadband Transducer and Arrays for Submarines (Component of Littoral Anti-Submarine Warfare (LASW) Future Naval Capability (FNC)).**

  Initiated:
  - Development of outboard power electronics and controls for conformal arrays with a highly reliable and low-profile design.

  Continued:
  - Development of in-situ calibration techniques to monitor large conformal arrays.

  Completed:
  - Development of the Magnetostrictive Piezoelectric Transducer (MPT) array for the High Frequency (HF) conformal program that can deliver high power over a 2+ octave frequency band.
  - Development of HF broadband panel projector array for the HF conformal array with the capability of velocity control over the entire frequency band of operation.
  - Development of broadband hybrid transducer array for the Ballistic Missile Submarine (SSBN) program. Demonstrated this more reliable, modern replacement transducer on an SSBN test platform.

- **Environmentally Adaptive (EA) AN/SQQ-89 (Component of LASW FNC)**

  Continued:
  - 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.
  - Testing of environmentally adaptive signal processing techniques in multiple fleet operational efforts.

  Completed:
  - Transition of environmentally adaptive processing development for non-Gaussian background noise.

- **Sonar Automation (Component of LASW FNC)**

  Initiated:
  - Sonar automation technology development plan to be used as a long-term master plan for the 6-year Sonar Automation Program.

- Development and demonstration of signal processing algorithms designed to detect and classify acoustic signatures of threat submarines.

Continued:

- Characterization of undersea threat signals and clutter to be used to design new signal processing algorithms for submarine and surveillance passive sonar systems.

- **Limits of Passive Sonar (Component of LASW FNC)**

Initiated:

- Passive acoustic array test-bed design and hardware component procurement to support future passive sonar system designs.

- **Counter Torpedo Detection, Classification, and Localization (CTDCL) (Component of LASW FNC)**

Initiated:

- System requirements definition for the AN/WSQ-11 "Tripwire" system that will protect surface ships from torpedo salvo attacks.
- Hardware risk-reduction efforts for the AN/WSQ-11 "Tripwire" to protect surface ships from torpedo salvo attacks.

FY 2003 PLANS:

- **Non-Acoustic ASW and Data Fusion Technology**

Continue:

- Optical standoff sensor platform installation and performance testing.
- Design and integration of the MMMDS mounted on VTUAVs.

Complete:

- Sea tests of optical standoff sensor systems.

- **Active Undersea Signal Processing**

Initiate:

- Development of improved techniques to distinguish submarine echoes from echoes produced by ocean bottom features using an understanding of the reflective properties of the ocean bottom and its underlying geologic foundation.

Continue:

- Development of signal processing improvements for coherent tactical active sonar systems aimed at improving the ability to detect, classify and locate small, slow moving submarines in shallow water environments.
- Investigation of synthetic aperture sonar techniques for improving target and clutter classification performance in tactical ASW sonar systems operating in shallow water environments.
- Investigations into time-reversal techniques that exploit the diversity of the shallow water underwater acoustic channel to improve the performance of active sonar systems.

Complete:

- Development of signal processing techniques that combine multiple waveforms from echo returns before tracks are formed. This effort has the potential to improve detection performance and holding times for surface ship sonar systems.

- **Passive Undersea Signal Processing**

Initiate:

- Development and evaluation of advanced sonar signal classification algorithms, using "support vector machines," that allow sonar system operators to compensate for local noise conditions and therefore improve their performance.

- **Platform Sensors/Arrays**

Initiate:

- Development of Vector Sensor Line Array with piezocrystal vector sensors for improved signal-to-noise and bandwidth.
- Development of Acoustic Flux Sensor for affordable improvement of sonar signal-to-noise.
- Development of a geo-acoustic inversion capability for submarines that uses data from the submarine's passive towed array.

Continue:

- Development of Reduced Diameter fiber optic sensor to improve towed array reliability.
- Development of sensors and algorithms to address degradation of towed array performance during operational maneuvers and turns.
- Fabrication of low cost Fishline fiber optic array for platform-deployed ASW-sensors.
- Assembly and laboratory measurements of a large aperture virtual sonar array.
- Fabrication and calibration of individual high frequency fiber optic sensors.
- Development of conformal hull array designs of significantly greater aperture and dramatically reduced volume and weight for application to the high frequency sail array designs for 688- and Virginia-class submarines.

