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

BUDGET ACTIVITY: 2 PROGRAM ELEMENT: 0602123N
PROGRAM ELEMENT TITLE: Force Protection 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
Force Protection Applied Research	133,261	118,413	75,909	98,763	99,329	126,541	125,286	122,150

A. MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION:

This program addresses applied research associated with providing the capability of Platform and Force Protection for the U.S. Navy. It supports the development of technologies associated with all naval platforms (surface, subsurface, terrestrial and air) and the protection of those platforms. The goal is to provide the ability to win or avoid engagements with other platforms or weapons and, in the event of engagement, to resist and control damage while preserving operational capability. Within the Naval Transformational Roadmap, this investment directly supports the Theater Air and Missile Defense transformational capability required by Sea Shield and the Ship to Objective Maneuver key transformational capability within Sea Strike by virtue of improvements in platform offensive performance, stealth and self defense. This program supports the Fleet and Force Protection and Missile Defense Future Naval Capabilities (FNC).

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

B. PROGRAM CHANGE SUMMARY:

	FY 2002	FY 2003	FY 2004	FY 2005
FY 2003 President's Budget Submission:	130,870	89,390	80,864	77,540
Adjustments from FY 2003 President’s Budget:				
Congressional Plus-Ups		31,725		
SBIR Reduction	-2,870			
Execution Adjustments	5,918			
Congressional Rescissions/Adjustments/Undistributed Reductions	-657	-1,417		
S&T Program Adjustments			-2,019	24,525
NWCF Rate Adjustments			-214	-15
Efficiencies at NWCF Activities			-765	-791
Pay Raise/Inflation Adjustments		-1,285	-1,957	-2,496
FY 2004/2005 President's Budget Submission:	133,261	118,413	75,909	98,763

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

BUDGET ACTIVITY: 2 PROGRAM ELEMENT: 0602123N
PROGRAM ELEMENT TITLE: Force Protection Applied Research

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: 0602123N Project Title: Force Protection
PROGRAM ELEMENT TITLE: Force Protection Applied Research 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
Force Protection Applied Research	133,261	118,413	75,909	98,763	99,329	126,541	125,286	122,150

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B. ACCOMPLISHMENTS/PLANNED PROGRAM:

	FY 02	FY 03	FY 04	FY 05
Surface Ship & Submarine Hull Mechanic & Electrical (HM&E)	$63,215	$44,989	$45,964	$61,438

Efforts include: signature reduction, hull life assurance, hydromechanics, distributed control for automated survivability and advanced electrical power systems. Signature reduction addresses electromagnetic, infrared and acoustic signature tailoring, both topside and underwater. Hull life assurance addresses development of new structural system approaches for surface ships and submarines, including the management of weapons effects to control structural damage and the improvement of structural materials. Hydromechanics addresses hydrodynamic technologies, including the signature aspects of the hull-propulsor interface. Distributed intelligence for automated survivability addressees both the basic technology of automating damage control systems as well as distributed auxiliary control with self-healing capability. Advanced electrical power system addresses electrical and auxiliary system and component technology to provide improvement in energy and power density operating efficiency and recoverability from casualties. This effort supports the Fleet and Force Protection and Missile Defense Future Naval Capabilities (FNC).

FY 2002 ACCOMPLISHMENTS:

Signature Reduction:

Initiated:

- For Submarines - Development of analytical models to further define modular submarine hull concepts.
- For Surface Ships – Basic planning of tow tank acoustic tests and numerical model of uncoated surface combatant hulls for surface ship acoustic program. Antenna isolation measurement for both high band and low arrays integrated into topside structures. Assessment of technology options for electromagnetic, thermal, electro-optical and visual signature reduction of Low-Observable Integrated Deckhouse (LID). Assessment of susceptibility of surface ships electrical fields causing mines to trigger for Near Field Deamping program.

Continued:

- For Submarines - Evaluation of control algorithms for advanced degaussing/de-amping of submarine hulls. Development of advanced numerical acoustic codes and gridding methods for those codes. Assessment of internal foundation structure impact to hull response to excitation/propulsion drive types. Actuator component acoustic evaluations.
- For Surface Ships - Development of physics based numerical model for electromagnetic scattering of hydrodynamic disturbances.

Completed:

- For Submarines - Feasibility study to develop realizable modular hull/payload modules. Analysis of full-scale trial data to establish hull response and radiated noise levels with hull treatments applied.
- For Surface Ships - Validation of numerical model to predict the eddy current contribution to magnetic signatures. Assessment of both internal and external degaussing coil arrangements. Recommendations for physics and software architecture for the next-generation infrared scene model.

Hull Life Assurance:

Initiated:

- Component design for dynamic ship protection. Study of Advanced Design Hardening Methods for hull structure design for Stainless Steel Advanced Double Hull (SSADH), Composite Hybrid Hull and other hull forms. Dynamic Behavior of Composite Ship Structures (DYCOSS) joint effort with Dutch Navy. Development of tools to describe failure mechanisms of sandwich composites.

Continued:

- Definition of composite hull structural failure modes and mechanisms, development of design concepts and design guidance for composite structural details. Design tool for integrated antenna and composite topside. Reliability based design and structural analysis code development.

Completed:

- Analytical tool development for dynamic ship protection system. Demonstration of the fiber-optic health monitoring system on the RV-Triton during rough weather trials. Characterization of composite hull shock response with shock table tests on topside joints. Analysis of results for composite hull shock tests performed in the Baltic Sea (joint effort with Germany).

Hydromechanics:

Continued:

- For Submarines - Improved maneuvering simulation capability. Study of flow noise over control surfaces. Development of experimental methods to control/eliminate the cavitation and apply to model-scale propellers.
- For Surface Ships - Numerical prediction of hydrodynamic disturbances generated by surface ships. Development, validation, and application of numerical codes to integrated propulsor/hull for advanced surface ship configurations. Development of prediction methods relating hydrodynamics and ship signatures.

Completed:

- For Submarines - Comparison of computational and experimental results for a looped-blade propulsor concept and design a looped-blade propeller for a full-stern propulsor. Maneuvering experiments using existing/modified propulsor hardware from the USS VIRGINIA and Office of Naval Research (ONR) Advanced Stern Programs.
- For Surface Ships - Demonstration and evaluation of the variable pitch prop design.

