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FY 2008/2009 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET
Exhibit R-2

DATE: February 2007

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

COST: (Dollars in Thousands)

Project Number & Title	FY 2006 Actual	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
POWER PROJECTION APPLIED RESEARCH	133,511	114,071	83,419	82,781	86,296	105,555	138,493	154,385

A. MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: This PE supports both advanced technology research and near to mid-term transition opportunities. The advanced research focus is primarily on High Energy Lasers (HEL), Electromagnetic railgun development, non-lethal high power microwave, advanced rocket propulsion, electro-optic/infrared (EO/IR) sensor technologies. The mid-term effort is focused on developing and demonstrating technologies supporting the Future Naval Capability (FNC) Program Enabling Capabilities (ECs) for Marine and Unmanned Vehicle Tactical Intelligence, Surveillance and Reconnaissance (ISR), Advanced Naval Fires Technology, Hostile Fire Detection and Response, Weapons of Mass Destruction (WMD), and Dynamic Target Engagement & Enhanced Sensor Capabilities. 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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B. PROGRAM CHANGE SUMMARY:

	<u>FY 2006</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
FY 2007 President's Budget Submission	135,454	84,914	67,205	71,966
Congressional Action	0	34,100	0	0
Congressional Reduction	0	-4,500	0	0
Congressional Undistributed Reductions/Rescissions	-539	-443	0	0
Execution Adjustments	1,120	0	0	0
Federal Technology Transfer	-22	0	0	0
Non-Pay Inflation Adjustments	0	0	-347	275
Program Adjustments	0	0	26,139	514
Program Realignment	0	0	-9,649	9,820
Rate Adjustments	0	0	71	206
SBIR Assessment	-2,502	0	0	0
FY 2008/FY 2009 President's Budget Submission	133,511	114,071	83,419	82,781

PROGRAM CHANGE SUMMARY EXPLANATION:

Technical: Not applicable.

Schedule: Not applicable.

C. OTHER PROGRAM FUNDING SUMMARY:

Not applicable.

D. ACQUISITION STRATEGY:

Not applicable.

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E. PERFORMANCE METRICS:

This PE develops early components technologies that if successful can be integrated into weapon systems that meet warfighter requirements. Most of the work in this PE can be classified between Technology Readiness Level (TRL) 2 (technology concept and/or application formulation) and TRL 4 (component and/or breadboard validation in laboratory environments). The metrics used to evaluate 6.2 programs are necessarily less precise than those used in 6.3 programs.

The metrics for this PE can be divided into two categories: technological and organizational/functional. Technological metrics address the success of the work performed. The primary technological metrics used in this PE involve laboratory experiments/tests demonstrating proof of the concept for the technology. This demonstration is frequently a hand-assembled functioning breadboard of the concept. The organizational/functional metrics applied to this PE include: transition of the technology to advanced development in a 6.3 PE and applicability of the technology to documented warfighter problems or requirements. Successful implementation of these categories would result in the application of a pass/fail metric and further evaluation for possible transition to a 6.3 development/demonstration program.

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POWER PROJECTION APPLIED RESEARCH	133,511	114,071	83,419	82,781	86,296	105,555	138,493	154,385

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 2006	FY 2007	FY 2008	FY 2009
WMD DETECTION	0	0	6,775	11,797

The Chief of Naval Operations (CNO) in the Navy Strategic Plan (NSP) has directed that the Navy be able to combat Weapons of Mass Destruction (WMD) at sea and ashore. This activity addresses the development of key technologies for standoff detection of WMD's and component nuclear materials on ships at sea. The program will develop and demonstrate technology for actively detecting fissile material and other weapons of mass destruction.

FY 2008 reflects the initiation of the Weapons of Mass Destruction (WMD) Detection Program in response to the Chief of Naval Operations' Navy Strategic Plan which specified that the Navy must combat WMDs at sea and ashore.

FY 2008 Plans:

- Initiate investigations into the use of Free Electron Laser (FEL) accelerator technologies for the detection of WMD's and nuclear components & materials. Conduct experiments to determine the ability of the FEL to perform remote detection of nuclear material on surfaces, and chemical biological agents in aerosol clouds.
- Initiate investigation into the feasibility of using particle beams (neutrons, gamma rays, muons, and others) to perform standoff detection of fissile material. Develop neutron and gamma ray detection technology

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to support the active interrogation of special nuclear materials.

- Initiate development of hand-held and portable radiation detector technology to support maritime interdiction operations.
- Initiate modeling and simulation efforts to determine the ability to use neutron activation analysis to locate smuggled nuclear weapons and material through underwater detection.

FY 2009 Plans:

- Initiate planning for a maritime demonstration of standoff detection of fissile materials.
- Continue investigations into using FEL accelerator and optical beams for WMD and chembio agent detection.
- Continue investigation of using particle beams for detection of special nuclear materials.
- Continue investigation of nuclear activation to locate smuggled nuclear weapons.

