FY 2006/2007 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: Feb 2005
Exhibit R-2

BUDGET ACTIVITY: 02
PROGRAM ELEMENT: 0602114N
PROGRAM ELEMENT TITLE: POWER PROJECTION APPLIED RESEARCH

COST: (Dollars in Thousands)

Project Number & Title	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate
POWER PROJECTION APPLIED RESEARCH	141,450	135,163	94,148	73,926	65,778	57,165	45,886	57,276

A. MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: This Program Element (PE) addresses the technology issues involving the Navy's capability to project Naval power on the broad seas and in the littoral regions. In particular, the technology developed in this PE will support Navy power projection requirements related to fleet defense and protection of Naval assets in the littoral area, Naval strike operations against critical shore targets, and support for Naval expeditionary forces ashore. This PE supports the Time Critical Strike (TCS) Future Naval Capability (FNC) and the Autonomous Operations (AO) FNC. Within the Naval Transformation Roadmap, this investment will achieve two of four key transformational capabilities required by Sea Strike as well as technically enable the Littoral Sea Control key transformational capability within Sea Shield.

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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PROGRAM CHANGE SUMMARY:

	FY 2004	FY 2005	FY 2006	FY 2007
FY 2005 President's Budget Submission	142,626	98,831	89,335	81,799
Cong Rescissions/Adjustments/Undist. Reductions	0	-1,360	0	0
Congressional Action	0	39,600	0	0
Program Adjustments	0	-1,908	4,879	-10,802
Execution Adjustments	334	0	0	0
Federal Technology Transfer	-31	0	0	0
FNC Realignment	0	0	-125	2,550
Non-Pay Inflation Adjustments	-140	0	2	3
Rate Adjustments	0	0	57	376
SBIR Assessment	-1,339	0	0	0
FY 2006/2007 President's Budget Submission	141,450	135,163	94,148	73,926

PROGRAM CHANGE SUMMARY EXPLANATION:
Technical: Not applicable.

Schedule: Not applicable.

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A. MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: This project addresses the technology issues involving the Navy’s capability to project naval power on the broad seas and in the littoral regions.

B. ACCOMPLISHMENTS/PLANNED PROGRAM:

	FY 2004	FY 2005	FY 2006	FY 2007
STRATEGIC SUSTAINMENT	23,120	29,852	23,319	13,447

The Strategic Sustainment activity develops technologies which will sustain and improve Navy's strategic system capabilities in the areas of Radiation Hardened System Design (RAD HARD), Solid Rocket Motor Ignition (SRM) Response, and drag reduction devices. This activity contains the Technology for the Sustainment of Strategic Systems (TSSS) and the Strategic Systems Infrastructure (SSI) effort. Increase in 2005 was due to the addition of tasks for the SSI effort. Decreases in FY 2006 and FY 2007 are due primarily to completion of TSSS Phase 1 effort.

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FY 2004 Accomplishments:

- TSSS: RAD HARD task continued efforts in upgrading and linking software. The SRM ignition response effort performed advanced nonlinear model comparisons with ground test data. Drag Reduction Devices developed an advanced aerospike drag reduction model. The accelerometer effort fabricated a Proof of Concept Superconducting and Atom Interferometer and Gravity Gradient Sensor.
- SSI: Initiated formulation of high performance propellants, development of the preliminary design and parametric testing for a Post Boost Control System (PBCS). Performed preliminary design of alternatives for an Exploding Bridgewire (EBW) detonator and conducted evaluation of test data of the effects of the external environment on missile electronics. Began transition of ONR's advanced transducer design and developed a new hydrophone array.

FY 2005 Plans:

- TSSS: Complete RAD HARD System Design Tool task. The SRM ignition response effort completes code validation and verification with flight test data. The Drag Reduction Devices task completes the development of an aero elasticity tool for performance prediction of missiles with drag reduction devices. Gravity Gradient Sensors and a new technology accelerometer for the Fiber Optic Gyro Navigator (FOGN) unit will be tested.
- SSI: Continue Missile propulsion effort with subscale static motor testing. PBCS will develop thermal/mechanical valve and flow impingement models. Ordnance Initiation technology effort will conduct design reviews and purchase prototype systems for evaluation. Missile electronics will continue the model development. Navigation Sonar will initiate development of a common electronics architecture to accommodate affordable hardware.

FY 2006 Plans:

- TSSS: Underwater launch task will conduct exit testing of the Underwater Launch Technology Sustainment System (ULTSS). Testing will be performed to demonstrate the utility of the ULTSS in guiding and advising engineers unfamiliar with Underwater Launch (UWL) technology in the creation of a conceptual design. Release of final version of ULTSS. The TSSS Phase I effort is completed.

- SSI: Missile tasks in Propulsion will continue efforts by conducting non-eroding throat tests, chamber bottle tests, insulator tests, component compatibility tests and propellant hazard assessment. The program

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will conduct an innovative testing of new rocket motor case/nozzle design. Continue Advanced PBCS Valve efforts by conducting materials compatibility tests, an Integrated Valve Assembly demo, subscale propellant mixes and a manifold concept demo. Ordnance Initiation Technologies program will test the ordnance initiation system as a laboratory prototype. Continue Missile Electronics efforts by conducting small coupon aging studies, conduct radiation hardening tests & assessments, complete board aging model development, and continue development of board level and missile level modeling techniques. Sonar effort will complete detailed design and begin fabrication of the prototype new technology hardware.