Distributed Intelligence for Automated Survivability:

Initiated:

- Assessment of explosion mitigation through preemptive use of water mist for advanced damage countermeasures.

Completed:

- Investigation of fire and smoke spread modeling for damage control. Automated damage control effort to provide design criteria for automated systems.

Advanced Electrical Power Systems:

Initiated:

- Support of power & energy research Centers of Excellence, Electric Power Consortium, including major test and instrumentation needs, for such things as advanced prototype testing, Superconducting Magnetic Energy Storage (SMES), and other applications of superconductivity, as well as, power and control systems.
- Studies to define advanced system state estimation concepts for controls and sensors. Development of technology basis for a family of electromechanical actuators. Advanced thermal management concepts and components. Design of system manager for Universal Control Architecture.

Continued:

- Evaluation of the potential of impact wafer bonded Fast Turn Off Switch (FTO) for future Navy systems. Evaluation of potential applications of silicon-carbide in future high voltage and high power applications. Development of advanced power system and control architectures for operation and reconfiguration of future all-electric ships. Demonstrate power electronics technology to reduce the size, weight and cost of Electromagnetic Aircraft Launch System (EMALS) and Electromagnetic Aircraft Launch Recovery System (EARS).

Completed:

- Demonstration of advanced passive components for high voltage application. Development of new hierarchical control architecture for power systems, Universal Control Architecture (UCA).

FY 2003 PLANS:

Signature Reduction:

Initiate:

- For Submarines – Development of acoustic wireless sensor array concept.
- For Surface Ships – Development of next generation infrared (IR) scene model.

Continue:

- For Submarines - Development of advanced numerical acoustic codes and gridding methods for those models. Continue development of analytical models to further define modular submarine hull concepts. Algorithm/finite element model validation for submarine advanced degaussing/deamping.
- For Surface Ships - Development of physics based numerical model for electromagnetic scattering of hydrodynamic disturbances. Continue surface ship acoustic program efforts with a flow noise model development.

Complete:

- For Submarines - Notional baseline payload module for modular hull application. Assessment of internal foundation structure impact to hull response to excitation/propulsion drive types. Actuator component acoustic evaluations.
- For Surface Ships - Tank test for surface ship acoustic behavior validation. Antenna isolation measurement for both high band and low arrays integrated into topside structures. The preliminary version of Next Generation IR Code for verification and validation.

Hull Life Assurance:

Continue:

- Assessment of alternative structural concepts for improving performance of combatant ship structures. Technologies assessed include Stainless Steel Advanced Double Hull (SSADH), composite primary hull, hybrid steel and composite hulls, and composite topsides. Design tool for integrated antenna and composite topside. Develop tools to describe failure mechanisms of sandwich composites. Reliability based design and structural analysis code development.

Complete:

- Definition of composite hull structural failure modes and mechanisms, development of design concepts and design guidance for composite structural details. Component design for dynamic ship protection system. Study on Advanced Design Hardening Methods for hull structure design for SSADH, Composite Hybrid Hull and other hull forms. Dynamic Behavior of Composite Ship Structures (DYCOSS) joint effort with Dutch Navy.

Hydromechanics:

Initiate:

- For Submarines - Model testing of a looped-blade propeller with a full stern to characterize powering, cavitation, acoustic, and maneuvering performance. Evaluation of internal pump submarine propulsor.

Continue:

- For Submarines - Improved maneuvering simulation capability. Develop experimental methods to control/eliminate the cavitation and apply to model-scale propellers. Study of flow noise over control surfaces.
- For Surface Ships - Development, validation, and application of numerical codes to integrated propulsor/hull for advanced surface ship configurations. Numerical prediction of hydrodynamic disturbances generated by surface ships. Development of prediction methods relating hydrodynamics and ship signatures.

Complete:

- For Submarines - Design and fabrication of loop bladed propeller. Experimental methods to control/eliminate the cavitation and apply to model-scale propellers.

Distributed Intelligence for Automated Survivability:

Continue:

- Assessment of explosion mitigation through preemptive use of water mist for advanced damage countermeasures.

Advanced Electrical Power Systems:

Continue:

- Studies to define advanced system state estimation concepts for controls and sensors. Development of technology basis for a family of electromechanical actuators including development of design requirements for actuators. Investigation of advanced thermal management concepts and components. Development of compact high-powered solid state switching technology for the EMALS and other pulsed and steady state applications. Development of advanced power system and control architectures for operation and reconfiguration of future all-electric ships. Support of power & energy research Centers of Excellence, including major test and instrumentation needs, for such things as advanced prototype testing, SMES, and other applications of superconductivity, as well as, power and control systems. Evaluation of potential applications of silicon-carbide in future high voltage and high power applications.

Complete:

- Evaluation of the potential of impact wafer bonded FTO for future Navy systems.
- Transition of demonstration Hardware, Application, and System Managers to advanced EMALS program Commercial Power Electron Building Block (PEBB) based utility products available for Navy application. Design of system manager for Universal Control Architecture (UCA).

FY 2004 PLANS:

Signature Reduction:

Continue:

- For Submarines - Development of advanced numerical acoustic codes and gridding methods. Continue development of modular submarine hull concepts.
- For Surface Ships - Development of next generation IR scene model by development of mitigation strategy supporting low observable infrared platforms, development of supporting physics and prototype measurement techniques. Develop a small-scale surface ship acoustic test plan for hull flow noise model validation of previous year's model. Development of physics based model of electromagnetic scattering of hydrodynamic disturbances.

Complete:

- For Submarines - Fabrication of prototype acoustic wireless sensor array concept.

Hull Life Assurance:

Initiate:

- Development of structural concepts identified in FY03 assessment of structural system performance. System demonstration of dynamic ship protection system.

Continue:

- Reliability based design and structural analysis code development. Design tool for integrated antenna and composite topside. Development of tools to describe failure mechanisms of sandwich composites.

Complete:

- Assembly of dynamic ship protection system.

Hydromechanics:

Initiate:

- For Submarines - Design and construction of test equipment for internal pump submarine propulsor.