	FY 2006	FY 2007	FY 2008	FY 2009
STRATEGIC SUSTAINMENT	21,991	13,530	6,700	0

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.

The reduction in FY 2007 through FY 2009 is due to the completion of TSSS in FY 2007 and SSI in FY 2008.

FY 2006 Accomplishments:

- TSSS: Underwater launch task conducted exit testing of the Underwater Launch Technology Sustainment System (ULTSS). Testing was 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. Released final version of ULTSS. Completed fabrication and test of prototype Atom Interferometer Gravity Gradient (AIGG) sensor using the documented exit criteria. Transferred to NAVAIR Strategic System Program (SSP). The TSSS Phase I effort is completed.
- SSI: Missile tasks in propulsion continued efforts by conducting non-eroding throat tests, chamber bottle tests, insulator tests, component compatibility tests and propellant hazard assessment. The program conducted an innovative testing of new rocket motor case/nozzle design. Continued advanced Post Boost Control System

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(PBCS) valve efforts by conducting materials compatibility tests, an integrated valve assembly demonstration, subscale propellant mixes and a manifold concept demonstration. Ordnance Initiation Technologies program integrated various sub-assemblies and performed laboratory testing on various prototype designs. Continued Missile Electronics efforts by conducting small coupon aging studies, conducted radiation hardening tests & assessments, completed board aging model development, and continued development of board level and missile level modeling techniques. Sonar effort completed detailed design and began 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. Goal is heavy wall testing simulating a very limited full scale Post Boost control system test. Continue Ordnance Initiation Technologies program. Complete the Missile Electronics Technologies program code development with final Validation and Verification of the models with experimental radiation hard data and aging data. Complete Navigation sonar task with 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 2008 Plans:

- SSI: Complete Missile propulsion efforts by conducting final testing. Complete 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. Complete Ordnance Initiation Technologies program by demonstrating and documenting new ordnance initiation technology that meets the requirements. Program completed.

	FY 2006	FY 2007	FY 2008	FY 2009
HIGH SPEED PROPULSION AND ADVANCED WEAPON TECHNOLOGIES	16,143	14,165	8,000	7,482

Work in this area focuses on 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.

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The decrease from FY 2006 to FY 2007 is a result of the transition of the High Speed Turbine program to a predominantly 6.3 flight demonstration program. The decrease from FY 2007 to FY 2008 is due to the completion of the 6.2 portion of the NAI RATTLRS Hypersonic Turbine program.

FY 2006 Accomplishments:

- Integrated High Performance Rocket Propulsion Technology (IHRPT): Completed and demonstrated Phase II performance goals of the Integrated High Payoff Rocket Propulsion Technology (IHPTPT) program using an air-to-air flight weight motor. Continued formulation and scale up of new propellants that will meet Phase III goals. Continued development of surface launch component technologies.
- Asymmetric Threat Defense: Continued demonstrating dual mode warhead effectiveness in both above and below water detonations. Demonstrated EO guidance processing algorithm performance to detect small boats in clutter environment and to maintain track of closely spaced boats.
- National Aerospace Initiative (NAI) High Supersonic Turbine Vehicle (HSTV): Continued development of component/subsystem technologies in propulsion, inlet, nozzle, airframe, and thermal management for high supersonic turbine powered weapon systems. Selected technologies for validation and conducted ground testing/validation.

FY 2007 Plans:

- IHRPT: Complete propellant formulation. Initiate demonstration of air-to-air system that uses new energetic ingredient compositions to meet Phase III IHRPT performance goals. Continue development of surface launch component technologies.
- NAI HSTV: Completed development of component/sub-system technologies for high supersonic turbine powered weapon systems. Conduct validation, ground testing and demonstrations.
- Asymmetric Threat Defense: Complete EO guidance processing and dual mode warhead efforts. Initiate identification of reactive material target interaction phenomenology, and development of lethality model. Initiate adaptive warhead technology development for air dominance and strike weapons, low cost miniaturization of guidance and control and propulsion control technologies. Continue development of propulsion and high temperature materials technologies to enable high speed weapons.

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FY 2008 Plans:

- IHRPRT: Continue FY 2007 efforts, less those noted as completed.
- Asymmetric Threat & Laser Control Technologies: Initiate Directed Energy (DE) beam control components and technologies for shipboard and air High Energy Lasers (HEL). Tasks include maritime atmospheric propagation tests, development of advanced optical coatings for high power lasers, and the development of the beam control components, algorithms and architecture to support a pod-based F-18 HEL. Continue high speed weapon and projectile investigations.

FY 2009 Plans:

- IHRPRT: Complete program through demonstration of Solid Rocket Motor Phase III goals at the subsystem level.
- Asymmetric Threat & Laser Control Technologies: Continue DE beam control development for ships and aircraft. Continue high speed weapon and projectile investigations.