Complete:

- Fabrication and field-testing of the performance of a complete polymer coated fiber array.

- **Acoustic Sources and Materials**

Initiate:

- Design and development of underwater projectors utilizing structural magnetostrictive material.
- Development of baffled ring transducer technology.

Continue:

- 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.
- Development of compact, high frequency cymbal transducer (a Class V flextensional transducer) for inclusion into a thin conformal array less than one-half inch thick.

- Development of Lead Zirconate Titanate materials 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.

- **High Frequency Broadband Transducer and Arrays for Submarines (Component of LASW FNC)**
  Initiate:
  - Testing of prototype candidate transducer arrays for down-select and development of final array test plans.
  Continue:
  - Development of outboard power electronics and controls for conformal arrays with a highly reliable and low-profile design.
  Complete:
  - Development of in-situ calibration techniques to monitor large conformal arrays.
  - Testing of prototype candidate transducer arrays for down-select to a prototype array contract.
- **EA AN/SQQ-89 (Component of LASW FNC)**
  Complete:
  - 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.
  - Testing of environmentally adaptive signal processing techniques in multiple fleet operational efforts.
  - Development of EA AN/SQQ-89 signal processing techniques.
- **Sonar Automation (Component of LASW FNC)**
  Continue:
  - Development and demonstration of signal processing algorithms designed to detect and classify acoustic signatures of threat submarines.
  - Characterization of undersea threat signals and clutter to be used to design new signal processing algorithms for submarine and surveillance passive sonar systems.
  Complete:
  - Sonar automation technology development plan to be used as a long-term plan for the 6-year Sonar Automation Program.
- **Limits of Passive Sonar (Component of LASW FNC)**
  Continue:
  - Passive acoustic array test-bed design and hardware component procurement to support future passive sonar system designs.
- **Counter Torpedo Detection, Classification, and Localization (CTDCL) (Component of LASW FNC)**
  Initiate:
  - Development of signal processing and system control algorithm for the AN/WSQ-11 “Tripwire” torpedo protection system.

- Development of an AN/WSQ-11 "Tripwire" testbed for the testing of signal processing and system control algorithms.
-

Continue:
- System requirements definition for the AN/WSQ-11 "Tripwire" system that will protect surface ships from torpedo salvo attacks.
- Hardware risk-reduction efforts for the AN/WSQ-11 "Tripwire" to protect surface ships from torpedo salvo attacks.

FY 2004 PLANS:

- **Non-Acoustic ASW and Data Fusion Technology**

Initiate:
- Advanced algorithm development for MMMDS.

Continue:
- Design and integration of the MMMDS mounted on VTUAVs.

Complete:
- Prototype MMMDS design.

- **Active Undersea Signal Processing**

Initiate:
- Development of active sonar signal processing techniques for surface ship sonar systems to detect, classify and localize torpedoes and autonomous underwater vehicles.

Continue:
- Development of improved techniques to distinguish submarine echoes from echoes produced by ocean bottom features using an understanding of the reflective properties of the ocean bottom and its underlying geologic foundation.
- Development of signal processing improvements for coherent tactical active sonar systems aimed at improving the ability to detect, classify and locate small, slow moving submarines in shallow water environments.
- Investigation of synthetic aperture sonar techniques for improving target and clutter classification performance in tactical ASW sonar systems operating in shallow water environments.
- Investigations into time reversal techniques that exploit the diversity of the shallow water underwater acoustic channel to improve the performance of active sonar systems.

Passive Undersea Signal Processing

Initiate:

- Concept development of sonar system automation technologies that automatically guide system operators through the complicated sequence operations required to detect, classify and track threat submarines.

Complete:

- Development and evaluation of advanced sonar signal classification algorithms, using "support vector machines," that allow sonar system operators to compensate for local noise conditions and therefore improve their performance.

- **Platform Sensors/Arrays**

Continue:

- Development of Reduced Diameter fiber optic sensor to improve towed array reliability.
- Development of sensors and algorithms to address degradation of towed array performance during operational maneuvers and turns.
- Development of a Vector Sensor Line Array with piezocrystal vector sensors for improved signal-to-noise and bandwidth.
- Development of Acoustic Flux Sensor for affordable improvement of sonar signal-to-noise.
- Development of a geo-acoustic inversion capability for submarines that uses data from the submarine's passive towed array. Demonstrate geo-acoustic inversion using own ship noise.

