FY 2007 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: Feb 2006
Exhibit R-2

BUDGET ACTIVITY: 01
PROGRAM ELEMENT: 0601152N
PROGRAM ELEMENT TITLE: IN-HOUSE LABORATORY INDEPENDENT RESEARCH (ILIR)

COST: (Dollars in Thousands)

| Project Number & Title | FY 2005 Actual | FY 2006 Estimate | FY 2007 Estimate | FY 2008 Estimate | FY 2009 Estimate | FY 2010 Estimate | FY 2011 Estimate |
|---|---|---|---|---|---|---|---|
| IN-HOUSE LABORATORY INDEPENDENT RESEARCH (ILIR) | 19,280 | 17,367 | 15,916 | 16,506 | 16,910 | 17,950 | 18,348 |

**A. MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION:** This program element (PE) sustains U.S. Naval Science and Technology (S&T) superiority by providing new technological concepts for the maintenance of naval power and national security and by helping to avoid scientific surprise while exploiting scientific breakthroughs and providing options for new Future Naval Capabilities. Support of basic biomedical research at the Uniformed Services University for the Health Sciences (USUHS) ended in FY05 in this PE and the RDT&E,N budget. The Department of Navy (DON) component responds to S&T directions of the DON Naval Power 21 transformation plan for long term Navy and Marine Corps improvements and is in consonance with future warfighting concepts and doctrine developed at the Naval Warfare Development Command and the Marine Corps Combat Development Command. It enables technologies to significantly improve the Joint Chiefs of Staff's Future Joint Warfighting Capabilities. The In-house Laboratory Independent Research (ILIR) program also adds increased emphasis to the revitalization of the scientist and engineer workforce component at the Navy's Warfare Centers and Laboratories by attracting superior candidates and retaining our best members through the provision of exciting and meaningful work. It is managed by the Director of Research of the Office of Naval Research (ONR) and executed by the Commanding Officers (COs) and Technical Directors (TDs) of the Naval Warfare Centers, Naval Personnel Research, Studies, and Technology Organization, and the Bureau of Medicine and Surgery laboratories. The FY05 USUHS component is executed by the President of USUHS.

The vision of the DON S&T strategy is "to inspire and guide innovation that will provide technology-based options for future Navy and Marine Corps Capabilities", where "Innovation is a process that couples Discovery and Invention with Exploitation and Delivery". DON Basic Research, which includes scientific study and experimentation, directed toward increasing knowledge and understanding in national-security related aspects of physical, engineering, environmental, and life sciences is the core of Discovery and Invention. Basic research projects are developed, managed, and related to more advanced aspects of research in some hundred-plus technology and capability-related 'thrusts', which are consolidated in twenty-two research areas. These in turn support the major motivational research focus areas of the Navy and Marine Corps-After-Next: maritime

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and space environments that impact operational capability; information science/knowledge management in network-centric operations; sensors and electronic systems for surveillance and tactical applications; energy/power/propulsion for performance gain and sustainment; advanced air/surface/undersea and multi-environment Naval platforms design/signature reduction; superior human performance/training/care of Sailors and Marines; and combat casualty care/infectious diseases/military operational medicine.

This portion of the DON Basic Research Program provides participating Navy Centers and Laboratories with funding for: basic research to support the execution of their assigned missions; developing and maintaining a cadre of active research scientists who can distill and extend results from worldwide research and apply them to Naval problems; promoting hiring and development of new scientists; and encouragement of collaboration with universities, private industry, and other Navy and Department of Defense laboratories, in particular the corporate Naval Research Laboratory (NRL).

ILIR projects are selected by Center/Lab COs and TDs near the start of each Fiscal Year through internal competition. Projects typically last three years, and are generally designed to assess the feasibility of new lines of research. Successful efforts attract external, competitively awarded funding. Because the Warfare Centers and Labs encompass the full range of naval technology interests, the scope of ILIR topics roughly parallels that of PE 0601153N, Defense Research Science. In FY05, about 67 projects were completed and 63 were initiated.