	FY 2006	FY 2007	FY 2008	FY 2009
UNMANNED VEHICLES	6,072	0	0	0

The focus of this activity is on those technologies that relate to the development of Unmanned Vehicles (UV) 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 (UUV), Unmanned Air Vehicles (UAV), Unmanned Ground Vehicles (UGV), UAV control systems, UAV radar systems, and UAV propulsion and power systems. Naval Research Laboratory (NRL) investment/performance is included in this effort.

Funding profile reflects the transition of Autonomous Operations (AO) efforts to PEs 0602747N and 0603114N and transition of all other efforts as noted below.

FY 2006 Accomplishments:

- IA: Completed development of multi-vehicle cooperation technologies. Completed medium-fidelity simulation of multi-vehicle cooperation technologies. 6.3 work related to this project continued/transitioned to PE 0603114N in FY 2007.

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- UUV: Completed Undersea Search and Surveillance (USS) and Communications Navigation Aid (CNA) efforts through transition to PMS-Explosive Ordnance Disposal (EOD) and ONI-34; Completed Submarine Track and Trail (STT) efforts in advanced undersea sensors, communications, and autonomy. The 6.3 STT UUV Technology efforts related to this project transitioned to PE 0602747N in FY 2007.
- UAV control: Continued development of airborne and shipboard battle manager platforms for UAVs and the airborne control station for control of multiple UAVs. Initiated investigation concerning the integration of the Landing Period Designator (LPD) algorithms and system into air wake tracking system for autonomous shipboard recovery of UAVs. This effort transitioned to PE 0603114N in FY 2007.
- UAV propulsion: Continued development of XTE-67/A1 demonstrator engine and demonstration of Integrated High Performance Turbine Engine Technology (IHPTET) Joint Technology Demonstrator Engine (JTED) components. Transitioned to PE 0603114N in FY 2007.
- Continued development of small autonomous mobile vehicles. (NRL) FY 2007 effort reflected in Navigation, EO/IR, and Sensor Technologies activity.
- Initiated design and development of a disposable Micro Air Vehicle (MAV) which will enable the airborne delivery and precision placement of miniature EW sensors and payloads. FY 2007 effort reflected in Navigation, EO/IR, and Sensor Technologies activity. (NRL)
- Autonomous Systems: Initiated development of near optimal trajectory planners to enhance the capabilities of UAVs and other distributed autonomous systems. FY 2007 effort reflected in Navigation, EO/IR, and Sensor Technologies activity. (NRL)

FY 2007 Plans:

- Efforts no longer funded in this Activity.

	FY 2006	FY 2007	FY 2008	FY 2009
NAVIGATION, ELECTRO OPTIC/INFRARED (EO/IR), AND SENSOR TECHNOLOGIES	9,974	13,853	11,082	10,555

This activity describes Navy Science and Technology (S&T) investments in the areas of EO/IR 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 includes NRL investment/performance in the technology areas of Electronics, Electronic Warfare, and Communications.

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Changes in the funding profile between FY 2006 and FY 2007 are due to natural progression of program initiations and completions. Reduction in funding from FY 2007 to FY 2008 is due to the transfer of the Navigation Technologies program to PE 0602271N under the RF Navigation Technology activity.

FY 2006 Accomplishments:

- Navigation Technologies: Continued Distributed Time Standards algorithm development, Rb Clock design and experiments, and Link 16 Time Transfer development and testing. Continued Tightly Coupled Global Positioning System/Inertial Navigation System (GPS/INS)/Long-range, Accurate Radio Navigational(LORAN) effort and Fiber Optic Ring Gyroscope development. Completed Algorithm development for Distributed Time Scaling and the Deeply Integrated GPS/INS width Nonlinear Filter project. Initiated the Magnetic Passive Reset for Inertial Navigation System (INS) and the development of Advanced GPS/INS (GIN) Systems for Strike Weapons.
- EO/IR: Continued development of low cost piezoelectric motion and jitter compensation for high resolution visible and infrared sensors. Millimeter Wave (MMW) and TeraHertz (THz) imaging effort completed development of MMW imagers and continued development of THz imaging through fog, clouds, clothing, and some walls. Continued Nano Sensors development of ultra low noise uncooled nanotechnology infrared sensors and nanoatomic sensor nonvolatile memories. Electronic zoom effort continued development of electronic liquid crystal based directional field of view and zoom imagers. Continued multi-sensor (visible, infrared, millimeter wavelength, terahertz and laser imagers) fusion for objection recognition.
- Electronics: Continued high power Hollow Core (HC)-Photonic Band Gap (PBG) development and Yb doped ceramic yttrium-aluminum-garnet(YAG) high power laser efforts. Completed target discrimination effort by conducting a real time demonstration of spectral emittance based target/material target discrimination using Long Wave (LW) Quantum Well Infrared Photodetector (QWIP) sensor. Completed study of WSLs for multiband IR photodiodes by demonstrating high performance dual-band Long Wave (LW) & Very Long Wave Infrared (VLIR) photodiode operation. Completed study of pre-growth molecular hydrogen cleaning of GaSb substrates. (NRL)
- Electronic Warfare: Continued IR obscurant technology development fabricating and evaluating fieldable IR obscurants and particle dissemination methods. (NRL)
- Communications: Continued covert high bandwidth communications effort. Completed development of MQW retroreflector with Cat's Eye Backplane. Transitioned compact, light-weight MQW communications to operational forces. Initiated the development of small hyperspectral sensors and associated signal processing algorithms in a compact format that will fit in small UAVs and be capable of detecting small targets. (NRL)