Continue:

- For Submarines – Improvement of maneuvering simulation capability. Study of flow noise over control surfaces.
- For Surface Ships - Numerical prediction of hydrodynamic disturbances generated by surface ships. Development of prediction methods relating hydrodynamics and ship signatures.

Complete:

- For Submarines - Model tests of loop bladed propeller characterizing powering, cavitation, acoustic and maneuvering performance. Performance prediction for internal pump submarine propulsor.
- For Surface Ships - Development, validation, and application of numerical codes to integrated propulsor/hull for advanced surface ship configurations. Validation of advanced prediction code for large amplitude non-linear motion of advanced surface ship hulls.

Distributed Intelligence for Automated Survivability:

Continue:

- Assessment of explosion mitigation through preemptive use of watermist for advanced damage countermeasures.

Complete:

- Test facility demonstration of watermist based blast mitigation system.

Advanced Electrical Power Systems:

Initiate:

- Development of Fast Turn Off Switch (FTO) based Power Electron Building Block (PEBB). Development of silicon carbide power switch. Dynamically reconfigurable electric distribution system demonstrations.
- Development of advanced power generation technologies, including high power density fuel cells for shipboard use. Investigate innovative approaches to diesel fuel reforming.

Continue:

- Studies to define advanced system state estimation concepts for controls and sensors. Support of power & energy research Centers of Excellence, including major test and instrumentation needs, for such things as advanced prototype testing, SMES, and other applications of superconductivity, as well as power and control systems. Development of advanced power system and control architectures for operation and reconfiguration of future all-electric ships.

Complete:

- Transition advanced thermal management concepts and components. Provide design and test data transition of electric actuator design.

Advanced Energetics:

Initiate:

- Technology development for the next generation reactive material (formulations, material properties and lethality models) for high density reactive materials and novel reactive structural materials.
- Development of difluoramine ingredient and formulations as candidates for next generation explosives and propellants.
- Development of advanced directed energy warheads, exploiting novel explosive and reactive material concepts.

FY 2005 PLANS:

Signature Reduction:

Continue:

- For Submarines - Development of advanced numerical acoustic codes and gridding methods. Development of modular submarine hull concepts.

Complete:

- For Submarines - Demonstration of prototype acoustic wireless sensor array system incorporating self powering, radio frequency unit and sensors. Control algorithms for advanced degaussing/de-amping of submarine hulls.
- For Surface Ships – Deliver next generation IR scene model and next generation IR code.

Hull Life Assurance:

Continue:

- Structural system concept development previously identified. Reliability based design and structural analysis code development. Design tool for integrated antenna and composite topside. Develop tools to describe failure mechanisms of sandwich composites. System demonstration of dynamic ship protection system.

Complete:

- System demonstration of dynamic ship protection system.

Hydromechanics:

Continue:

- For Submarines - Improved maneuvering simulation capability. Construction and test of equipment for internal pump submarine propulsor.
- For Surface Ships - Numerical prediction of hydrodynamic disturbances generated by surface ships.

Complete:

- For Submarines - Quiet control surface design tool based on control surface flow noise studies.
- For Surface Ships - Validate prediction methods relating hydrodynamics and ship signatures.

Distributed Intelligence for Automated Survivability:

Complete:

- Full-scale test demonstration of watermist based blast mitigation.

Advanced Electrical Power Systems:

Continue:

- Studies to define advanced system state estimation concepts for controls and sensors. Support of power & energy research Centers of Excellence, including major test and instrumentation needs, for such things as advanced prototype testing, SMES, and other applications of superconductivity, as well as power and control systems. Development of advanced power system and control architectures for operation and reconfiguration of future all-electric ships. Dynamically reconfigurable electric distribution system demonstrations. Development of FTO based PEBB. Development of Silicon Carbide power switch. Advanced power generation program, including high power density advanced fuel cells and innovative diesel fuel reforming.

	FY 02	FY 03	FY 04	FY 05
Advanced Energetics	$8,107	$11,000	$0	$12,800

Advanced Energetics efforts address technology development to provide substantial improvements in energetic material systems and subsystems primarily in terms of performance, but also addressing safety, reliability, and affordability concerns, and ultimately to transition advanced technology to the Fleet. Goals include: advanced

energetic materials for thermobarics, agent defeat, and reactive material based warhead subsystems for both defensive and offensive applications. Efforts include development of new fuels, oxidizers, and explosive formulations, reliable simulation tools and diagnostics to develop and design superior performance reduced vulnerability systems tailored to specific warfighter missions.

FY 2002 ACCOMPLISHMENTS:

Initiated:

- Advanced Energetics effort (Navy component of the Defense Threat Reduction Agency led Thermobaric Weapon Advanced Concept Technology Demonstration (ACTD)). Navy responsibility was payload development. Tasks included development of the explosive fill, subscale testing of material, scale up through full scale validation, and ultimately qualification.

FY 2003 Plans:

Continue:

- Advanced energetics development of composition synthesis and process for the Thermobaric Warhead Explosive Fill ACTD.

Complete:

- Applied research portion of Advanced Energetics effort in Thermobaric Weapon ACTD. PE 0602123N takes the effort through subscale payload testing portion of the development in FY03. Remainder will be picked up in Advanced Energetics under PE 0603123N in FY04.

FY 2004 Plans:

Moved to HM&E activity

FY 2005 Plans:

Continue efforts initiated in HM&E activity:

- Technology development for the next generation reactive material (formulations, material properties and lethality models) for high density reactive materials and novel reactive structural materials.
- Development of difluoramine ingredient and formulations as candidates for next generation explosives and propellants.
- Development of advanced directed energy warheads, exploiting novel explosive and reactive material concepts.

	FY 02	FY 03	FY 04	FY 05
Sensors & Associated (S&A) Processing	$14,850	$12,400	$12,619	$8,311

Activity focuses on applied research for complementary sensor and processing technologies for 21st century warfighting success and platform protection. Current small platforms (both surface and airborne) have little to no situational awareness (S&A) or self-protection against air, surface, and asymmetric threats. The goal of this

activity is to provide these platforms with effective self-protection. The technology areas specific to platform protection will develop individual or multispectral (Electro-Optic (EO), Infrared (IR), Radio Frequency (RF), electromagnetic (EM), visual and acoustic) sensors and associated processing. To defend platforms from current and advanced threats in at-sea littoral environments and in port these technologies must improve multispectral detection and distribution of specific threat information. This activity supports the Fleet and Force Protection and Missile Defense Future Naval Capabilities (FNC).