Complete:

- Testing of low cost Fishline fiber optic array for platform-deployed ASW-sensors.
- At-sea testing and evaluation of Vector Sensor Line Array with piezocrystal vector sensors for improved signal to noise and bandwidth.
- Development of Conformal Hull Array designs of significantly greater aperture and reduced volume and weight for application to high frequency sail array designs for the 688- and Virginia-class submarines. Transition to the Advanced Systems Technology Office (ASTO), SEA-93, Program Element 0603561N.
- Fabrication and calibration of individual high frequency fiber optic sensors, and testing the high frequency acoustic array in the lab and in a field demonstration.
- Assembly and laboratory measurements of a large aperture virtual sonar array.

- **Acoustic Sources and Materials**

Initiate:

- Development of a hybrid sensor to detect both acoustic and magnetic signatures.
- Development of miniature underwater sources and sensors that mimic biological processes for use in small Unmanned Underwater Vehicles (UUVs).

Continue:

- Design and development of underwater projectors using structural magnetostrictive materials.
- 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.
- Development of baffled ring transducer technology.

Complete:

- Development of compact, high frequency cymbal transducers for inclusion into a thin conformal array less than one-half inch thick.

- **High Frequency Broadband Transducer and Arrays for Submarines (Component of LASW FNC)**
  This effort has been terminated. Final analysis and documentation will be developed as part of Program Element 0603747N.
- **Sonar Automation (Component of LASW FNC)**
  Continue:
  - Development and demonstration of signal processing algorithms designed to detect and classify acoustic signatures of threat submarines.
  - Characterization of undersea threat signals and clutter to be used to design new signal processing algorithms for submarine and surveillance sonar systems.
- **Limits of Passive Sonar (Component of LASW FNC)**
  Complete:
  - Passive acoustic array test-bed design and hardware component procurement to support future passive sonar system designs.
- **Counter Torpedo Detection, Classification, and Localization (CTDCL) (Component of LASW FNC)**
  Continue:
  - Development of signal processing and system control algorithm for the AN/WSQ-11 "Tripwire" torpedo protection system.
  - Development of an AN/WSQ-11 "Tripwire" testbed for the testing of signal processing and system control algorithms.

  Complete:
  - System requirements definition for the AN/WSQ-11 "Tripwire" system that will protect surface ships from torpedo salvo attacks.
  - Hardware risk-reduction efforts for the AN/WSQ-11 "Tripwire" to protect surface ships from torpedo salvo attacks.

FY 2005 PLANS:

- **Non-Acoustic ASW and Data Fusion Technology**
  Initiate:
  - Testing of the MMMDS on VTAUVs.

  Continue:
  - Advanced algorithm development for the MMMDS.

  Complete:
  - Testing of the prototype MMMDS design.
- **Active Undersea Signal Processing**

Initiate:
- Development of an integrated solution to environmentally adaptive signal processing, incorporating environmental sensing, adaptive transmit waveforms, and receive signal processing.

Continue:
- Development of active sonar signal processing techniques for surface ship sonar systems to detect, classify and localize torpedoes and autonomous underwater vehicles.
- Development of improved techniques to distinguish submarine echoes from echoes produced by ocean bottom features using an understanding of the reflective properties of the ocean bottom and its underlying geologic foundation.
- Development of signal processing improvements for coherent tactical active sonar systems aimed at improving the ability to detect, classify and locate small, slow moving submarines in shallow water environments.

Complete:
- Investigation of synthetic aperture sonar techniques for ASW tactical towed array applications.
- Investigations into time reversal techniques that exploit the diversity of the shallow water underwater acoustic channel to improve the performance of active sonar systems.

- **Passive Undersea Signal Processing**

Complete:
- Concept development of sonar system automation technologies that automatically guide system operators through the complicated sequence operations required to detect, classify and track threat submarines.

- **Platform Sensors/Arrays**

Initiate:
- Development of low cost, compact, combined acoustic sensor.