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FY 2007 Plans:

- Navigation Technologies: Continue Rb Clock development and testing, Fiber Optic Ring Gyroscope development, Magnetic Passive reset for INS, and Advanced GPS/INS systems for strike weapons. Initiate self-locked Intra-Cavity Alkali Vapor Laser (ICAL) opto-atomic clock project and Repeat spoofer detection and location project. 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. Continue small hyperspectral sensor development. (NRL)
- 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)
- Complete development of small autonomous mobile expendable EW vehicles that can replenish their energy supply. Select multi-mode locomotion method and energy harvesting technique and construct and demonstrate vehicles. (NRL)
- Continue development of Micro Air Vehicle (MAV). (NRL)
- Autonomous Systems: Continue development of near optimal trajectory planners to enhance the capabilities of UAVs and other distributed autonomous systems. (NRL)

FY 2008 Plans:

- Navigation Technologies: Program funded in PE 0602271N under the RF Navigation Technology activity.
- EO/IR: Continue Millimeter Wave (MMW) and TeraHertz (THz) Imaging effort, development of ultra low noise

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uncooled nanotechnology infrared sensors, and development of electronic field of view and zoom imagers. Continue development of new processes/methodologies to enable construction of composite countermeasures that fit the engagement timeline while maintaining effectiveness against existing and emerging IR guided threats (NRL). Continue the development of an active optics system that can survey a wide area and instantly, non-mechanically zoom-in on an area of interest for target tracking/identification (NRL).
- Communications: Complete small hyperspectral sensor development (NRL).
- Autonomous Systems: Continue development of near optimal trajectory planners to enhance the capabilities of UAVs and other distributed autonomous systems (NRL). Continue design and development of a disposable MAV which will enable the airborne delivery and precision placement of miniature EW sensors and payloads (NRL). Continue the design of an advanced auto gyrotor that combines a swashplateless rotor system and active stability augmentation for autonomous systems (NRL).
Complete development of a compact, efficient heavy fuel engine for UAVs(NRL).

FY 2009 Plans:

- EO/IR: Continue development of ultra low noise uncooled nanotechnology infrared sensors. Continue development of electronic field of view and zoom imagers. Complete Millimeter Wave (MMW) and TeraHertz (THz) Imaging project. Continue development of new processes/methodologies to enable construction of composite countermeasures that fit the engagement timeline while maintaining effectiveness against existing and emerging IR guided threats (NRL). Continue the development of an active optics system that can survey a wide area and instantly, non-mechanically zoom-in on an area of interest for target tracking/identification (NRL).
- Autonomous Systems: Complete development of near optimal trajectory planners to enhance the capabilities of UAVs and other distributed autonomous systems (NRL). Complete design and development of a disposable MAV which will enable the airborne delivery and precision placement of miniature EW sensors and payloads (NRL). Complete the design of an advanced auto gyrotor that combines a swashplateless rotor system and active stability augmentation for autonomous systems (NRL).

	FY 2006	FY 2007	FY 2008	FY 2009
DIRECTED ENERGY AND EM GUNS (FORMERLY ELECTRIC WEAPONS)	31,931	30,108	42,696	45,437

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 Electro Magnetic (EM) gun program that is focused on

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developing the technology to launch a long range projectile from Navy ships. This activity also includes NRL investment/performance in these research areas.

Decrease in FY 2006 to FY 2007 is due to adjustments in EM gun funding. The increase between FY 2007 and FY 2008 is due to a larger investment in advance technology component development and testing required as the FEL program progresses to the higher power weapons-level outputs. The increase between FY 2008 and FY 2009 is also due to the increased funding required to scale the FEL up to weapons-level power output.