In FY05 support for the basic medical research at USUHS provided the only programmed research funds received by the University. In addition, it facilitated the recruitment and retention of faculty; supported unique research training for military medical students and resident fellows; and allowed the University’s faculty researchers to collect pilot data in order to secure research funds from extramural sources (estimated $35 million annually). In FY06 USUHS will move to Health Affairs at OSD.

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

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**B. PROGRAM CHANGE SUMMARY:**

| | FY 2005 | FY 2006 | FY 2007 |
|---|---|---|---|
| FY 2006 President's Budget Submission | 19,375 | 15,500 | 15,951 |
| Congressional Action | 0 | 2,100 | 0 |
| Congressional Undistributed Reductions/Rescissions | -15 | -233 | 0 |
| Execution Adjustments | 5 | 0 | 0 |
| FY 2005 SBIR | -89 | 0 | 0 |
| Program Adjustments | 4 | 0 | 0 |
| Rate Adjustments | 0 | 0 | -35 |
| FY 2007 President's Budget Submission | 19,280 | 17,367 | 15,916 |

**PROGRAM CHANGE SUMMARY EXPLANATION:**
Technical: Not applicable.

Schedule: Not applicable.

**C. OTHER PROGRAM FUNDING SUMMARY:**
Not applicable.

**D. ACQUISITION STRATEGY:**
Not applicable.

**E. PERFORMANCE METRICS:**
The ILIR initiative seeks to improve the quality of defense research conducted predominantly through the Navy warfare center laboratories. It also supports the development of technical intellect and education of engineers and scientists in disciplines critical to national defense needs through the development of new knowledge in a military laboratory environment. Initial research focus is often conducted in an unfettered nature since it is basic research, but many projects do focus on applying recently developed theoretical knowledge to real world military problems with the intention of developing new capabilities and improving the performance of existing ones. Individual project metrics then become more tailored to the needs of specific

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applied research and advanced development programs. Example metrics include a recent project that is expected to result in a ten fold improvement in the ability to optimize the search for underwater mines in a defined region using multiple, cooperating autonomous vehicles through the development of new adaptive sampling algorithms. National Research Council of the National Academies of Science and Engineering's congressionally directed "Assessment of Department of Defense Basic Research" concluded that the DoD is managing its basic research program effectively.

FY 2007 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: Feb 2006
Exhibit R-2a

BUDGET ACTIVITY: 01
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PROJECT TITLE: IN-HOUSE LABORATORY INDEPENDENT RESEARCH (ILIR)

COST: (Dollars in Thousands)

| Project Number & Title | FY 2005 Actual | FY 2006 Estimate | FY 2007 Estimate | FY 2008 Estimate | FY 2009 Estimate | FY 2010 Estimate | FY 2011 Estimate |
|---|---|---|---|---|---|---|---|
| IN-HOUSE LABORATORY INDEPENDENT RESEARCH (ILIR) | 17,448 | 15,267 | 15,916 | 16,506 | 16,910 | 17,950 | 18,348 |

**A. MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION:** This project sustains U.S. Naval S&T superiority, provides new technological concepts for the maintenance of naval power and national security, and helps avoid scientific surprise, while exploiting scientific breakthroughs and providing options for new Future Naval Capabilities. It responds to S&T directions of the DON Naval Power 21 transformation plan for long term Navy and Marine Corps improvements. It is in consonance with future warfighting concepts and doctrine developed at the Naval Warfare Development Command and the Marine Corps Combat Development Command, and enables technologies to significantly improve the Joint Chiefs of Staff's Future Joint Warfighting Capabilities. It is managed by the ONR Director of Research and executed by the COs and TDs of the Naval Warfare Centers, Naval Personnel Research, Studies, and Technology Organization, Bureau of Medicine and Surgery laboratories, and in FY05 USUHS.

This portion of the DON Basic Research Program provides participating Navy Centers and Laboratories with funding for basic research to support the execution of their assigned missions, for developing and maintaining a cadre of active research scientists who can distill and extend results from worldwide research and apply them to naval problems, to promote hiring and development of new scientists, and to encourage collaboration with universities, private industry, and other Navy and Department of Defense laboratories, in particular the corporate NRL. In FY06 the USUHS effort will move to Health Affairs at OSD.