Continue:
- Development of low cost, compact, fiber-laser acoustic motion sensor.
- Development of Vector Sensor Line Array with piezocrystal vector sensors fro improved signal-to-noise and bandwidth.
- Development of Acoustic Flux Sensor for affordable improvement of sonar signal-to-noise.
- Development of a geo-acoustic inversion capability for submarines that uses data from the submarine's passive towed array. Demonstrate using an operational Navy asset.

Complete:
- Evaluation of Reduced Diameter fiber-optic sensor to improve towed array reliability. Transition to the Advanced Systems Technology Office (ASTO), SEA-93, Program Element 0603561N.
- Evaluation of sensors and algorithms to address degradation of towed array performance during operational maneuvers and turns. Transition to the Advanced Systems Technology Office (ASTO), SEA-93, Program Element 0603561N.

- **Acoustic Sources and Materials**

Continue:
- Development of miniature underwater sources and sensors that mimic biological processes for use in small UUVs.
- 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.
- Development of baffled ring transducer technology.

Complete:
- Design and development of underwater projectors using structural magnetostrictive materials.
- Development of a hybrid sensor to detect both acoustic and magnetic signatures.

- **Limits of Passive Sonar (Component of LASW FNC)**

Initiate:
- Focused research program to establish fundamental limits of passive sonar performance in shallow water using the passive acoustic array test-bed.

- **Counter Torpedo Detection, Classification, and Localization (CTDCL) (Component of LASW FNC)**

Continue:
- Development of signal processing and system control algorithm for the AN/WSQ-11 "Tripwire" torpedo protection system.
- Development of an AN/WSQ-11 "Tripwire" testbed for the testing of signal processing and system control algorithms.

	FY02	FY03	FY04	FY05
Neutralization	25,947	23,415	18,759	20,431

This effort includes:

- **Counterweapon/Countermeasure** effort develops technologies that will increase the probability of survival for surface and submarine platforms against torpedo threats.
- **Explosives and Undersea Warheads** effort develops technologies with significant enhancement in capabilities over current technologies.
- **Non-Traditional Homing (Component of Littoral Anti-Submarine Warfare (LASW) Future Naval Capability (FNC))** addresses the development of the operational utility of a stealthy torpedo detection, classification and homing sensor. This is a high risk development that holds promise for providing an improvement in probability of kill that is revolutionary.
- **Weapon Silencing** addresses noise control techniques to reduce radiated noise of torpedoes.
- **Weapon Simulation Based Design** addresses design tools and optimization methods for torpedoes.
- **Supercavitation Technology** addresses physics of supercavitation, and vehicle control and guidance for high-speed torpedo.

- **Torpedo Propulsion** addresses advanced torpedo propulsion including both electric and thermal power sources. This effort also addresses the Office of Naval Research (ONR) propulsion program for high-speed supercavitating weapons focusing on power sources based on water-combustion of hydro-reactive metallic fuels.
- **Weapon Guidance and Control** includes advanced waveforms (e.g. low-probability-of-intercept waveforms), detection algorithms, adaptive canceling algorithms, frequency-domain beamforming, adaptive normalization, target-angle estimation, target classification, acoustic arrays, auxiliary non-acoustic sensors, algorithms for exploiting multi-sensor data (data fusion), and algorithms for mission planning and weapon control.
- **Weapon/Platform Connectivity (Component of LASW FNC)** develops technologies to dramatically improve tactical control for submarine-on-submarine engagements by increasing torpedo placement accuracy, improving target detection probability, and enhancing torpedo homing fidelity.
- **SwampWorks Advanced Torpedo (SAT)** effort develops technologies to meet emerging challenges of low Doppler, small targets (diesel submarines), in harsh littoral environments.

FY 2002 ACCOMPLISHMENTS:

- **Counterweapon/Countermeasure**
  Continued:
  - Development of technologies for terminal defense against close-in waterborne/underwater threats and high-speed weapons.
  Completed
  - Transfer of technology development for Anti-Torpedo Torpedo (ATT) and Next Generation Countermeasure (NGCM) to Fleet/Force Protection FNC (F/FP FNC).
- **Explosive and Undersea Warheads**
  Continued:
  - Development of directed energy concept proof of principle for enhanced performance undersea warhead. Development of this advanced concept will permit enhanced performance torpedo warheads in reduced volumes.
  - 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.
  Completed:
  - Development of underwater explosive effects hydrocode that provides computational methods to accurately evaluate the effects of damage resulting from underwater explosions.
  - Development of Micro Electro-Mechanical Systems (MEMs) Safing and Arming (S&A) technology. This capability permits reduction of size and cost of future torpedo S&A systems by up to 90%.
- **Non-Traditional Homing**
  Continued:

- Development of a non-traditional torpedo homing concept to provide a robust adjunct homing capability - including proof of concept in-water, pier-side testing of an alternative sensor.