FY 2006 Accomplishments:

- DE: Continued 1 micron filamentation, halo limitation, and short Rayleigh range studies. Continued lethality testing and optical propagation studies. Current injector task completed assembly and test the Advanced Energy Systems (AES) Cryounit. Continued testing of Radio Frequency (RF) gun High Voltage Power Supply (HVPS) components which are required for the 100 kW high current injector. Installed HVPS gun and commission HVPS. Began gun performance tests and 750 MHz cryounit integration. FEL development effort continued 750 MHz cryomodule design, completed facility upgrade for 100 kW FEL development, and began cryomodule construction.
- EM gun: Developed initial technology for full scale proof of concept demonstrator for testing of integrated launch package (ILP) in 2009. Conducted investigation of improved rail gun rail wear techniques. Conducted 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, and examined rail/bore life issues expected to be seen at larger scale.
- Continued to pursue superior designs of insulators to handle the thermal and mechanical shocks generated by the launch in EM railguns. (NRL)
- Initiated development of 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. Continue FEL development and investigation into the application of FEL technology to other areas including advanced materials, optics, bioscience, medical, manufacturing, weaponization, and solid state physics.
- EM Gun: Complete preliminary designs of 32MJ muzzle energy electromagnetic demonstration launchers and

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begin detailed design with industry partners in preparation for fabrication (FY08/09) and demonstration (FY10). Continue bore life risk reduction tests by scaling laboratory launcher muzzle energy from 8 to 16MJ to ensure bore life characteristics of the rails and insulators apply at the higher energies. Finalize projectile conceptual designs from two industry vendors and begin projectile preliminary design. Initiate conceptual design of rotating machine pulsed power. Continue Integrated Product Team (IPT) collaborations between industry, Navy and the Army Electromagnetic Launch program to ensure consistent, non-duplicative technology maturity activities.

- Continue investigation of surface treatments such as advanced coatings or "MAX-phase" materials to harden the rails in electromagnetic railguns. (NRL)

- Continue development of designs for viable novel electric weapon architectures that enhance performance and maintainability. (NRL)

FY 2008 Plans:

- DE: Continue cryomodule and FEL component development at the FEL testing and integration facility. Initiate investigations of high power microwave sources, fiber lasers, and beam control technologies for target detection, acquisition, tracking, aimpoint maintenance of DE systems for ship and air target engagements. Initiate development of high power optical and amplifier components for high power weapons level lasers. Initiate aero-optical mitigation techniques for DE applications.

- EM Gun: Continue material, physics and thermal property research for both launchers and projectiles. Continue launcher and projectile component investigations and preliminary development, lethality studies and preliminary design for projectile, Bore Life Launcher component testing, Integrated Product Team (IPT) and bore life consortium collaborations between industry, Navy and the Army electromagnetic launch program. Complete preliminary design of the electromagnetic demonstration launchers with industry partners. Initiate preliminary designs of pulse power systems and begin examination of system interface with ship integration.

- Continue investigation of surface treatments such as advanced coatings or "MAX-phase" materials to harden the rails in electromagnetic railguns. (NRL)

- Continue development of designs for viable novel electric weapon architectures that enhance performance and maintainability. (NRL)

FY 2009 Plans:

- DE: Continue cryomodule and FEL component development and investigations of fiber lasers, high power microwave sources, and high power weapons-level component development.

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- EM Gun: Continue material, physics and thermal property research for both launchers and projectiles. Continue launcher and projectile development. Continue preliminary design and lethality studies of projectile, design of next generation pulse power systems, Integrated Product Team (IPT) and Bore Life Consortium collaborations.
- Continue investigation of surface treatments such as advanced coatings or "MAX-phase" materials to harden the rails in electromagnetic railguns. (NRL)
- Continue development of designs for viable novel electric weapon architectures that enhance performance and maintainability. (NRL)

	FY 2006	FY 2007	FY 2008	FY 2009
STRIKE AND LITTORAL COMBAT TECHNOLOGIES	1,562	8,444	8,166	7,510

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 is included. Efforts in this PE transitioned from these PEs 0602131M, 0602235N, 0602236N, 0603114N, 0603236N and 0603640M.

The funding profile from FY 2006 to FY 2007 reflects the reorganization of FNC Program investments into ECs. As a result of this reorganization, the funding for each EC has been aligned to a Budget Activity 2 and Budget Activity 3 PE as appropriate. This Activity reflects the alignment of investments for the following ECs: Advanced Naval Fires Technology Spiral 1, Hostile Fire Detection and Response Spiral 1, Marine and UxV Tactical Intelligence, Surveillance, and Reconnaissance (ISR), and Dynamic Target Engagement & Enhanced Sensor Capabilities. Reduction in funding from FY 2007 to FY 2008 is due to the completion of the GMTI scout project in FY 2007 and the transition of a portion of the Decision Support for Dynamic Target engagement work to 6.3 development.