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PROGRAM ELEMENT: 0601152N PROGRAM ELEMENT TITLE: IN-HOUSE LABORATORY INDEPENDENT RESEARCH (ILIR)
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**B. ACCOMPLISHMENTS/PLANNED PROGRAM:**

| | FY 2005 | FY 2006 | FY 2007 |
|---|---|---|---|
| **OCEAN/SPACE SCIENCES** | 4,020 | 3,945 | 4,129 |

**FY 2005 Accomplishments:**

• Continued development of capsule vaccines against Campylobacter Jejuni, a class of vaccine that would protect against one of the major causes of bacterial diarrhea world wide.
• Researched automatic classification and tracking with assignment uncertainties to address fundamental issues in signal processing, especially accurate estimation of tracker error covariance matrices.
• Initiated research into Beaked Whale (Ziphius cavirostris, Mesoplodon densirostris, Mesoplodon europaeus) bioacoustic and spatial/temporal habitat characterization in the Tongue of the Ocean, Bahamas.
• Initiated research into in the field of Nonparametric Tolerance Intervals to construct a distribution-free method to generalize the performance of decision trees and neural networks. This work allows for effective adaptive classification in uncertain environments.
• Initiated research into 3D elastic wave propagation in layered prolate spheroids with losses using the vector wave equation in prolate spheroidal coordinates for sonar array applications.

**FY 2006 Plans:**

ILIR projects are intended to be roughly three years long; therefore, typically 30% of the ILIR projects turn over each year. Projects selected for FY06 will focus on supporting the ONR Grand Challenge in Naval Battlespace Awareness, Innovative Naval Prototypes initiatives in Persistent Surveillance and Sea Basing, and National Naval Responsibility Initiatives in Ocean Acoustics and Undersea Weaponry.

**FY 2007 Plans:**

ILIR projects are intended to be roughly three years long; therefore, typically 30% of the ILIR projects turn over each year. Projects selected for FY07 will focus on supporting the ONR Grand Challenge in Naval Battlespace Awareness, Innovative Naval Prototypes initiatives in Persistent Surveillance and Sea Basing, and National Naval Responsibility Initiatives in Ocean Acoustics and Undersea Weaponry.

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| | FY 2005 | FY 2006 | FY 2007 |
|---|---|---|---|
| **ADVANCED MATERIALS** | 2,965 | 2,916 | 3,035 |

**FY 2005 Accomplishments:**

• Explored new materials and advanced structure-property-process relationships involving toughening for high-temperature polymer-matrix composites that are suitable for naval aviation applications.
• Studied shear-enhanced configurations and tailorability of chemical thresholds for polymer materials.
• Researched new magnetic materials for weapons, vibration/noise reduction, energy scavenging, sensors, and sonar transducers.
• Explored the scientific merit of using the decomposition by x-rays and electrolysis of Class II fluoride salts like BaF2 and SrF2 to develop a solid state battery and x-ray detector with physical dimensions less than 1 micrometer on silicon (Si) devices.
• Developed a model for the mechanism of self-healing through the characterization of the thermal and rheological behavior of ethylene-methacrylic acid (EMAA) ionomers with known self-healing behavior.
• Developed an understanding of the effects of surface-immobilization on the function of antimicrobial and germinant molecules.
• Conducted a three-pronged approach to identifying new n-doping systems based on current and new theories of charge stability and transport.
• Investigated the fundamental electromechanical behavior of single crystal ferroelectric materials (PiezoCrystals).
• Initiated exploration of high performance nanocomposite barrier coatings for next generation acoustic sensors.
• Initiated studies applying synthetic chemistry techniques to ferromagnetic materials to control their properties and then elucidate the roles they play in microwave absorption.
• Initiated research into applying refined scattering measurement techniques to a range of suitable sample media in order to investigate the sensitivity and range of applicability (e.g., from the single scattering limit to multiple scattering and beyond).