- **Weapon Silencing**
  Continued:
  - Development of a low noise integrated motor propulsor entitled Low Acoustic Signature Motor/Propulsor for Electrically Powered Undersea Vehicles (LAMPrEy) to enhance weapon silencing.
  - Development of an Active Noise Control technology that reduces vehicle shell vibration and noise radiation using Active Fiber Composite materials.
  - Development of active-passive mount technologies for reducing weapon machinery noise by conducting laboratory experiments and demonstrations.

  Completed:
  - Development of torpedo noise modeling and incorporated it into the Undersea Weaponry Design and Optimization (UWDO) design toolbox.
  - In-water demonstration of smart skin torpedo noise radiation control concepts.
- **Weapon Simulation Based Design**
  Continued:
  - 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.

  Completed:
  - Development of design architecture and tools for 6.25 inch weapon, and transitioned design tools to Naval Under Warfare Center's (NUWC) Electric Lightweight Torpedo.
- **Supercavitation Technology**
  Continued:
  - Development of high-speed supercavitating torpedo vehicle control and homing sensor. Continue to conduct experiments and tests on vehicle control concepts and homing sensors.

  Completed:
  - Development of simulation codes for high-speed supercavitating torpedo. Conducted first free-running 4-inch vehicle testing in water.
- **Torpedo Propulsion**
  Continued:
  - 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 hydro-reactive materials.
- **Weapons Guidance and Control**
  Continued:

- Development of innovative adaptive broadband signal processing algorithms that will improve a torpedo's single-ping detection, classification and localization performance. This initiative investigated signal processing advancements made in the radar community.
- Development of technologies to support connectivity between torpedo and platform sensors. This included generation of a fire-control-quality track by combining information from multiple platform sensors, communication between a torpedo and platform-sensor nodes in motion, and guidance of the torpedo using platform-sensor information to defeat countermeasures and threat evasive maneuvers.

- **Weapon/Platform Connectivity**

  Continued:
  - 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.

  Completed:
  - A favorable assessment of the value of alternative torpedo intelligent controller technologies relative to the controller employed in current Fleet heavyweight torpedos.

- **SwampWorks Advanced Torpedo (SAT)**

  Initiated:
  - Development of a next-generation prototype heavyweight torpedo (SwampWorks Advanced Torpedo) effective in meeting new challenges of low Doppler, small targets (diesel submarines), in the harsh littoral environments.

  Completed:
  - Development and demonstration of the feasibility of the advanced half-length torpedo via a series of subsystem and vehicle demonstrations.
  - Demonstration of vehicle self noise, stability and control, and proof-of-concept littoral upgrade to the MK 48 advanced capability (ADCAP) sonar as well as broadband recording system

FY 2003 PLANS:

- **Counterweapon/Countermeasure**

  Continue:
  - Development of technologies for terminal defense against close-in waterborne/underwater threats and high-speed weapons.

- **Explosive and Undersea Warheads**

  Continue:
  - Development of directed energy concept proof of principle for enhanced performance undersea warhead. Development of this advanced concept will permit enhanced performance torpedo warheads in reduced volumes.
  - 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.

- **Non-Traditional Homing**
  Continue:
  - Development of a non-traditional torpedo homing concept to provide a robust adjunct homing capability - including proof of concept in-water testing of an alternative sensor and associated detection and tracking algorithms on a submarine.
- **Weapon Silencing**
  Initiate:
  - Conduct in-water testing of integrated motor propulsor-- LAMPrEy.

  Continue:
  - Development of a low noise integrated motor propulsor project entitled LAMPrEy to further enhance the Torpedo Stealth effort.
  - Development of affordable noise control concepts for machinery and propulsor radiated noise.