FY 2006 Accomplishments:

- Hand Held Precision Targeting: Initiated/completed 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.
- Continued Synthetic Aperture Radar (SAR) algorithm development, Image-While-Scan (IWS) technology development, and wide bandwidth amplifier development. (NRL)
- Completed queuing receiver brassboard for a high probability of intercept wide instantaneous bandwidth

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receiver and conducted a small-scale signal collection in a maritime environment field test. (NRL)

- Continued W-band decoy development. (NRL)
- Continued Joint Time Frequency Analysis (JTFA) improved processing algorithm development. (NRL)
- Initiated development of software for a genetic algorithm selection process for use with identified analytic performance metrics for the optimization of communications jamming techniques. (NRL)

FY 2007 Plans:

- Marine and UxV Tactical ISR (MUTI): Initiate and complete effort to develop improved radar that will provide real-time tactical targeting and improved sensor processing to provide improved access to available ISR products. Specific tasks include: signal intelligence visualization, automated pattern recognition, dynamic replanning/autonomous vehicle control, fully integrated advanced demonstrator engine, multi-vehicle cooperation/targeting and networking communications software. (formerly funded in PE's 0602131M and 0603114N)
- Dynamic Target Engagement & Enhanced Sensor Capability (DTEESC): Initiate effort to develop the capability to improve the processing of dynamic targets from 100 to 400 targets per day. It will also improve UAV performance in the areas of increased endurance and support for more autonomous operations. Specific tasks include the development of: decision support algorithms for dynamic target engagement, remote sensor fusion hardware for ground sensors, an ultra endurance UAV, and a GMTI sensor for use on UAVs. (formerly funded in PE's 0602235N, 0603640M, and 0603114N)
- Hostile Fire Detection and Response Spiral 1 (HFDR): Complete effort to develop technologies for hostile fire detection and active response capabilities that will increase individual Marine and tactical level unit survivability and mobility. Specific efforts include: advanced ammo packaging, EW Integrated System for Small Platforms (EWISSP), and the GUNSLINGER hostile fire detection and counter fire system. (formerly funded in PE's 0602131M, 0602236N, and 0602235N)
- Advanced Naval Fires Technology Spiral 1 (ANFT): Complete effort to reduce the time delay from target acquisition to engagement through improved information sharing interfaces, accurate mobile and lightweight fire control systems, and improved forward digital target acquisition and hand off. Specific tasks include: adaptive expeditionary maneuver warfare system, advanced gun barrel technology, advanced weapons material technology, improved fire control systems, advanced fires coordination technology, and advanced target acquisition. (formerly funded in PE's 0602236N and 0603236N)
- Complete W-band decoy development with a demonstration of active ECM techniques. (NRL)
- Complete the development of improved processing algorithms based on the JFTA by incorporating algorithmic tools into existing SAR system for testing. (NRL)
- Continue IWS technology development. (NRL)

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- Continue genetic algorithm selection process for communication jamming.(NRL)
- Initiate development of passive interferometric imaging system to detect millimeter wave radio frequency (RF) anomalies within the background environment by using exotic signal processing techniques. (NRL)

FY 2008 Plans:

- Discriminate and Provide Terminal Guidance for Weapons Targeted at Moving Targets: Initiate development of Weapons Data Link terminal to improve in-flight control of weapons in real time. Initial work will focus on research to improve RF amplification at high bandwidths and low-observable, high gain weapon mounted antennas.
- Dynamic Target Engagement: Continue development of Decision Support System for dynamic target engagement.
- Increased Capability Against Moving and Stationary Targets: Initiate development of Direct Attack Seeker Head (DASH) by developing low cost multi-passive array technology using Imaging Infrared (IIR) and millimeter Wave (mmW) in a common aperture architecture. Initiate development of Multi-Mode Sensor/Seeker (MMSS) technology development to develop advanced signal processing techniques to classify and identify moving targets using Automatic Target Recognition (ATR).
- Continue development of passive interferometric imaging system to detect millimeter wave RF anomalies within the background environment by using exotic signal processing techniques. (NRL)
- Complete IWS technology development. (NRL)
- Complete genetic algorithm selection process for communication jamming. (NRL)

FY 2009 Plans:

- Discriminate and Provide Terminal Guidance for Weapons Targeted at Moving Targets: Continue development of Weapons Data Link terminal.
- Dynamic Target Engagement: Complete development of Decision Support System for dynamic target engagement.
- Increased Capability Against Moving and Stationary Targets: Continue development of DASH weapon seeker and MMSS surveillance technologies.
- Continue development of passive interferometric imaging system to detect millimeter wave RF anomalies within the background environment by using exotic signal processing techniques. (NRL)
- Initiate development and apply emerging technologies that support delivery of Technology Oversight Group approved FNC enabling capabilities structured to close operational capability gaps in power projection; package emerging power projection technologies into deliverable FNC products and ECs that can be integrated into acquisition programs within a five year period; and mature power projection technologies that support naval requirements identified within the Sea Strike and FORCEnet naval capability pillars.

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CONGRESSIONAL PLUS-UPS:

	FY 2006	FY 2007
COMPUTATIONAL DESIGN TOOLS FOR HIGH POWER SOURCES FOR DIRECTED ENERGY APPLICATIONS	0	996

This plus up will support the application of a 3 dimensional design tool to model a charge particle beam of the type used in a Free Electron Laser (FEL).