**FY 2006 Plans:**

ILIR projects are intended to be roughly three years long; therefore, typically 30% of the ILIR projects turn over each year. Projects selected for FY06 will focus on supporting ONR Grand Challenges in Naval Materials by Design and Intelligent Naval Sensors, Innovative Naval Prototypes initiatives in Electromagnetic Gun & and

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Sea Basing, and National Naval Responsibility Initiatives in Undersea Weaponry and Naval Engineering.

**FY 2007 Plans:**

ILIR projects are intended to be roughly three years long; therefore, typically 30% of the ILIR projects turn over each year. Projects selected for FY07 will focus on supporting ONR Grand Challenges in Naval Materials by Design and Intelligent Naval Sensors, Innovative Naval Prototypes initiatives in Electromagnetic Gun & and Sea Basing, and National Naval Responsibility Initiatives in Undersea Weaponry and Naval Engineering.

| | FY 2005 | FY 2006 | FY 2007 |
|---|---|---|---|
| **ELECTRONICS SENSOR SCIENCES** | 2,268 | 2,230 | 2,322 |

**FY 2005 Accomplishments:**

• Researched a programmable nonlinear dynamical array to provide a low-power and low-cost integrated sensor-processor consisting of a novel architecture that uses dynamical circuits as the fundamental computational building blocks.
• Explored the effects of the chalcogen element selenium on undoped semi-insulating (USI) gallium arsenide (GaAs) towards new Navy sensors.
• Developed the theory and algorithms to support a numerically tractable, mathematically sound approach to determining the proper allocation of distributed sensor assets (both active and passive) in a tactical environment.
• Researched metal/dielectric periodic multilayer structures thought to exhibit a new type of photonic transmission band corresponding to resonant tunneling of evanescent waves.
• Investigated grating diffraction and its polarization by experiment and theory on surface gratings and volume gratings.
• Examined and characterized the detection statistics at an analog receiver’s decision circuit when the dominant noise source is the optical phase noise of the lasers used in a proceeding coherent fiber-optic antenna remoting link.
• Investigated the possibilities of using nanoscale ferromagnet and superconductor joined systems to serve as ultra-sensitive sensors of weak magnetic fields.

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**FY 2006 Plans:**

ILIR projects are intended to be roughly three years long; therefore, typically 30% of the ILIR projects turn over each year. Projects selected for FY06 will focus on supporting ONR Grand Challenges in Electric Power Sources and Multifunctional Electronics for Intelligent Naval Sensors, Innovative Naval Prototypes initiatives in Electromagnetic Gun and Persistent Surveillance, and the National Naval Responsibility Initiative in Undersea Weaponry.

**FY 2007 Plans:**

ILIR projects are intended to be roughly three years long; therefore, typically 30% of the ILIR projects turn over each year. Projects selected for FY07 will focus on supporting ONR Grand Challenges in Electric Power Sources and Multifunctional Electronics for Intelligent Naval Sensors, Innovative Naval Prototypes initiatives in Electromagnetic Gun and Persistent Surveillance, and the National Naval Responsibility Initiative in Undersea Weaponry.

| | FY 2005 | FY 2006 | FY 2007 |
|---|---|---|---|
| **INFORMATION SCIENCES** | 1,918 | 1,887 | 1,965 |

**FY 2005 Accomplishments:**

• Conducted research into advancing and simplifying the state of the art in quantum dense coding using an optical communications system that will convey, on average, two bits of information from the transmitter to the receiver per transmitted single-frequency photon.
• Conducted research into high-data-rate communication in underwater channels using space-time coding and processing.
• Investigated capture and implementation of the international maritime rules, as provided in the Coast Guard Collision Regulations (COLREGS), into a multi-objective decision framework, to prove a level of autonomous tactical decision making capability for both unmanned underwater vehicles and unmanned surface vehicles and tactical decision aids aboard submarines.
• Conducted research on sea state determination for an autonomous surface craft.
• Explored threat management using passive inference of network infrastructure topology.
• Researched directing the chemical reaction between the electrode surface and a specific ligand of the metal complex, to enable the molecular dipoles to be aligned at the interface generating the asymmetric environment

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important for nonlinear optics.
• Initiated research into Wavelet inspirited data mining.
• Initiated exploration of natural language communications between humans and information systems.