FY 2002 ACCOMPLISHMENTS:

Distributive Aperture System (DAS):

Initiated:

- For Surface Ships - The Navy began advanced research for the development of a ship based DAS Infrared Search and Track (IRST) for DDX, CGX, and CVNX platforms. The DAS addressed future surface combatant needs to win or avoid engagements by weapons and platforms, and asymmetric threats faced in the littorals. The DAS program investigated, examined and evaluated new technologies and techniques for focal plane arrays, anamorphic optics, stabilization techniques, modularized replaceable packaging, and high-speed processors and algorithms. The DAS sensor, consisting of eight modules for surface ships varied based on the size of ship. It provided surface ships with a 360-degree panoramic staring view on the horizon to line of sight, and detected, declared, and tracked air contacts and surface contacts within 2-3 seconds. The sensor modules can pan downward to view the surface from near the ship to line of sight for in port counter terrorism awareness. DAS addressed the surface naval ships needs for a passive fighting ability and in-port security capability. Two International FY02 Project Agreements (United Kingdom and Australia) assisted the DAS program in the development of sensor, signal processing algorithms, and high-speed technologies.
- For Surface Ships - A Shipboard EO/IR Closed Loop Self Protection project development for the demonstration of an integrated threat detection, classification, and closed loop laser jamming system to counter EO/IR/Laser guided anti-ship missiles. This was done by using a multi-line high power laser system operating in the visible to longwave IR spectral band; a rangefinder that ranged passive targets out to 20km; and a transceiver and signal processor that classified a target in less than 3 seconds.
- For Naval Aircraft - As anti-air threat missile systems increase in both number and technical sophistication, the Navy has developed a Missile Warning System (MWS) effort that uses a solid-state two color staring sensor and tracking system to provide aircraft systems with the detection, location and identification of sophisticated threat missiles with the fidelity required to queue laser-based directional infrared countermeasures (DIRCM) systems and launch off-board decoys. The MWS system demonstrated a Time to go (TTG) accuracy of +/- 15% for missile ranges greater than 1.5 kilometers and a 75% increase in the minimum detection range for Man Portable Air Defense Systems (MANPADs) with no increase in the false alarm rate.
- For Naval Aircraft - The EO/IR Laser Jammer for Tactical Aircraft (TACAIR) effort focused on components related to the jamming portion of the DIRCM system that also included the MWS project. These components included technology enhancements to the power and beam characteristics of the laser-based countermeasure and demonstrated effective jam codes for all Tier 1 and Tier 2 threat missiles and a common jam code with

95% effectiveness for all Tier 1 and Tier 2 threat missiles. These capabilities enabled tactical aircraft to operate routinely in airspace below 20,000 feet by providing self-protection against current and advanced IR guided missile threats.

- For Small Platforms - EO/IR self-protection for Small Surface Vehicles, part of the Electronic Warfare Integrated System for Small Platforms (EWISSP) project, was initiated to provide a small platform with automatic response self and local area protection against IR guided and laser designated missiles and munitions. Accomplishment was with an integrated system capable of detecting and localizing laser designators and providing missile launch indication at a range of 4 km. The EWISSP effort will be continued under PE0602235N in FY 03.
- For Marine Corps - The End User Terminal (EUT) effort, structured to develop improved personal communications, situational awareness and sniper detection for ground troops that use less power, provide greater range and ease of use, was initiated and will use a central processing unit that delivers the performance similar to the 550 MHz Pentium III but at ¼ the power level. The daylight readable low power display will provide a minimum of 256 colors and an 80% power reduction over existing units.

Completed:

- For Surface Ships - The Shipboard Laser Acquisition System (SBLAS) effort completed fabrication and characterization of an off-axis laser detection system and a decoy subsystem that will become part of the EWISSP project.
- For Naval Aircraft - The Electrical IR Decoy Launcher developed the capability for multiple decoy shots and investigating components and designs for a non-foreign object damage (FOD) less cartridge.

Biocentric Technologies:

Initiated:

- Scale-up and determine yield optimization of green synthesis of energetic materials using enzymes toward an environmentally acceptable production method for energetic materials without the use of hazardous reagents and generation of hazardous by-products.
- Evaluation of sensors for trinitrotoluene (TNT) and other explosives to be used as autonomous underwater vehicle payloads for detection of unexploded ordnance (UXO).
- Feasibility study of energy harvesting benthic fuel cells using bioelectrochemical mechanisms at the water-sediment interface. The goal is to use naturally occurring microbes to harvest low levels of power (~0.1 Watt) on a continuous basis.
- Evaluation of applicability of chemical sensing from autonomous underwater vehicles for Special Forces applications.

Continued:

- Chemical Sensing in the Marine Environment effort, for locating the source of chemical plumes in very shallow waters using sensors on autonomous underwater vehicles. This will provide the Navy with a new capability for the difficult task of remotely identifying UXO in the littoral zone.
- Chemical Sensing in the Marine Environment effort, to characterize chemical plume structure in the very shallow water regime. Previous research indicates that the plume structure is quite variable and heavily dependent on environmental conditions and interactions. Mapping of plume structure under various

environmental scenarios is necessary to guide the development of sensor systems for underwater UXO detection.

- Development of novel biosensors for explosives for underwater applications. These novel biosensor systems will provide sensitive, selective, and rapid detection of explosive signatures (such as TNT), a capability that the Navy currently lacks.
- Work on tailored acoustic materials for quieter platforms.
- Investigation of bio-inspired algorithms for image processing hardware development.
- Development of oligonucleotide taggants as molecular barcodes for Naval applications.
- Development of novel nonporous fouling-resistant enzymatic composite membranes for wastewater treatment.