  Complete:
  - Development of active-passive mounts for reducing weapon machinery noise.
  - Active controller hardware implementation in Active Fiber Composites effort.
- **Weapon Simulation Based Design**
  Continue:
  - Development of a Weapon Design and Optimization capability in a virtual environment using results of FY01 and FY02 efforts.
  - Implementation of Multidisciplinary Design Optimization (MDO) in weapon design.
  - Optimization of undersea weapon system designs with respect to cost and performance requirements.

  Complete:
  - Warhead and Guidance & Control sections design using UWDO tools.
- **Supercavitation Technology**
  Initiate:
  - In-water testing of 4-inch vehicle with vehicle control devices and homing sensors.

  Continue:
  - Development of high-speed supercavitating torpedo vehicle control and homing sensors.
  - Experiments and tests on vehicle control concepts and homing sensors.

  Complete:
  - Computational Fluid Dynamics (CFD) codes development and vehicle simulation.
- **Torpedo Propulsion**
  Continue:
  - 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 concepts development for hybrid propulsion systems, high power rechargeable batteries, micro-turbines, and hydro-reactive materials.

- **Weapons Guidance and Control**
  Initiate:
  - Development of improved modeling and simulation capabilities, including improved threat models, torpedo system models and acoustic environment simulation. Establish Navy-wide modeling standards for the development, maintenance and testing of software.

  Continue:
  - Development of innovative adaptive broadband signal processing algorithms that will improve a torpedo's single-ping detection, classification and localization performance. This initiative will investigate signal processing advancements made in the radar community.
  - Development of technologies to support connectivity between torpedo and platform sensors. This will include generation of a fire-control-quality track by combining information from multiple platform sensors, communication between a torpedo and platform sensor nodes in motion, and guidance of the torpedo using platform sensor information to defeat countermeasures and threat evasive maneuvers.
- **Weapon/Platform Connectivity**
  Continue:
  - 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.

  Complete:
  - Development of a high communications bandwidth fiber optic link between a submarine firing platform and a torpedo.
- **SwampWorks Advanced Torpedo (SAT)**
  Continue:
  - Development of a next-generation prototype heavyweight torpedo (SwampWorks Advanced Torpedo) effective in meeting new challenges of low Doppler, small targets (diesel submarines), in the harsh littoral environments.

  Completed:
  - Development of the fully functional sonar and signal processing system.
  - Development of a new rechargeable electric propulsion system for the weapon.

FY 2004 PLANS:

- **Counterweapon/Countermeasure**
  Continue:
  - Development of technologies for terminal defense against close-in waterborne/underwater threats and high-speed weapons.
- **Explosive and Undersea Warheads**
  Initiate:
  - Development of MEMS Inertial Measuring Unit (IMU) into the S&A. This will permit the reduction of the safe standoff distance required for a quick reaction weapon without any own-ship safety compromise.

Continue:
- Development of directed energy concept proof of principle for enhanced performance undersea warhead. Development of this advanced concept will permit enhanced performance torpedo warheads in reduced volumes.
- 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.

- **Non-Traditional Homing**

Initiate:
- Proof of concept in-water testing of a second alternative sensor and associated detection and tracking algorithms on a submarine.

Continue
- Development of a non-traditional torpedo homing concept to provide a robust adjunct homing capability.

Complete:
- Proof of concept in-water testing of an alternative sensor and associated detection and tracking algorithms on a submarine

- **Weapon Silencing**

Continue:
- Development of a low noise integrated motor propulsor project entitled LAMPrEy to further enhance the Torpedo Stealth effort.
- In-water testing of integrated motor propulsor—LAMPrEy.
- Development of affordable noise control concepts for machinery and propulsor radiated noise.

- **Weapon Simulation Based Design**

Continue:
- Development of a Weapon Design and Optimization capability in a virtual environment.
- Implementation of MDO in weapon design.
- Optimization of undersea weapon system designs with respect to cost and performance requirements.

- **Supercavitation Technology**

Continue:
- In-water testing of 4-inch vehicle with vehicle control devices and homing sensors.
- Development of high-speed supercavitating torpedo vehicle control and homing sensor.
- Experiments and tests on vehicle control concepts and homing sensors.

- **Torpedo Propulsion**

Continue:
- 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 concepts development for hybrid propulsion systems, high power rechargeable batteries, micro-turbines, and hydro-reactive materials.