FY 2007 Plans:

- SSI: Continue Missile propulsion efforts by conducting larger scale non-eroding throat tests, chamber bottle tests, insulator tests, component compatibility tests and propellant hazard assessment. Continue Advanced PBCS Valve Technology and Materials program efforts by conducting materials compatibility tests, Integrated Valve Assembly demo, subscale propellant mixes and a manifold concept demo. Goal is heavy wall testing simulating a very limited full scale Post Boost control system test. Ordnance Initiation Technologies program completes final tests on the prototype demonstrating the new technology, with documentation of designs showing applications to strategic missiles. The Missile Electronics Technologies program completes code development with final Validation and Verification of the models with experimental radiation hard data and aging data. Navigation sonar will complete Laboratory and tank testing of the new technology transducer and hydrophones. Prototype hardware will be integrated aboard USNS WATERS to provide a Navigation Sonar System (NSS) test bed and evaluated at-sea in an operational environment.

	FY 2004	FY 2005	FY 2006	FY 2007
HIGH SPEED PROPULSION AND ADVANCED WEAPON TECHNOLOGIES	16,949	36,046	17,118	14,257

The work in this activity supports technologies that support high speed weapons delivery and advanced weapons development. High speed weapons (Mach 3 to Mach 6+) will provide the Navy the capability to attack time critical targets by delivering a weapon over long distances in very short periods of time.

The increase from FY 2004 to FY 2005 was due to increased funding for the National Aerospace Initiative (NAI) high speed propulsion effort. The decrease in FY 2006 reflects conclusion of Hy Fly, reduced 6.2 effort in NAI Hypersonic Turbine Vehicle (HTC), and transfer of Non-Lethal Weapons to PE 0602651M.

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FY 2004 Accomplishments:

- HyFly: Continued air vehicle and fuel system testing and validation of the operational flight program software using hardware in-the-loop testing.
- Integrated High Payoff Rocket Propulsion Technology (IHPRPT): Continued development of surface launch component technologies.
- Asymmetric Threat Defense: Continued subsystem design and development of detection/tracking algorithms and components for the Ship-Linked Interceptor (SLI) and Laser Anointed Interceptor (LAI) including the Inertial Measurement Unit (IMU), warhead, fuzing, explosive, control actuators, and signal processing algorithms.
- National Aerospace Initiative High Supersonic Turbine Vehicle (NAI HSTV) technology base: Program supported the development of high-speed supersonic turbine engine and airframe technologies for expendable weapons applications. Initiated flow path and turbine engine component development and demonstration effort to increase the performance of inlet and nozzles, high temperature compressor, and turbine.

FY 2005 Plans:

- HyFly: Conduct direct connect tests and a freejet test to optimize engine performance.
- IHPRPT: Continue surface launch component development and begin initial design for the air launched demonstration effort.
- Asymmetric Threat Defense: Continue development of detection and continuous target tracking algorithms. Continue design and fabrication of the SLI and LAI.
- NAI HSTV: Continue development and validation of flow path and turbine engine components and continue component rig testing. Begin design and fabrication of airframe components and assessment of thermal management techniques.
- Non-Lethal Weapons: This program has been transferred to PE 0602651M.

FY 2006 Plans:

- IHPRPT: Design, assess and process new energetic material ingredients for advanced composite rocket motor development. Demonstrate end burning propellant grain, survivable nozzle and high pressure composite case air-to-air rocket motor. Demonstrate Phase II performance goals in 5.2-inch end burning, flight-weight motor.
- Asymmetric Threat Defense: Design and fabricate seeker, fuze and warhead prototypes.

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- NAI HSTV: Continue development of component/sub-system technologies in propulsion, inlet, nozzle, airframe, and thermal management for high supersonic turbine powered weapon systems. Select technologies for validation and conduct ground testing/validation.

FY 2007 Plans:

- IHPRPT: Scale-up and formulate new propellant ingredients and compositions. Eliminate nozzle erosion commensurate with ducting, acceleration and exhaust of high temperature solid propellant gases and particulates. Demonstrate impulse performance gains of >5% through low-to-zero erosion nozzle concepts.
- Asymmetric Threat Defense: Demonstrate seeker performance with captive carry flight over water. Demonstrate fuze and warhead performance against static boat targets.
- NAI HSTV: Continue development of component/sub-system technologies for high supersonic turbine powered weapon systems. Conduct validation, ground testing and demonstrations.

	FY 2004	FY 2005	FY 2006	FY 2007
UNMANNED VEHICLES	14,604	9,258	6,439	8,099

The focus of this activity is on those technologies that relate to the development of Unmanned Vehicles (UVs) that will support Naval forces and expeditionary operations. Specific technology areas include the development of Intelligent Autonomy (IA) technologies to increase autonomy, performance, and affordability in Unmanned Underwater Vehicles (UUVs), Unmanned Air Vehicles (UAVs), Unmanned Ground Vehicles (UGVs), UAV control systems, UAV radar systems, and UAV propulsion and power systems. Naval Research Laboratory (NRL) investment/performance is included in this effort.