**FY 2006 Plans:**

ILIR projects are intended to be roughly three years long; therefore, typically 30% of the ILIR projects turn over each year. Projects selected for FY06 will focus on supporting ONR Grand Challenges in Naval Battlespace Awareness and Intelligent Naval Sensors, Innovative Naval Prototypes initiatives in Persistent Surveillance and Sea Basing, and National Naval Responsibility Initiatives in Undersea Weaponry.

**FY 2007 Plans:**

ILIR projects are intended to be roughly three years long; therefore, typically 30% of the ILIR projects turn over each year. Projects selected for FY07 will focus on supporting ONR Grand Challenges in Naval Battlespace Awareness and Intelligent Naval Sensors, Innovative Naval Prototypes initiatives in Persistent Surveillance and Sea Basing, and National Naval Responsibility Initiatives in Undersea Weaponry.

| | FY 2005 | FY 2006 | FY 2007 |
|---|---|---|---|
| **COMBAT CASUALTY CARE, INFECTIOUS DISEASES & MILITARY OPERATIONAL MEDICINE (USUHS)** | 1,919 | 0 | 0 |

**FY 2005 Accomplishments:**

Combat Casualty Care (CCC)
• Completed exploration of the role of energy metabolites in the treatment of hemorrhagic shock and oxidative stress; investigation of the function of natural antibodies (chiefly related to B1 cells) in post-ischemic recovery; and establishment of a basic science framework for using benzoquinone ansamycin to treat traumatic brain injury.
• Initiated investigations of molecular- and cellular-level mechanisms affected by penetrating traumatic brain injury, and of the role of channel activation in ischemic preconditioning.

Infectious Diseases (ID)
• Completed testing of novel combinations of antiviral and anti-inflammatory agents to treat influenza in a

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rat model; and delineation of interactions between Shigella proteins and host cells to identify new targets for effective treatment of dysentery.
• Initiated work on pilot projects regarding characterization and enhancement of natural protective mechanisms for infectious diarrhea, E. coli, gonorrhea, and influenza.
• Initiated two separate studies of leishmaniasis, one epidemiological investigation of possible domestic transmission vectors that involve returning warfighters, the other of molecular-level mechanisms of natural resistance.

Military Operational Medicine (MOM)
• Delineated the role of the proteasome in neuroprotection from hemorrhagic shock in rats.
• Initiated studies exploring possible genetic basis for abnormal responses to exertional stress such as rhabdomyolysis, with an eye to developing better diagnostic tools, and of the differential effects of nicotine and stress, especially those possibly based on gender.

**FY 2006 Plans:**

This effort will move to Health Affairs at OSD in FY06.

**FY 2007 Plans:**

This effort will move to Health Affairs at OSD in FY06.

| | FY 2005 | FY 2006 | FY 2007 |
|---|---|---|---|
| **HUMAN PERFORMANCE SCIENCES** | 1,918 | 1,887 | 1,965 |

**FY 2005 Accomplishments:**

• Exploited the biology of IC-21 macrophages to develop novel detectors and decontaminants for anthrax.
• Researched the precision with which people can abstract information from graphics-based radar displays about the range, speed and angle of approach of contacts.
• Researched into human-in-the-loop intelligent software agent learning.
• Derived basic guidance for the use of animated graphic material for delivery in electronic performance support applications.
• Initiated investigation of the distribution of free subspace identification for data exploration and bi-

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clustering.
• Initiated development of a specific and sensitive biological sensor for microbial agents employing a partial complement fixation reaction.
• Initiated research into short-term statin administration that can reduce the volume or frequency of precordial bubbles detected immediately following decompression from a hyperbaric exposure.
• Initiated research in the potentiation of B-cell immune responses to Enterotoxigenic Escherichia Coli Surface Antigen 3 (CS3) Adhesin by genetic fusion with a binding peptide.