- **Weapons Guidance and Control**
  Continue:
  - Development of innovative adaptive broadband signal processing algorithms that will improve a torpedo's single-ping detection, classification and localization performance.
  - Development of technologies to support connectivity between torpedo and platform sensors. This will include generation of a fire-control-quality track by combining information from multiple platform sensors, communication between a torpedo and platform sensor nodes in motion, and guidance of the torpedo using platform sensor information to defeat countermeasures and threat evasive maneuvers.
  - Development of improved modeling and simulation capabilities, including improved threat models, torpedo system models and acoustic environment simulation. Establish Navy-wide modeling standards for the development, maintenance and testing of software.
- **Weapon/Platform Connectivity**
  Continue:
  - 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.
  Complete:
  - A high fidelity concept of operations assessment of competing technologies being developed in this project.
- **SwampWorks Advanced Torpedo (SAT).**
  Continue:
  - Development of a next-generation prototype heavyweight torpedo (SwampWorks Advanced Torpedo) effective in meeting new challenges of low Doppler, small targets (diesel submarines), in the harsh littoral environments.
  Complete:
  - Demonstration of fully functional sonar and signal processing suite integrated within the fleet guidance and control section, and demonstrated in open water firings.
  - Demonstration of tactical benefit of a wakeless, quiet propulsion system.
  - Generate performance and cost models for evaluation in fleet acquisition and ownership models.

FY 2005 PLANS:

- **Counterweapon/Countermeasure**
  Continue:
  - Development of technologies for terminal defense against close-in waterborne/underwater threats and high-speed weapons.
- **Explosive and Undersea Warheads**
  Continue:
  - Development of directed energy concept proof of principle for enhanced performance undersea warhead. Development of this advanced concept will permit enhanced performance torpedo warheads in reduced volumes.

- 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 MEMS IMU into the S&A. This will permit the reduction of the safe standoff distance required for a quick reaction weapon without any own-ship safety compromise.

- **Non-Traditional Homing**
  Continue:
  - Development of a non-traditional torpedo homing concept to provide a robust adjunct homing capability - including upgrading the initial detection and tracking algorithms.
  Complete:
  - Proof of concept in-water testing of a second alternative sensor and associated detection and tracking algorithms on a submarine.
- **Weapon Silencing**
  Continue:
  - Development of affordable noise concepts for machinery and propulsor radiated noise.
  Complete:
  - Development and in-water testing of integrated motor propulsor— LAMPREY.
- **Weapon Simulation Based Design**
  Continue:
  - Development of a Weapon Design and Optimization capability in a virtual environment.
  - Implementation of MDO in weapon design.
  - Optimization of undersea weapon system designs with respect to cost and performance requirements.
- **Supercavitation Technology**
  Continue:
  - In-water testing of 4-inch vehicle with vehicle control devices and homing sensors.
  - Development of high-speed supercavitating torpedo vehicle control and homing sensor.
  - Experiments and tests on vehicle control concepts and homing sensors.
- **Torpedo Propulsion**
  Continue:
  - 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 concepts development for hybrid propulsion systems, high power rechargeable batteries, micro-turbines, and hydro-reactive materials.
- **Weapons Guidance and Control**
  Continue:

- 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.
- Development of innovative adaptive broadband signal processing algorithms that will improve a torpedo's single-ping detection, classification and localization performance.
- Development of technologies to support connectivity between a torpedo and platform sensors. This will include generation of a fire-control-quality track by combining information from multiple platform sensors, communication between a torpedo and platform sensor nodes in motion, and guidance of the torpedo using platform sensor information to defeat countermeasures and threat evasive maneuvers.
- Development of improved modeling and simulation capabilities, including improved threat models, torpedo system models and acoustic environment simulation. Establish Navy-wide modeling standards for the development, maintenance and testing of software.

- **Weapon/Platform Connectivity**
  Continue:
  - 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 including down-selecting between competing applied research approaches to fully coherent broadband processing to enable focusing of advanced development efforts.
- **SwampWorks Advanced Torpedo (SAT)**
  Complete:
  - In-water demonstration of SAT.

	FY02	FY03	FY04	FY05
Project Morgan	2,885	1,705	0	0

Details are of a higher classification.