FY 2004 Accomplishments:

- UAV radar: Completed airborne testing using a Piper Aztec as a surrogate platform.
- IA: Continued development of dynamic replanning and autonomous control and operations technologies. Completed UAV/UGV reconnaissance demonstration jointly with Defense Advanced Research Projects Agency (DARPA) and in-water maritime situation awareness demonstration.
- UUV: Continued development of Electro Magnetic/Electro Optic (EM/EO) sensors, software, sensor data fusion, integrated autonomous control approaches for Maritime Reconnaissance (MR), and multi-vehicle Undersea Search and Surveillance (USS) and communication link development.

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- UAV control: Continued testing of threat detection/collision avoidance software and the development of secure jam resistant communications and multiple UAV information displays.
- UGV: Continued development of robotic communication technologies in support of the Marine Corps Gladiator Tactical Unmanned Ground Vehicle (TUGV) program; transitioned them to the Marine Corps for System Design and Development(SDD).
- UAV propulsion: Continued development fabrication and rig testing of Navy UAV propulsion component technologies under the Integrated High Performance Turbine Engine technology (IHPTET) program, including the advanced PW-800 commercial gas generator core and the XTL-17 supersonic missile engine.
- Autonomous Mobile Platform (AMP): Initiated effort to create small sensor platforms capable of extended endurance. Developed propulsion/energy storage/replenishment, navigation/guidance systems, and locomotion technologies.
- Developed four configurations of the Survivable Mobile, Long Endurance (vehicles that will allow small sensor platforms to rejuvenate their power source and to reposition themselves as required. (NRL)
- Continued development of high-performance, low-cost Electro-Optic/Infrared (EO/IR) airborne surveillance sensors for unmanned aerial vehicles, and ultra-high performance EO/IR sensors. (NRL)

FY 2005 Plans:

-IA: Continue development of dynamic replanning and autonomous control technologies. Conduct simulation of dynamic replanning and multi-vehicle technology for littoral Intelligence Surveillance & Reconnaissance (ISR). Complete simulation demonstration of multi-vehicle distributed cooperative control jointly with Air Force for Intelligence Surveillance & Reconnaissance (ISR) and strike missions. Complete joint DARPA UAV/UGV reconnaissance demonstration.
- UUV: Continue development and transition of UUV-deployed ISR EM/EO sensors and software, multi-vehicle USS and communication link development; continue Magnesium Semi-Fuel Cell energy source development and demonstration. Complete preparation of transition data package for the Integrated Motor Propulsor(IMP).
- UAV control: Continue development of command, control and displays for multiple UAVs, and single frequency multi-point UAV communications.
- UAV propulsion: Ground test demonstrator engine and a Mach 3.5 capable expendable turbine engine.
- AMP: Integrate energy replenishment and storage with a mobile platform and demonstrate replenishment and relocation operation.
- Integrate energy replenishment and storage mechanism in small autonomous vehicles and demonstrate replenishment and relocation. (NRL)
- Complete development of high performance EO/IR sensors for UAV's. (NRL)

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- Initiate development of a lightweight, 4.5 hp recuperated, turbo-shaft engine with an integral 3 kW generator for UAV propulsion and portable power generation. (NRL)

FY 2006 Plans:

- IA: Complete development of multi-vehicle cooperation technologies. Complete medium-fidelity simulation of multi-vehicle cooperation technologies for multiple classes of Naval unmanned vehicles in littoral ISR.
- UUV: Transition USS and Communications Navigation Aid (CNA) products to PMS-Explosive Ordnance Disposal (EOD) and ONI-34 per Technology Transition Agreements (TTAs); standup Submarine Track and Trail (STT) efforts in the areas of advanced undersea sensors, communications, and autonomy.
- UAV control: Continue developing and testing airborne and shipboard battle manager platforms for UAVs operating from Littoral Combat Ship (LCS) ships. Continue developing and begin testing an open architecture airborne control station that can be used onboard a P-3 type aircraft for the control of multiple UAVs.
- UAV propulsion: Continue Ground test demonstrator engine and a Mach 3.5 capable expendable turbine engine.
- Continue development of lightweight UAV engine. (NRL)

FY 2007 Plans:

- UUV: Continue STT efforts in the areas of advanced undersea sensors, communications, and autonomy.
- UAV control: Continue developing and testing airborne and shipboard battle manager platforms for UAVs operating from LCS. Continue testing an open architecture airborne control station that can be used onboard a P-3 type aircraft for the control of multiple UAVs.
- UAV propulsion: Continue Ground test demonstrator engine and a Mach 3.5 capable expendable turbine engine.
- Complete long-term demonstration of multiple sensor-equipped vehicles, covering autonomous sensing operation and multiple replenishment/relocation cycles under autonomous or semi-autonomous control. (NRL)

	FY 2004	FY 2005	FY 2006	FY 2007
NAVIGATION, ELECTRO OPTIC/INFRARED (EO/IR), AND SENSOR TECHNOLOGIES	13,310	6,928	6,983	7,052

This activity describes Navy Science and Technology (S&T) investments in the areas of Electro Optic/Infrared devices, Global Positioning Station (GPS) and Fiber Optic Gyro (FOG) Navigation systems, and advanced sensors. The network centric and navigation technology effort is focused on improving the navigation accuracy of Naval forces through improvements in FOGs, distributed timekeeping systems, and GPS improvements. This effort also

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includes NRL investment/performance in the technology areas of Electronics, Electronic Warfare, and Communications.