Completed:

- Transitioned the metallized lipid tubule materials for radar absorbing and antenna isolation applications. These materials show potential as replacement for the existing systems now used for this purpose, displaying competitive absorption properties but weighing approximately 60% less, a very important advantage given the small decoy vehicles on which they are deployed.
- Investigation of bio-molecular barcodes for unique identification and tracing of materials. These barcodes or taggants act as microscopic markers that can be used to trace and identify material of naval interests, e.g., military equipment and personnel, and which have high applicability for counter-terrorism programs.
- Chemical Sensing in the Marine Environment effort to characterize the source strengths of underwater unexploded ordnance. Distance from source and associated concentration profile data will drive the operational requirements necessary to guide the development of sensor systems for underwater UXO detection.

FY 2003 PLANS:

Distributive Aperture System (DAS):

Initiate:

- For Naval Aircraft - Integrated Defensive Electronic Countermeasures (IDECM) effort to add additional capability to the radio frequency countermeasures (RFCM) system for F/A-18 E/F self-protection. This consists of developing an RF decoy towline capable of operating intermittently for 30 seconds at 650 degrees centigrade for 3 minutes total exposure time and applying Gallium Arsenide technology to design a prototype solid-state transmitter for the fiber optic towed decoy.

Continue:

- For Surface Ships – Development of DAS technologies and associated processing with the international partners. Examination and integration of the sensor modules into a single system design to support shipboard combat operations. A high-speed processor and associated algorithms, ported to middleware, is examined for real-time application. Test and verify technologies in laboratories prior to shipboard DAS demonstration. The DAS effort will deliver a three-sensor package with associated processing and high-speed central processor for integration into surface combatants. International partners will mirror the U.S. effort and help to explore, examine, and evaluate the DAS sensor, signal processing algorithms, and high-speed processor technologies to support a FY05/06 demonstration. Develop the data processor and optical augmentation software algorithms for threat classification.

- For Marine Corps - EUT examination of techniques to inject advanced-scope information into its network. Integration of the RF module and the vest/garment. Develop RF transmitters using Gallium Nitride on Silicon Carbide transistor technology. The goal is a factor of 3 improvement in efficiency vs. current man wearable transmitters being used by the Marine Corps Warfighting Laboratory.
- For Naval Aircraft - Missile Warning System (MWS) test improved Time to go (TTG) accuracy conduct live fire demonstrations and tests, and test high temperature focal plane arrays.
- For Naval Aircraft - EO/IR laser jammer for TACAIR. Examine two-color (low operating temperature) Focal Plane Arrays (FPA) for common optics.

Complete:

- For Surface Ships - Shipboard EO/IR closed loop self-protection, development of the optical train design. The repackaging of the mid-wave IR laser completion supports the preparation for a future functional field demonstration.

Biocentric Technologies:

Initiate:

- Development of stochastic chemical sensors for naval applications to provide single molecule detection.

Complete:

- Chemical Sensing in the Marine Environment locating the source of chemical plumes in very shallow waters using sensors on autonomous underwater vehicles. The resulting field tests will demonstrate whether the onboard sensor systems possess the necessary sensitivity and speed to accurately locate UXO.
- Chemical Sensing in the Marine Environment characterization of chemical plume structure in very shallow water regimes. Optimized search strategies are used onboard an autonomous underwater vehicles (AUV) to trace chemical plume from UXO.
- Development of novel biosensors for explosives for underwater applications. These novel biosensor systems are expected to provide sensitive, selective, and rapid detection of explosive signatures (such as TNT), a capability that is currently lacking but is needed to provide real-time data for swift decision making.
- Discontinue scale-up and optimize the yield of a green synthetic methodology for production of energetic materials using enzymes toward an environmentally acceptable production method for energetic materials without the use of hazardous reagents and generation of hazardous by-products.
- Efforts directed toward using TNT and other explosives sensors as AUV payloads for detection of UXO.
- Discontinue development of energy harvesting benthic fuel cells using bioelectrochemical mechanisms at the water-sediment interface. The goal is to use naturally occurring microbes to harvest low levels of power (~0.1 Watt) on a continuous basis.
- Discontinue investigation of chemical sensing from AUV for Special Forces applications.
- Tailored acoustic materials for quieter platforms.
- Investigation of bio-inspired algorithms for image processing hardware development.
- Development of oligonucleotide taggants as molecular barcodes for Naval applications.
- Development of novel nonporous fouling-resistant enzymatic composite membranes for wastewater treatment.

FY 2004 PLANS:

Distributive Aperture System (DAS):

Continue:

- For Surface Ships - Investigation, development, and testing of components, materials and technology for a DAS sensor module.
- For Naval Aircraft - IDECM design and development of a prototype solid state transmitter for the Fiber Optic Towed Decoy (FOTD) using Gallium Arsenide (GaAs) technology.
- EO/IR Laser Jammer for TACAIR development and testing of a common jam code with 95% effectiveness for all Tier 1 and 2 IR-guided missile threats.
- For Marine Corps - EUT design and development of enhanced RF transmitters using Gallium Nitride on Silicon Carbide (GaN/SiC) transistor technology.

Complete:

- For Surface Ships - Shipboard EO/IR Closed Loop Self Protection system design of the Shipboard Integrated Electro-optic Defense System (SHIELDS).
- For Naval Aircraft - MWS demonstration of a 100% improvement in FPA cryogenic cooling efficiency at elevated ambient temperatures

Biocentric Technologies:

Initiate:

- Development of reagentless sensors for Weapons of Mass Destruction.

Continue:

- Development of stochastic chemical sensors for naval applications to provide single molecule detection.

FY 2005 PLANS:

Distributive Aperture System (DAS):

Continue:

- For Surface Ships - Development of components and packaging for the prototype sensor module for the DAS initial packaged sensor module testing.
- For Surface Ships - Shipboard EO/IR Closed Loop Self Protection design of the multifunction signal processor/controller.
- For Naval Aircraft - IDECM development and testing of the on-board algorithms and software incorporating the latest electronic countermeasures techniques.
- EO/IR Laser Jammer for TACAIR design and development of the solid state pointer tracker system.
- For Marine Corps - EUT development of the mid-wave infrared (MWIR) camera module for the multifunction rifle sight (MFRS).