Congressional Plus-Ups:

	FY02	FY03
Acoustic Temperature Profiler	0	2,494

Improve the Acoustic Temperature Profiler (ATP) measurement sensitivity across a wider range of depths, thereby increasing the accuracy of the Sound Velocity profile. The ATP is a technique that allows the temperature profile of the ocean to be measured nearly continuously. The Sound Velocity Profile (SVP) is a critical environmental parameter used for estimating and predicting sonar system performance. Phase III would improve ATP measurement sensitivity across a wider range of depths, thereby increasing the accuracy of the SVP.

	FY02	FY03
Lithium Carbon Monofluoride Battery	0	977

Conduct research into new Lithium Carbon Monofluoride Battery types and applications, to raise the operating temperature and to develop ultra-thin coin cells. This program would develop an advanced lithium/carbon monofluoride (Li/CFx) battery, containing a relatively low toxicity electrolyte and a safer, higher energy CFx cathode material which makes possible twice the mission time of naval mines and surveillance systems, versus present lithium batteries.

	FY02	FY03
Low Acoustic Signature Motors	0	2,054

Provide applied research to Low Acoustic Signature Motor/Propulsor for Electrically Powered Undersea Vehicles (LAMPREY) technology development. Modifications would be made to the propulsor/control surfaces/after body of the water tunnel test hardware; and the modified hardware would be installed on an at-sea test vehicle. The vehicle would be instrumented to measure propulsor shaft speed, motor operating conditions, and vibration of the propulsor and vehicle hull to help interpret radiated noise measurement results. The results would be reduced and interpreted to ascertain noise sources and levels to compare to water tunnel measurements, and to compare to design and performance prediction results.

	FY02	FY03
Magnetorestrictive Transduction	0	5,282

Conduct research involving magnetorestrictive materials and their uses. Effort focuses research to advance the state-of-the-art of giant magnetorestrictive materials in several areas to include: developing better methods of producing Galfenol materials; quantifying variability in TERFENOL-D production and the resulting impact to transducer designs; and integrating and testing at sea the Multiband transducer array on a WLD-1 Remote Minehunting Vehicle.

	FY02	FY03
SAUVIM	*0	1,662

*$1,644 (Appropriated in FY02 in PE 0602633N)

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.

	FY02	FY03
	FY02	FY03
Undersea Defensive Warfare Systems (6.25 ATT Technology)	0	1,173

Develop technology to enable the 6.25” Anti-Torpedo Torpedo (ATT) to operate with increased effectiveness in intercepting threat torpedoes at shallow depths and in the wake of a surface ship, and to meet speed and range requirements set forth by the AN/WSQ-11 Tripwire Torpedo Defense System acquisition program, into which this technology will transition.

	FY02	FY03
Undersea Defensive Warfare Systems (Rapid Response ATT Weapon)	0	1,173

Expand the capabilities of the 6.25" Anti-Torpedo Torpedo (ATT) technology, enabling a submarine-launched quick reaction response weapon for use against torpedoes and other close aboard targets.

C. OTHER PROGRAM FUNDING SUMMARY:

NAVY RELATED RDT&E:
- PE 0601153N (Defense Research Sciences)
- PE 0602114N (Power Projection Applied Research)
- PE 0602123N (Force Protection Applied Research)
- PE 0602435N (Ocean Warfighting Environment Applied Research)
- PE 0602782N (Mine and Expeditionary Warfare Applied Research)
- PE 0603114N (Power Projection Advanced Technology)
- PE 0603123N (Force Protection Advanced Technology)
- PE 0603506N (Surface Ship Torpedo Defense)
- PE 0603553N (Surface ASW)
- PE 0603561N (Advanced Submarine System Development)
- PE 0603747N (Undersea Warfare Advanced Technology)
- PE 0603758N (Navy Warfighting Experiments and Demonstrations)
- PE 0604221N (P-3 Modernization Program)
- PE 0604261N (Acoustic Search Sensors (ENG))
- PE 0604784N (Distributed Surveillance Systems)

NON-NAVY RELATED RDT&E:
PE 0603763E (Marine Technology)
PE 0603739E (Advanced Electronics Technologies)
PE 0602702E (Tactical Technology)
PE 0602173C (Support Technologies – Applied Research)

D. ACQUISITION STRATEGY: Not Applicable.