FY 2004 Accomplishments:

- Tightly Coupled Global Positioning System/Inertial Navigation System (GPS/INS): Incorporated Micro Electronic Mechanical Systems (MEMS) IMU into existing test bed. Completed zero-age ephemeris and Controlled Radiation Pattern Antenna (CRPA) mutual coupling reduction projects.
- EO/IR technologies: Multispectral Infrared Focal Plane Array (IRFPA)- Developed two color longwave focal plane based algorithms for missile defense. Continued development of high-performance, low-cost Electro-Optic/Infrared (EO/IR) airborne surveillance sensors for unmanned aerial vehicles, and ultra-high performance EO/IR Imagers. Continued work to develop auto-target identification techniques for Laser Range-gated imagers.
- Navigation Technologies: Continued Distributed Time Standards, Rb Double Bubble Maser Atomic Clock, time synchronization and precision time transfer, and algorithm development for Distributed Time Scaling efforts. Initiated GPS/INS/LORAN effort to remove noise and improve GPS and LORAN performance.
- Millimeter Wave (MMW) threat detection: Initiated effort to develop preliminary hardware and software designs for channelized and photonic Ka/W band Electronic Warfare (EW) receiver designs.
- Electronics: Continued development of system simulation tool in ZEMAX and tested spectral emittance based target discrimination algorithm for three band Long Wave Infrared (LWIR) sensor. Continued effort with demonstration of the first long wave IR (LWIR) “W”-structured type-II superlattice (WSL) photo-diodes. These devices exhibited stronger absorption and turn-on than comparable binary and ternary antimonide superlattice photodiodes. Designed WSL based heterostructure for dual-band photodiodes, and completed dual-band test maskset. Continued identification of the correlation between arsenic background pressure and cross-contamination of arsenic in GaSb layers and interfaces in InAs/GaSb superlattices using cross-sectional tunneling electron microscopy (XSTM) and x-ray diffraction (XRD). Initiated design of Photonic Band Gap (PBG) structures for infrared (IR) transmission and demonstrated feasibility to extrude micro-structured performs and have drawn preliminary Hollow Core (HC)-PBG fiber. (NRL)
- Electronic Warfare: Continued development of infrared countermeasures (IRCM) against imaging missiles using a unique state-of-the-art hardware-in-the-loop hybrid approach. Initiated development of IR obscuration technologies using evolving nanoparticle technology to provide surface vessel protection to achieve an order of magnitude improvement over current obscurants. (NRL)

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- Communications: Continued development and conducted demonstrations for operational forces of covert, high bandwidth, free space laser communications systems. Continued development of Multi-Quantum Well (MQW) retroreflector covert communications system. Increase bandwidth by order of magnitude using a cat's eye backplane. (NRL)

FY 2005 Plans:

- Navigation Technologies: Continue Precision Time and Time Interface transfer demonstration, Deeply Coupled GPS/INS with nonlinear filter algorithm development, Distributed Time scaling Technology, Rb Double Bubble Maser Atomic Clock, and static testing of Tightly Coupled GPS/INS/Loran projects. Initiate the following four projects: MEMS INS device development, Communication Navigation and Identification (CNI) device, GPS receiver for landing systems, and Space and Frequency Adaptive Processing for GPS Anti-Jam (AJ) antennas.
- EO/IR technologies: Continue Multispectral IRFPA assembly and testing, and fabrication of photonic MMW threat detection prototype receivers. Continue development of high-performance, low-cost EO/IR airborne surveillance sensors for unmanned aerial vehicles, and ultra-high performance EO/IR Imagers. Continue development of auto-target identification techniques for Laser Range-gated imagers.
- Electronics: Continue spectral emittance based target discrimination work, LWIR WSL development, GaSb substrate study, and high power laser HC-PBG effort. Initiate study Yb doped ceramic YAG and Y2O3 for optical cooling efficiency, investigate high power 1030 nm lasers as a pump source. (NRL)
- Electronic Warfare: Complete IRCM effort by implementing preprocessing and track algorithms into imaging seeker surrogates. Continue IR obscurant technology development. (NRL)
- Communications: Continue covert high bandwidth communications and MQW retroreflector communications system efforts. (NRL)

FY 2006 Plans:

- Navigation Technologies: Continue Distributed Time Standards algorithm development, Rb Clock design and experiments, and Link 16 Time Transfer development and testing. Continue Tightly Coupled GPS/INS/LORAN effort, Fiber Optic Ring Gyroscope development, algorithm development for GPS Anti-Jam (AJ) and direction finding. Complete Algorithm development for Distributed Time Scaling and the Deeply Integrated GPS/INS width Nonlinear Filter project. Initiate the Magnetic Passive Reset for Inertial Navigation System (INS) and the development of Advanced GPS/INS (GIN) Systems for Strike Weapons.
- EO/IR: Continue Jitter Compensation development of low cost piezoelectric motion and jitter compensation for high resolution visible and infrared sensors. Millimeter Wave (MMW) and TeraHertz (THz) Imaging effort