Biocentric Technologies:

Initiate:

- Development of novel biomimetic propulsion systems for autonomous underwater vehicles.

Continue:

- Design and development of reagentless sensors for Weapons of Mass Destruction.

Complete:

- Development of stochastic chemical sensors for naval applications to provide single molecule detection.

	FY 02	FY 03	FY 04	FY 05
Missile Defense (MD)	$18,900	$10,500	$10,162	$8,771

Missile Defense (MD) applied research develops enabling technology for littoral Theater Air and Missile Defense (TAMD) enhancements for transition to acquisition programs. These enhancements will interact efficiently, effectively, and in time to detect, control, and engage projected anti-ship cruise missiles, overland cruise missiles, aircraft and theater ballistic threats. The Missile Defense Science and Technology (S&T) efforts directly provide elements of the capability required by the Joint Requirements Oversight Council (JROC) TAMD Capstone Requirements Document (CRD) (2001). This effort supports the Missile Defense FNC.

FY 2002 ACCOMPLISHMENTS:

Initiated:

- Littoral Affordability (classified project).
- Directed Energy effort began High Energy Laser (HEL) Analysis Feasibility Study to identify and provide analyses of; (a) those areas deemed necessary to determine the feasibility of deploying HEL weapons aboard U.S. Navy assets and (b) the feasibility of using Free Electron Laser (FEL) as an ordnance system for Fleet Air Defense. Development of preliminary baseline Surface Combatant HEL top level and sub-system requirements, for both Diode Pumped Solid State High Energy Laser (DPSSHEL) and FEL technology based systems, based upon the existing draft USN MNS and anticipated capabilities.
- Using the Army Developed Tactical Cruise Missile System (TACMS) as a basis, conduct feasibility and design efforts for adaptation of this system to a submarine launched TACMS, TACMS-P, for a wide range of precision strike targets.

Continued:

- Distributed Weapons Coordination (DWC), (an evolution from Composite Threat Evaluation / Weapon Assignment (TEWA)), development of algorithms (compatible with an open-architecture combat system) to collate theater-wide sensor use and weapons status for common threat evaluation (CTE) and Preferred Shooter Recommendation (PSR) functions.

Completed:

- Infrared (IR) Sensors effort, which conducted requirements analysis and technical assessment of alternatives for advanced IR sensors for airborne detection of Theater Ballistic Missile (TBM) events. Development and demonstration Navy Terminal Theater Ballistic Missile (TBM) Defense CTE and PSR functionality at a laboratory simulation facility.
- Preliminary Design Review for TACMS-P ACTD. TACMS-P ACTD establishment of interface with the Army Fuze body at Picatinny Arsenal in New Jersey demonstrated fuze safety theme. Hardware has been procured and software development is ongoing.

FY 2003 PLANS:

Initiate:

- Articulation of requirement and methodology for sensor coordination in support of integrated fire control and theater-wide surveillance/tracking.

Continue:

- Littoral Affordability (classified program).
- DWC development of algorithms for the AEGIS Combat System, CTE and PSR functions. Demonstrate Navy Anti-Air Warfare (AAW) combined with terminal TBM defense functionality in a laboratory simulation facility.

Complete

- The TACMS-P ACTD critical review.

FY 2004 PLANS:

Initiate:

- Technology development for the next generation reactive material (formulations, material properties and lethality models) for high density reactive materials and novel reactive structural materials.
- Development of difluoramine ingredient and formulations as candidates for next generation explosives and propellants.
- Development of advanced directed energy warheads, exploiting novel explosive and reactive material concepts.

Continue:

- Littoral Affordability (classified project).
- DWC development of algorithms for the AAW and TBMD functionality of CTE and PSR in the naval open architecture combat system. It will take first steps to demonstrate this capability in an “open system” environment at a contractor facility.

FY 2005 PLANS:

Continue:

- Littoral Affordability (classified program).
- DWC development of algorithms for the naval open architecture combat system, CTE and PSR functions and sensor coordination. Demonstrate Navy and Joint Integrated Air Defense functionality in a laboratory simulation facility.
- Technology development for the next generation reactive material (formulations, material properties and lethality models) for high density reactive materials and novel reactive structural materials.
- Development of difluoramine ingredient and formulations as candidates for next generation explosives and propellants.
- Development of advanced directed energy warheads, exploiting novel explosive and reactive material concepts.

	FY 02	FY 03	FY 04	FY 05

Aircraft Technology	$10,701	$7,000	$5,511	$5,831

Activity develops enabling technology for naval aviation, with emphasis on the demands imposed by aircraft carrier flight operations and Marine Corps amphibious and field operations. This effort exploits emerging technologies of: (a) structures and flight controls to reduce the total life-cycle-cost and extend the operational life of future and legacy air vehicles; (b) reduced observables, (c) aerodynamic designs of Naval-unique aircraft components; (d) advanced electrical power systems for air vehicles; (e) advanced helmet/display systems; and (f) predicting safer, more reliable at-sea operating envelopes. The effort provides mission area analysis and concept definition required for the applied research phase of air vehicle programs.

Applied research efforts address manned and unmanned airborne platform technologies for future joint warfighting capabilities to promptly engage regional forces in decisive combat on a global basis and to employ a range of more suitable actions at the lower end of the full range of military operations, which achieve military objectives with minimum casualties and collateral damage. This activity adheres to Defense Science and Technology (S&T) Reliance Agreements and supports the Department of Defense Science and Technology Strategy, which coordinates and minimizes duplication of aircraft technology efforts. Individual Naval aircraft technology applied research efforts fill Naval Aviation needs that are not met by Air Force, Army, National Aeronautics and Space Administration (NASA), Defense Advanced Research Projects Agency (DARPA) and industry programs.

FY 2002 ACCOMPLISHMENTS:

Initiated:

- Technology demonstration of an all-composite (fatigue & corrosion insensitive) replacement for dynamically loaded control surfaces for tactical aircraft.
- Time-accurate Computational Fluid Dynamics (CFD) modeling of ship airwake flows to provide higher fidelity simulations, enhancing safety.