	FY 2006	FY 2007
H.264 VIDEO COMPRESSION	0	996

This effort supports the application of H.264 Video Compression for high speed data compression.

	FY 2006	FY 2007
HALOH ENGINE	0	1,296

This effort develops a HALOH engine.

	FY 2006	FY 2007
HIGH ENERGEY SUPERIOR BATTERY TECHNOLOGY FOR DEFENSE APPLICATIONS	0	996

This effort develops a high energy battery for defense applications.

	FY 2006	FY 2007
MULTIFUNCTIONAL OXIDE MATERIALS APPLICATIONS AND DEVICES	0	996

This effort develops multi-functional metal oxide materials and devices.

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	FY 2006	FY 2007
MULTIFUNCTIONAL OXIDE MATERIALS MFMA	0	996

This effort develops multi-functional metal oxide materials.

	FY 2006	FY 2007
AIRCRAFT CARRIER SURVEILLANCE SYSTEM	3,353	0

Continued development of this project with Northrup Grumman Mission System, Ball Aerospace, and Axsys Technologies, Inc to combine hemispherical MIDAS detection with long-range SEASPARROW identification and lethality for shipboard surveillance and protection. High resolution IR sensor has been integrated into NATO SEASPARROW director and was successfully demonstrated in March 2006. Deliverables: The contractor delivered three (3) 640 x 480 sensors to ONR and the Navy end-CY06. These cameras are earmarked for a LANTFLT LPH' NATO Sea Sparrow system for operational demonstration.

	FY 2006	FY 2007
AUTONOMOUS UNDERWATER VEHICLE DOCKING AND RECHARGING STATION	2,011	0

This effort initiated the design and fabrication of functional subsystems for an Autonomous Underwater Vehicle Docking and Recharging Station to demonstrate key technologies and perform risk reduction.

	FY 2006	FY 2007
COMBUSTION LIGHT GAS GUN PROJECTILE	4,092	3,985

FY 2006: This effort completed the build and test of 45mm sub-scale gun and autoloader in order to demonstrate feasibility of cryogenic storage, transfer of working fluids and rate firing. Continued development of the 155mm Combustion Light Gas Gun, planned for use as high velocity (>2km/s) test bed support for hypersonic projectiles. Assessed concept as programmatic risk reduction enhancement for potential future Navy Land Attack weapons. Additionally, designed and fabricated instrumented diagnostic projectiles for advanced hypervelocity Naval gun systems.

FY 2007: This effort supports the combustion light gas projectile.

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	FY 2006	FY 2007
DEVELOPMENT PROCESSES FOR FULL SCALE PRODUCTION OF SILICON CARBIDE WAFERS	1,628	1,445

FY 2006: This effort developed thin film and bulk crystal silicon carbide SiC, a wide gap semiconductor for electrical power conditioning, and RF apps below 3GHz. This 'Halo-precursor' technique will produce higher perfection and purity SiC with better reproducibility and yield than current industrial process - physical vapor deposition or PVT.

FY 2007: This effort supports the development processes for full scale production of silicon carbide wafers.

	FY 2006	FY 2007
DEVICE INTEGRATION OF WIDE BANDGAP SEMICONDUCTORS AND MULTIFUNCTIONAL OXIDES	1,438	2,192

FY 2006: This effort developed high performance thin film dielectrics (insulators) for high frequency, RF capacitors and tunable passive components for microwave monolithic integrated circuits (MMICs) to be used in Frequency-agile Radar systems (AMRFS). The deposition technique is Molecular Beam Epitaxy which allows in situ monitoring and feedback growth control. Current technology produces non-tunable materials which are lossy at radio frequencies, non-tunable, and non reproducible.

FY 2007: This effort supports the device integration of wide bandgap semiconductors and multifunctional oxides.

	FY 2006	FY 2007
DOD AGILE MANUFACTURING CENTER FOR CASTINGS TECHNOLOGY (AMCAST)	2,012	0

The initial phase of the project provided an assessment of cost and lead time reduction for twenty five DoD casting applications using the Rapid Cast Technology (RCT) process. Later phases of the project implemented the RCT process at the NUWC Keyport to create patterns, molds and cores locally for DoD casting applications.

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	FY 2006	FY 2007
ELECTRONIC MOTION ACTUATION SYSTEMS	2,107	2,192

FY 2006: This effort supported electronic motion actuation systems. It developed the next generation linear electric actuators, and demonstrated satisfactory performance of a heavy duty, high power density linear electric actuator in a land-based test facility. Satisfactory testing demonstrated their viability for service in a Navy surface ship/submarine thereby allowing hydraulic systems to be eliminated. Deliverables: Power-dense electric actuation prototype capable of reducing shipboard and depot repair and maintenance workloads, and to reduce ship's operator watch stander duties (shipboard manning).

FY 2007: This effort supports electronic motion actuation systems.