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will complete development of MMW imagers and continue development of THz imaging through fog, clouds, clothing, and some walls. Continue Nano Sensors development of ultra low noise uncooled nanotechnology infrared sensors and nanoatomic sensor nonvolatile memories. Electronic Zoom effort will continue development of electronic liquid crystal based directional field of view and zoom imagers. Continue multi-sensor (visible, infrared, millimeter wavelength, terahertz and laser imagers) fusion for objection recognition.
- Electronics: Continue high power HC-PBG development and Yb doped ceramic YAG high power laser efforts. Complete target discrimination effort by conducting a real time demonstration of spectral emmitance based target/material target descrimination using LW QWIP sensor. Complete study of WSLs for multiband IR photodiodes by demonstrating high performance dual-band LW & VLIR photodiode operation. Complete study of pre-growth molecular hydrogen cleaning of GaSb substrates. (NRL)
- Electronic Warfare: Continue IR obscurant technology development effort. (NRL)
- Communications: Continue covert high bandwidth communications effort. Complete development of MQW retroreflector with Cat's Eye Backplane. Transition compact, light-weight MQW communications to operational forces. (NRL)

FY 2007 Plans:

- Navigation Technologies: Continue Rb Clock development and testing, Fiber Optic Ring Gyroscope development, GPS AJ and Direction Finding algorithm development, Magnetic Passive reset for INS, and Advanced GPS/INS systems for strike weapons. Complete Network Centric Navigation (Link-16 Time Transfer), Distributed Time Standards, and Tightly Coupled GPS/INS/Loran efforts.
- EO/IR: Complete development of low cost piezoelectric motion and jitter compensation for high resolution visible and infrared sensors. Continue Millimeter Wave (MMW) and TeraHertz (THz) Imaging project. Complete development of ultra low noise uncooled nanotechnology infrared sensors and continue development nanoatomic sensor nonvolatile memories. Complete development of electronic liquid crystal based directional field of view and zoom imagers. Complete multi-sensor (visible, infrared, millimeter wavelength, terahertz and laser imagers) fusion for objection recognition effort.
- Electronics: Complete demonstration of high laser power through IR transmitting HC-PBG fiber. Complete performance optimization and scaling law development for the Radiation Balanced Laser. (NRL)
- Electronic Warfare: Complete development of IR obscuration technologies for surface vessel protection to achieve order of magnitude improvement over current obscurants and develop dissemination system prototype. (NRL)
- Communications: Continue development of free space laser communications systems with the development of a hybrid infrared system with dramatically lower power requirements at the sensor/transmitter. (NRL)

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ELECTRIC WEAPONS	13,452	9,898	38,632	30,328

The goal of this activity is to develop Directed Energy (DE) and Electric Propulsion power weapons for Navy applications. One major component of the DE program is the Free Electron Laser (FEL) which if successful could be applicable for shipboard applications as a defense weapon against advanced cruise missiles and asymmetric threats. The other major component is the EM gun work that is focused on developing the technology to launch a long range projectile from Navy ships. This activity also includes NRL investment/performance in these research areas.

FY 2004 Accomplishments:

- DE: Completed commissioning and demonstration of a 10 kW FEL. Performed FEL beam quality experiments at the 10 kW level and conducted design studies for advanced injector configurations. Initiated design studies to evaluate multiple design alternatives and costs involved with the development, fabrication, and demonstration of a 100 kW FEL.
- EM gun: Initiated program to develop EM gun technology. Initial effort focused on rail wear issues, energy storage, and pulsed power switching. Demonstrated 90mm prototype in initial lethality tests against different strike targets.

FY 2005 Plans:

- DE: Continues with fabrication of high current, high brightness injectors including superconducting Radio Frequency (RF) cavity base design. Conduct experiments with alternative FEL amplifier configurations to compare performance to current oscillator configuration and to determine the best scale up path to a megawatt FEL.
- Investigate tribologic aspects of sliding metal-to-metal high current contacts in the rails of EM railguns. (NRL)

FY 2006 Plans:

- DE: Perform 1 micron filamentation, halo limitation, and short Rayleigh range studies. Continue lethality testing and optical propagation studies. Current injector task will complete assembly and test the Advanced Energy Systems (AES) Cryounit. Continue testing of radio frequency (RF) gun High Voltage Power Supply (HVPS)

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components which are required for the 100 kW high current injector. Install HVPS gun and commission HVPS. Begin gun performance tests and 750 MHz cryounit integration. FEL development effort will continue 750 MHz cryomodule design, complete facility upgrade for 100 kW FEL development, and begin cryomodule construction.
- EM gun: Develop technology for Full Scale Proof of Concept Demonstrator for testing of integrated launch package (ILP) in 2009. Conduct investigation of improved rail gun rail wear techniques. Conduct testing of capacitor based pulse forming network system to 32 megajoules (of 200 required) of stored power with prototypical rail gun system increasing in power level and projectile speed, while examining rail/bore life issues expected to be seen at larger scale.
- Pursue superior designs of insulators to handle the thermal and mechanical shocks generated by the launch in EM railguns. (NRL)
- Create and develop novel electric weapon architectures and designs that enhance performance and maintainability. (NRL)

FY 2007 Plans:

- DE: Complete gun performance tests. Complete 750 MHz Cryounit integration and low power characterization. FEL development task will complete cryomodule design. Continue cryomodule construction.
- EM Gun: Continue examination of rail/bore life issues expected to be seen at larger scale. Complete Heat Transfer and Heat Management analysis. Conduct analysis of Dynamic Load Sharing of High Power Electrical Distribution Bus architecture. Complete initial high power switching demonstration required for electrical pulse forming network (PFN). Assess electromagnetic noise to nearby power systems and electronics systems.
- Investigate surface treatments such as advanced coatings or "MAX-phase" materials to harden the rails in electromagnetic railguns. (NRL)
- Develop designs of viable novel electric weapon architectures that enhance performance and maintainability. (NRL)

	FY 2004	FY 2005	FY 2006	FY 2007
STRIKE TECHNOLOGIES	5,438	3,959	1,657	743

The focus of this effort is on those technologies that will support Naval Precision Strike Operations and provide the Navy of the future the ability to quickly locate, target, and strike critical targets ashore. NRL investment/performance in this effort are included.

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FY 2004 Accomplishments:

- Enhanced Target Acquisition and Locating System (ETALS): Completed development of the mechanical, electrical, and software interfaces between the Miniature Azimuth Gyrocompass Unit-1 (MAGU-1) and the Target Location Designation and Handoff System (TLDHS) Lightweight Laser Designator/Rangefinder (LLDR). Conducted operational testing of the MAGU-1 to verify that it is suitable for the planned replacement for the AN/GVS-5.
- Advanced Gun Barrel (AGB) & Seeker Technology: Continued development of refractory materials, coating/liner application processes, metal matrix composites, and integration into two advanced barrel concepts for use on the DD(X) ship.
- Initiated investigation of wide bandwidth amplifier technology for decoy applications. Investigate arrays of passive reflectors to provide a distributed Radar Cross Section (RCS) at W-band. (NRL)

FY 2005 Plans:

- AGB & Seeker Technology: Continue work necessary for full scale fabrication of a prototype 155mm gun barrel with advanced interior. Develop and test advanced functionally graded composite material designs and fabricate a composite barrel test section. Complete development of advanced missile guidance technology and automatic target recognition / targeting for time sensitive targets.
- Initiate the development of improved processing algorithms for integration into existing Synthetic Aperture Radar (SAR) image formation processors to enhance the resolution of SAR data. (NRL)
- Initiate development and demonstration of image-while-scan (IWS) technologies needed to perform imaging and identification of targets of radars operating in non-spotlight mode. (NRL)
- Continue wide bandwidth amplifier development. (NRL)

FY 2006 Plans:

- Hand Held Precision Targeting: Complete development of the rangefinder module including integration of an inertial measurement unit (IMU) and magnetometer. This will allow the forward observer to use a laser range finder for target designation in a magnetically hostile environment.
- AGB & Seeker Technology: Continue Advanced Gun barrel technology prototype development.
- Continue SAR algorithm development, IWS technology development, and wide bandwidth amplifier development. (NRL)

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FY 2007 Plans:

- AGB & Seeker Technology: Complete with testing of full scale advanced gun barrel technology prototype using multiple projectile test firings.
- Continue IWS technology development. (NRL)
- Complete SAR algorithm work by incorporating algorithmic tools into existing SAR system for testing. (NRL)
- Complete wide bandwidth amplifier effort by testing evaluating candidate decoys against W-band radars. (NRL)

CONGRESSIONAL PLUS-UPS:

	FY 2004	FY 2005
ADVANCED DEVELOPMENT AND DEMONSTRATION OF ELECTRIC ACTUATOR TECH	1,154	0

Prototype electric actuators was developed and tested. An assessment of the suitability of electric actuators to replace the present hydraulic actuators for shipboard use was conducted.

	FY 2004	FY 2005
ADVANCED HIGH-ENERGY THERMOBARIC WARHEAD DEVELOPMENT	0	990

This effort will configure and demonstrate an advanced high-energy thermobaric explosive composition that will provide enhanced internal blast pressures and moderate thermal effects in confined environments for the M72 LAW (Light Anti-tank Weapon) ASM. Primary efforts include fuze development and booster testing.

	FY 2004	FY 2005
ADVANCED HYBRID STORED ENERGY DEVICES FOR AFFORDABLE AIR WEAPONRY	0	1,485

Effort supports Advanced Hybrid Stored Energy Devices for Affordable Air Weaponry.

BUDGET ACTIVITY: 02
PROGRAM ELEMENT: 0602114N PROGRAM ELEMENT TITLE: POWER PROJECTION APPLIED RESEARCH
PROJECT TITLE: POWER PROJECTION APPLIED RESEARCH

	FY 2004	FY 2005
ADVANCED MULTI-INT EXPLOITATION SYSTEMS (AMIES)	2,698	0

This effort developed a suite of airborne multi-intelligence sensors (SIGINT and ELINT) along with existing advanced sensors. Developed the required signal processing algorithms and optimized them for real-time sensor fusion.

	FY 2004	FY 2005
ADVANCED REACTIVE MATERIAL ENHANCED NANOCOMPOSITE WARHEADS (ARMENW)	2,485	2,575

This effort supported the manufacturing technology development and production scale up of high density nano material composites used in the construction of advanced warheads for air and surface weapons. FY04 – Formulated new nano metal and metal oxide materials and compositions enhancing ordnance abilities against surface and air targets. High density nano metals compounded with hydrocarbon and fluorinated polymers using reproducible production techniques were demonstrated and evaluated.
FY05 – Conduct research, development, and testing of high density reactive material compositions (densities greater than 5 gram/cubic centimeters) to determine effectiveness against various surface and air targets.