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| | FY 2005 | FY 2006 | FY 2007 |
|---|---|---|---|
| **NAVAL PLATFORM DESIGN SCIENCES** | 1,220 | 1,201 | 1,250 |

**FY 2005 Accomplishments:**

• Conducted experimental studies and modeling of information embedded shipboard power systems.
• Investigated nonlinear control theory for electric machines and components.
• Investigated strontium fluoride-based heteroepitaxial systems of silicon using compliant substrate techniques.
• Conducted spectroscopic and electrochemical investigations of nanophase vanadium oxides.
• Developed new formulations of behavior-based approaches that are appropriate for unmanned air vehicle control and determined appropriate metrics for measuring system performance.

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• Investigated new ceramic dielectric materials that enable the development of high-voltage/high frequency/low loss/ thermally stable multilayer ceramic capacitors (MLCC).
• Conducted an investigation of polarization and mode changes depending on the environmental stress in single mode fibers as they relate to aircraft control.
• Initiated experimental investigation and theoretical modeling of microscale processes associated with phase change heat transfer.
• Initiated development & integration of high-lift actuators and neuro-science based control for Maritime Reconnaissance Autonomous Vehicle (MRAV).
• Initiated, developed and validated analysis procedures to predict powering, cavitation and unsteady shaft forces for specific water jet designs.
• Initiated activities to measure the Hugoniot shock wave equation of state and fracture strength for structural steels.

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ILIR projects are intended to be roughly three years long; therefore, typically 30% of the ILIR projects turn over each year. Projects selected for FY07 will focus on supporting ONR Grand Challenges in Electric Power Sources and Naval Materials by Design, Innovative Naval Prototypes initiatives in Electromagnetic Gun and Sea Basing, and the National Naval Responsibility Initiative in Naval Engineering.

| | FY 2005 | FY 2006 | FY 2007 |
|---|---|---|---|
| **ENERGY SCIENCES** | 1,220 | 1,201 | 1,250 |

**FY 2005 Accomplishments:**

• Investigated the decomposition pathways of reactive materials which enhance the Navy’s effectiveness in their use of guide formulators in developing new, tailored reactive materials for future use.

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- Conducted impact shock experiments with shear-enhanced configurations for polymer-based materials.
- Explored the nitramine-metal interface through in-situ characterization of the surface in an ultra high vacuum environment (~1 x 10-10 Torr) using X-ray Photoelectron Spectroscopy (XPS) and Infrared Reflection Absorption Spectroscopy (IRRAS).
- Initiated kinetics measurement studies and understanding of the reaction mechanisms of energetic and binder materials during the combustion process using T-Jump Fourier transform infra-red spectroscopy.
- Initiated study of the effects of impurities and defects on the absorption spectra of material that exhibits a range of shock sensitivity.
- Initiated an effort to develop structures that are conceptually the products of fusing rings such as nitrotriazole, 1,2,4,5-tetrazine, 1,2,3,5-tetrazine, and triazine.

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**CONGRESSIONAL PLUS-UPS:**

| | FY 2005 | FY 2006 |
|---|---|---|
| NAVY S&T OUTREACH | 1,832 | 2,100 |

FY 2005 - The Naval Science and Technology for America's Readiness (N-STAR) effort included the development of an outreach activity at Navy R&D Centers collaborating with universities, community colleges, high schools, and middle schools to create a pipeline of students who are interested in pursuing careers in science and engineering fields. The FY05 effort developed the N-STAR outreach activity at the Naval Surface Warfare Center, Dahlgren Division.

FY 2006 - This effort supports Navy S&T Outreach research.

**C. OTHER PROGRAM FUNDING SUMMARY:**
NAVY RELATED RDT&E:
PE 0601153N Defense Research Sciences

NON-NAVY RELATED RDT&E:
PE 0601101A In-House Laboratory Independent Research (Army)
PE 0601102F Defense Research Sciences (Air Force)

**D. ACQUISITION STRATEGY:**
Not applicable.