Continued:

- Abrupt Wing Stall (AWS) figures of merit development and verification, CFD validation, and wind tunnel test techniques to mitigate/eliminate AWS on current/future fighter/attack aircraft.
- Development and simulation of advanced control laws for ship-board auto-land of unconventional vehicles.
- Development and simulation of automated maneuvering algorithms to improve lethality, safety, and survivability for Naval Mission tasks.
- Development of Advanced optics and head tracker of a multi-mode helmet vision system. Transitioned effort to PE 0603216N.
- Development of survivability/reduced observables technology (classified).
- Piloted simulation of intelligent flight control prognostics and reconfiguration algorithms to improve safety, survivability, and affordability of flight control systems.

Completed:

- Flight-testing with DARPA and Boeing of an Unmanned Air Vehicle (UAV) to demonstrate conversion from rotary-wing to fixed-wing flight using a canard/rotor wing concept.

FY 2003 PLANS:

Initiate:

- Investigation of reconfigurable air vehicles.

Continue:

- Technology demonstration of an all-composite replacement for dynamically loaded control surfaces for tactical aircraft.
- Time-accurate CFD modeling of ship airwake flows to provide higher fidelity simulations, enhancing safety.
- Validation through real-time hardware demo of intelligent flight control prognostics and reconfiguration algorithms to improve safety, survivability, and affordability of flight control systems.
- Survivability/reduced observables technology development (classified).

Complete:

- Piloted simulation of intelligent flight control prognostics and reconfiguration algorithms to improve safety, survivability, and affordability of flight control systems.
- Development and simulation of advanced control laws for shipboard auto-land of unconventional vehicles.
- Development and simulation of automated maneuvering algorithms to improve lethality, safety, and survivability for Naval Mission tasks.
- Abrupt Wing Stall figures of merit development and verification, CFD validation, and wind tunnel test techniques to mitigate/eliminate AWS on current/future fighter/aircraft aircraft.

FY 2004 PLANS:

Continue:

- Investigation of in-flight, autonomously reconfigurable air vehicles. This effort includes studies and workshops to define this revolutionary-type of air platform concept. This effort will include the leveraging of results from methodology, theory and model development of fatigue & corrosion-insensitive structures, ship-aircraft airwake computational capability, and intelligent flight control prognostics & reconfiguration algorithms.
- Survivability/reduced observables technology development (classified).

Complete:

- Validation through real-time hardware demo of intelligent flight control prognostics and reconfiguration algorithms to improve safety, survivability, and affordability of flight control systems.

FY 2005 PLANS:

Continue:

- Investigation of in-flight, autonomously reconfigurable air vehicles. This effort includes studies and workshops to define this revolutionary-type of air platform concept. This effort will include the leveraging of results from methodology, theory and model development of fatigue & corrosion-insensitive structures, ship-aircraft airwake computational capability, and intelligent flight control prognostics & reconfiguration algorithms.
- Survivability/reduced observables technology development (classified).

Complete:

- Validation through component demonstration of methodology for the design & analysis of fatigue & corrosion insensitive aircraft structure (control surface).

	FY 02	FY 03	FY 04	FY 05
Underwater (UW) Platform Self Defense	$3,100	$1,500	$1,653	$1,612

Activity develops enabling technologies that will increase the survivability of surface ship and submarine platforms against torpedo threats. Proposed technologies focus on defeating high priority threats including torpedoes (i.e. straight running, wake homing, acoustic homing, high speed torpedoes, air dropped torpedoes, and salvoes of torpedoes). The long-term goal of the UW Platform Self Defense activity is to develop technologies that will ultimately be placed on board ship. Technologies should be developed to minimize shipboard impact, allow automatic employment, and require minimal organizational maintenance. Specific technology includes two efforts. The Next Generation Countermeasure (NGCM): A mobile adaptive acoustic countermeasure with acoustic communication links to enable countermeasure connectivity and group behavior to defeat threat torpedoes. The Anti-Torpedo Torpedo (ATT)/Tripwire Demonstration: Technologies for passive shipboard detection, classification, and localization (DCL) of incoming torpedoes and an ATT to engage the threat torpedoes. This effort supports the Fleet and Force Protection FNC.

FY 2002 ACCOMPLISHMENTS:

Initiated:

- Development of technology for NGCM

Continued:

- Development of ATT component technology in propulsion, MicroElectroMechanical Systems (MEMS), and Guidance and Control (G&C).

FY 2003 PLANS:

Initiate:

- Transition of counter-torpedo technologies to Naval Sea Systems Command (NAVSEA) (PMS-415) Tripwire Torpedo Defense System (AN/WSQ-11) and Next Generation Countermeasure (NGCM).

Continue:

- Development of technology for NGCM.
- Continue development of ATT component technology in propulsion, MEMS, and G&C.

FY 2004 PLANS:

Continue:

- Development of technology for NGCM.
- Continue development of ATT component technology in propulsion, MEMS, and G&C.
- Transition of Next Generation Countermeasure (NGCM).

FY 2005 PLANS:

Continue:

- Development of technology for NGCM.
- Development of ATT component technology in propulsion, MEMS, and G&C.
- Transition of Next Generation Countermeasure (NGCM).

Congressional Plus-Ups:

	FY 02	FY 03
American Underpressure System (AUPS)	961	$0

Completed the test program of the AUPS including the control system design. In FY02 the project developed control simulation data to verify performance and safety of the system in order to fully respond to the United States Coast Guard stated requirements and permit rulemaking changes.

	FY 02	FY 03
Anti-Corrosion Modeling Software	0	1,223

Develop workable corrosion maintenance guidelines and criteria for high strength steel components, in particular arrestment gear of carrier aircraft. Present airframe criteria calling for the repair and/or replacement of all corroded parts in the Fleet are very difficult to implement both with respect to time and resources. The results of this effort will enable maintenance teams to delineate between aircraft corrosion with potential safety impacts and corrosion that is cosmetic.

	FY 02	FY 03
Battery Charging Technology	831	2,078

Provide applied research efforts to the development of improved battery charging technology that increases battery life 2-3 fold and reduces battery charging time. The battery charging technology will also detect impending battery failure to permit replacement prior to power loss. Application of this technology will prevent data loss, mission abort, and loss of life, as well as weight reduction for Marine Corps field units. This will also avoid the fleet failures of important Uninterruptible Power System (UPS) and starting systems that have left a couple of DDG51 class ships in the dark. FY 03 will focus on the development and application of algorithms for application to battery charging.