	FY 2004	FY 2005
ADVANCED SMART OPTICAL SENSOR PAYLOAD TECHNOLOGY FOR SURVEILLANCE	0	990

Effort supports Advanced Smart Optical Sensor Payload Technology for Surveillance.

	FY 2004	FY 2005
AIRCRAFT CARRIER SURVEILLANCE SYSTEM	0	2,774

Effort supports Aircraft Carrier Surveillance System.

BUDGET ACTIVITY: 02
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	FY 2004	FY 2005
CHEMICAL WEAPON DETECTION FOR UAV APPLICATIONS	1,349	0

This effort developed a standoff (non-contact up to 1000 feet away) passive sensor of chemical weapon agents for use on the Silver Fox expendable UAV or if reconfigured for use as a handheld device. The new sensor will be based on differential absorption radiometer (DAR) technology.

	FY 2004	FY 2005
COMBUSTION LIGHT GAS GUN	4,090	4,160

This effort involved the development of the technologies to develop a hyper-velocity weapon based on high-energy electric plasma ignition heating of injected light gas. FY04: Completed initial design of cryogenic handling and fill system and completed set up and test fire of 45mm gun test bed. FY05: Design and engineer a 155mm CLGG system capable of demonstrating full scale, single shot performance. Demonstrate operational characteristics using cryogenic propellants.

	FY 2004	FY 2005
DEVICE INTEGRATION OF WBG SEMICONDUCTORS AND CRYSTALINE OXIDES	1,345	1,684

FY04: This effort developed techniques and instrumentation to improve passive oxide components for tunable power microwave amplifiers for application to the Advanced Multifunction Radio Frequency System. FY05: The deposition system for oxide component deposition will be commissioned and growth parameter variables quantified. Test structures will be grown for initial calibration and feedback for optimization of deposition parameters.

	FY 2004	FY 2005
ELECTROMAGNETIC (EM) RAIL GUN TEST MUNITION	0	1,090

Effort supports Electromagnetic (EM) Rail Gun Test Munition.

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	FY 2004	FY 2005
FIRELIDAR	1,445	1,684

FY04: This effort developed an eyesafe laser imaging system complementary to IR imagers. Firelidar used a 1.5 micron laser and a highly transmissive narrow band filter to minimize blooming from fire sources, to see through smoke, water, and glass. FY05: Effort will focus on innovative technologies to overcome the deficiencies of an infrared sensors used by firefighters. These sensors currently bloom and become useless in brightness of a hot fire. The approach will use laser illumination and spectral filters to see through fire and smoke. Imagery will also be relayed via a wireless LAN to the command center.

	FY 2004	FY 2005
FREE ELECTRON LASER	6,728	0

This effort developed technologies to support the development of a high average power Free Electron Laser system that is applicable to shipboard self defense.

	FY 2004	FY 2005
GALLIUM NITRIDE (GAN) MICROELECTRONICS AND MATERIALS DEVELOPMENT	2,884	0

This effort developed a reliable Gallium Nitride (GaN) Radio Frequency (RF) Power Technology that is more reliable and affordable by bringing 4 inch wafer processing on line and through the use of High Density Dielectric Passivation (HDDP) processes.

	FY 2004	FY 2005
HIGH EFFICIENCY PIEZOELECTRIC CRYSTALS	2,024	0

This effort developed defect-free lead magnesium niobate-lead titanate (PMN-PT) piezoelectric crystal material for significant (2-10) cost and performance improvement in Navy sonar and hydrophones, laser-acoustic modulators, focal plane micro-dither, and electronic beam steering applications.

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	FY 2004	FY 2005
HYBRID LIDAR-RADAR FOR IMPROVED OPTICAL IMAGING	1,639	0

This effort developed frequency modulation techniques on 3D laser ranged imaging sensor to mitigate the effects of medium backscatter and stray light interference. These techniques will allow imaging in murky water and through clouds.

	FY 2004	FY 2005
HYPERSONIC WEAPONS ENABLING CAPABILITY	0	990

This effort will develop Hypersonic weapon integration technologies.

	FY 2004	FY 2005
INTEGRATED BIOLOGICAL WARFARE TECHNOLOGY PLATFORM	4,962	3,467

FY04: This effort applied the integrated Biological and Chemical Warfare Defense (IBCWD) decision analysis technology software to survey vessels approaching aircraft carriers on the high seas. FY05: The program will transform the IBCWD software framework into a system that provides situation awareness, real-time response planning, and integrated collaborative center for decision maker interaction.

	FY 2004	FY 2005
INTEGRATED HIGH PAYOFF ROCKET PROPULSION TECHNOLOGY PROGRAM (IHPRPT)	988	0

This effort developed technologies that increase the performance of solid propellants used in tactical missiles. Tasks involve synthesis of high energy propellant ingredients and formulations and investigate advanced propulsion technologies to meet the IHPRPT performance goals.

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	FY 2004	FY 2005
INTEGRATED PERSONNEL PROTECTION SYSTEM	0	1,188

Effort supports Integrated Personnel Protection System.