	FY 02	FY 03
Center for Advanced Power Systems (CAPS)	3,467	4,988

Development of a superconducting system research laboratory which includes development of the following major components: Superconducting Magnetic Energy Storage (SMES) Facility and High Temperature Superconducting Prototype Shipboard Transformer Research Facility. This laboratory will be used to simulate pulsed loads and to investigate future ultra-dense shipboard power system architectures. Development of a reconfigurable power conversion research

laboratory which includes procurement and development of programmable power converters and advance power system control structures. (FY02 Title was Center for Advanced Transportation Technology).

	FY 02	FY 03
Endeavor	961	3,325

Development of an integrated set of ship design tools including structural loading and hydrodynamic modeling tools.

	FY 02	FY 03
Fusion of Hyperspectral and Panchromatic Data	4,322	0

Conducted research to develop a real-time airborne fusion processor and algorithms for the Navy Hyperspectral/Imaging for Surveillance and Targeting (HISTAR) program. Established proposal for HISTAR. Research supported development of a hyperspectral sensor and signal processing for the Shared Reconnaissance Pod (SHARP) on the F/A-18 aircraft for real-time detection and classification of threat targets.

	FY 02	FY 03
Data Fusion Processor	0	3,325

Apply advanced technology to a fusion processor. The effort develops a real-time airborne fusion processor and algorithms for the Navy Hyperspectral/Imaging for Surveillance and Targeting (HISTAR) program. Funding will support the development of a hyperspectral sensor and signal processing for the Shared Reconnaissance Pod (SHARP) on the F/A-18 aircraft for real-time detection and classification of threat targets.

	FY 02	FY 03
Integrated Fuel Processor – Fuel Cell System	0	1,761

Develop a novel fuel processing system to reform the JP-5 fuel used for Naval aircraft. The fuel processor technology would be integrated into a turnkey fuel cell system, with payoffs of increased efficiency and lower emissions of auxiliary power units used on board aircraft and ocean-going vessels.

	FY 02	FY 03
Laser Welding and Cutting	0	1,956

Apply advanced technology to laser welding and cutting. The effort will provide development of laser based fabrication for application in Navy shipbuilding, including welding and cutting technologies. Laser based cutting and welding technologies could enhance shipyard productivity/automation, reduce costs, enhance ship performance/reliability/maintainability, and reduce weld-induced distortion/associated rework costs/ship signature. This technology could lead to low cost, higher quality production methods that would benefit U.S. shipyards.

	FY 02	FY 03
Miniature Autonomous Vehicles	0	977

Develop a distributed communication and control architecture for a cooperating multi-vehicle fleet of autonomous underwater vehicles (AUV). Control architecture will be validated by computer simulation and in-water prototype testing.

	FY 02	FY 03
Modular Advanced Composite Hull Form	1,445	977

Investigate hybrid (composite to steel) joints for application to hybrid ship hull and lifting body. The research explores joining concepts and develops experimental, theoretical, and analytical methods to assess their reliability under sea loads. The Hybrid Hull concept will facilitate the use of composites in Naval combatants to achieve stealth and survivability.

	FY 02	FY 03
Small Watercraft Demonstrator	0	4,156

Initiate development of a small watercraft with improved performance characteristics compared to existing small watercraft. Efforts focus on development of a very high power-to-weight ratio hybrid electric propulsion system, and hull form designs to optimize seakeeping at all speeds.

	FY 02	FY 03
Fiber Reinforced Polymer Composites Research	0	977

Identify key processing parameters that affect the variability of material properties in marine composite laminates. Develop models that predict mechanical design property as a function of these parameters. Link the material property results to a structural reliability analysis model for fiber reinforced composite panels.

	FY 02	FY 03

Three Dimensional Printing (3DP) Metal Working Technology	2,401	*

Provided applied research to the technique of three dimensional printing (3DP) metal working. The system incorporates a Three Dimensional Printing (3DP) machine and supporting process equipment. The project included working to define, develop and demonstrate the system and 3DP process on specific DOD and DLA applications. This project will advance the potential use of the 3DP process and its unique capabilities for the manufacture of components in an e-manufacturing environment. (*Appropriated in FY03 in PE 0602236N, $3,765)

	FY 02	FY 03
Unmanned Sea Surface Vehicle (USSV)	0	5,281

Initiate development of an advanced class of surface craft optimized for unmanned missions. The primary focus is on enhanced speed, range, endurance, seakeeping, and payload fraction, considered in the context of potential unmanned vehicle missions. Issues of launch, recovery, and host platform compatibility will also be explored.

C. OTHER PROGRAM FUNDING SUMMARY:

NAVY RELATED RDT&E:
- PE 0204152N (E-2 Squadrons)
- PE 0205601N (HARM Improvement)
- PE 0601153N (Defense Research Sciences)
- PE 0602131M (Marine Corps Landing Force Technology)
- PE 0602235N (Common Picture Applied Research)
- PE 0602271N (RF Systems Applied Research)
- PE 0603123N (Force Protection Advanced Technology)
- PE 0603235N (Common Picture Advanced Technology)
- PE 0603271N (RF Systems Advanced Technology)
- PE 0603502N (Surface and Shallow Water Mine Countermeasures (MCM))
- PE 0603513N (Shipboard System Component Development)
- PE 0603553N (Surface Anti-Submarine Warfare)
- PE 0603561N (Advanced Submarine Systems Development)
- PE 0603573N (Advanced Surface Machinery Systems)
- PE 0603609N (Conventional Munitions)
- PE 0603640M (Marine Corps Advanced Technology Demonstrations)
- PE 0604307N (Surface Combatant Combat System Engineering)
- PE 0604518N (Combat Information Center Conversion)
- PE 0604558N (New Design SSN)
- PE 0604561N (SSN-21 Development Program)

NON NAVY RELATED RDT&E:
PE 0602270A (Electronic Warfare Technology)
PE 0602204F (Aerospace Sensors)

D. ACQUISITION STRATEGY: Not Applicable.