	FY 2004	FY 2005
INTELLIGENT CONTROL SYSTEMS FOR SWARM UNMANNED AERIAL VEHICLES	4,096	0

This effort developed the algorithms and intelligent control technologies to enable the employment of multiple UAV's for the completion of a variety of operational missions.

	FY 2004	FY 2005
INTERROGATOR FOR HIGH-SPEED RETRO-REFLECTOR COVERT COMMUNICATIONS	1,928	1,981

FY04: This effort increased retro reflector data rate to 10-50 Megabits per second. Developed Cats-eye lens for wide intercept angle to minimize laser interrogator pointing accuracy. FY05: This effort will develop and deliver a micro electronic mechanical system (MEMS) optical mirror, steered laser interrogator on a small tactical UAV and interrogate a 50 Mbps retro-reflector on an unattended ground sensor.

	FY 2004	FY 2005
KILL ASSIST ADVERSE-WEATHER TARGETING SYSTEM (KAATS)	3,059	1,684

This developed technologies to support a system that will provide precision targeting and weapon delivery in adverse weather for time critical missions. FY04: The Relative Guidance Data Link was designed, fabricated, integrated into the Joint Direct Attack Munitions (JDAM) weapon. FY05: Integrate and test sensor platform UAV. Demonstrate sensor on a UAV with relative targeting against a fixed target.

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	FY 2004	FY 2005
MILLIMETER/TERAHERTZ IMAGING ARRAYS	0	2,081

This effort will perform work to realize simultaneous infrared (IR) and millimeter wave (MMW) imaging capabilities through a common aperture and to fuse IR and MMW imagery for all-weather and high resolution imaging.

	FY 2004	FY 2005
MOBILE ON-SCENE SENSOR AIRCRAFT C4I CENTER	0	990

This effort will develop a mobile forward C4I deployed center that can receive imagery from an airborne sensor and executing command and control over that sensor.

	FY 2004	FY 2005
NON-LINEAR DYNAMICS - CONTROL OF CHAOS	3,278	0

This effort initiated a new research institute focused in the broad area of nonlinear dynamics with specific research topical areas such as chaos-excited nondestructive evaluation, micromechanical/microfluidic devices, adaptive antenna arrays, and autonomous vehicle controls.

	FY 2004	FY 2005
RADAR INFRARED IMAGING	2,017	0

This effort developed a new type of passive millimeter wave (MMW) imager based on the imposition of MMW side bands on an optimal carrier. If successful, this approach will significantly improve MMW imaging sensitivity performance.

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	FY 2004	FY 2005
SILVER FOX UNMANNED AERIAL VEHICLE (UAV)	0	2,476

This effort is to integrate the latest sensor and data link technologies into the Silver Fox UAV. The work will also expand the operational use of Silver Fox into the maritime environment.

	FY 2004	FY 2005
THERMAL MANAGEMENT SYSTEMS FOR HIGH DENSITY ELECTRONICS	5,059	5,943

FY04: This effort evaluated and demonstrated advanced cooling techniques for military processing systems. It included the cooling of a classified telecommunications processing system which has Special Operations Forces (SOF) deployment requirements. It also ruggedized high capacity imagery and data fusion processing airborne hardware. FY05: The work will utilize the advanced cooling techniques that have been developed and refine the techniques to work within the space, weight, and durability requirements of mobile electronics.

	FY 2004	FY 2005
ULTRA SHORT PULSE LASER TECHNOLOGY	1,349	0

This effort established a micromachining testbed to assist the transfer of ultra-short pulse laser machining technology. Developed precise micro-machining with negligible heat affected zones, improved holes in turbine blades, fuel injectors and airframes, semiconductor machining on Infrared focal plan arrays, etc.

	FY 2004	FY 2005
UNATTENDED IMAGING SENSOR NETWORK (UISN)	0	990

Effort supports Unattended Imaging Sensor Network (UISN).

C. OTHER PROGRAM FUNDING SUMMARY:
NAVY RELATED RDT&E:
PE 0601152N (In-house Laboratory Independent Research)
PE 0601153N (Defense Research Sciences)
PE 0602123N (Force Protection Applied Research)

BUDGET ACTIVITY: 02
PROGRAM ELEMENT: 0602114N PROGRAM ELEMENT TITLE: POWER PROJECTION APPLIED RESEARCH
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PE 0602235N (Common Picture Applied Research)
PE 0602131M (Marine Corps Landing Force Technology)
PE 0603114N (Power Projection Advanced Technology)
PE 0603640M (Marine Corps Advanced Technology Demonstration)
PE 0603790N (NATO Research and Development)

NON-NAVY RELATED RDT&E:
PE 0602303A (Missile Technology)
PE 0602618A (Ballistics Technology)
PE 0602624A (Weapons and Munitions Technology)
PE 0603004A (Weapons and Munitions Advanced Technology)
PE 0602173C (Support Technologies – Applied Research)
PE 0603763E (Marine Technology)
PE 0603739E (Advanced Electronics Technologies)
PE 0602702E (Tactical Technology)
PE 0602203F (Aerospace Propulsion)
PE 0602601F (Space Technology)
PE 0602602F (Conventional Munitions)
PE 0603216F (Aerospace Propulsion and Power Technology)

D. ACQUISITION STRATEGY:
Not applicable.