	FY 2006	FY 2007
FREE ELECTRON LASER	3,352	0

This effort performed S&T in electron beam physics for the high power free electron laser.

	FY 2006	FY 2007
HIGH ENERGY DENSITY CAPACITORS FOR MILITARY APPLICATIONS	1,441	2,491

FY 2006: This effort supported the high energy density capacitors for pulsed power applications that will be developed based on kraft paper/polysiloxane technology developed under an ONR SBIR phase III award.

FY2007: This effort supports high energy density capacitors for military applications.

	FY 2006	FY 2007
HIGH PERFORMANCE FREQUENCY MODULATED (FM) FIBEROPTIC LINK	1,151	1,096

FY 2006: Drexel University in conjunction with Southern Methodist University, Photodigm, University of Texas at Dallas, and the University of Texas at Austin developed and designed a high performance coherent modulated fiber-optic link. The fiber-optic link connected a microwave sensor (antenna) with a central processing unit, and contains no electronic components. All pertinent signal processing, tasks such as up and down conversion

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of the microwave signals, are executed in the optical domain.

FY 2007: This effort supports the high frequency modulated fiberoptic link.

	FY 2006	FY 2007
HIGH POWER FEL DEVELOPMENT FOR NAVY APPLICATIONS	1,437	0

This effort designed and built technologies and capabilities for the production of a free electron laser system.

	FY 2006	FY 2007
MARINE MAMMAL HEARING AND ECHOLOCATION RESEARCH	958	1,494

FY 2006: This effort investigated the hearing ability in two species of dolphins. Specific areas of effort include studies of temporary threshold shift and development of evoked potential audiometric techniques for rapid measurement of hearing.

FY 2007: This effort supports marine mammal hearing and echolocation research.

	FY 2006	FY 2007
MDETEC	958	0

This effort conducted an environmental impact assessment to determine suitability and generate approval recommendation for Navy directed energy range asset at Pacific Missile Range Facility.

	FY 2006	FY 2007
MILLIMETER TERAHERTZ IMAGING ARRAYS	3,448	1,245

FY 2006: This effort developed the following: Task 1 - ground breaking sub-terahertz and millimeter wave sensors and their corresponding focal plan arrays. Task 2 - developed and applied suitable electromagnetic modeling algorithms to the design and efficiency analyses of sub-terahertz and millimeter wave devices and sensors. Task 3 - developed advanced optical element synthesis, super resolution image reconstruction

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algorithms, computational imaging methods, and biologically inspired imaging.

FY 2007: This efforts supports millimeter terahertz imaging arrays.

	FY 2006	FY 2007
MULTI-SENSOR HYPERSPECTRAL SYSTEM FOR DAY/NIGHT RECONNAISSANCE	2,494	3,587

FY 2006: This effort developed and integrated a miniaturized hyperspectral multi-sensor system. The system was developed in a ball turret integrated multi-sensor suite. The miniaturized units provided the full spectral coverage required for the day or night operations.

FY 2007: This effort supports the multi-sensor hyperspectral system for day/night reconnaissance.

	FY 2006	FY 2007
NAVY SECURITY AUTOMATION AND FUTURE ELECTRO-ROBOTS	958	0

Continued to develop a fully autonomous system capable of detecting suspicious objects through images captured by electro-optic sensors in aerial vehicles. The imaging devices being considered are long-range visible cameras and long wave infra-red cameras.

	FY 2006	FY 2007
OBLIQUE ANGLE HYPERSPECTRAL IMAGE FUSION	1,592	0

This effort developed new methodologies for remote sensing image exploitation, with an emphasis placed on oblique and multi-look imagery. The primary interest is in the areas of large-scale scene segmentation, small-scale object isolation, shadow suppression, 3-dimensional reconstruction, and change detection. Of particular interest is the problem of detecting an object (e.g., a vehicle) that lies in the shadow of buildings or a tree line. The imagery of interest includes that from framing cameras, line scanners, and whiskbroom sensors.

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	FY 2006	FY 2007
RETROREFLECTING OPTICAL COMMUNICATIONS FOR SPECIAL OPERATIONS	966	2,989

FY 2006: This effort focused on the development and refinement of advanced technologies and development of hardware and software tools to control the shipboard thermal environment. Utilization of the Rugged Mobile High-Density Electronic Equipment designed as part of the Intergraph Solutions Group (ISG)/Rocky Research proposal was integral to this task.

FY 2007: This efforts supports retroreflecting optical communications for special operations.

	FY 2006	FY 2007
SILVER FOX UNMANNED AERIAL VEHICLE (UAV)	1,681	0

This effort completed experimentation/demonstration of emerging technologies integrated into the Silver Fox UAV. Counter-IED-centered technologies, as well as technologies that support fully autonomous ship launch and recovery were included in this experimentation effort.

	FY 2006	FY 2007
SPECTRAL BEAM COMBINING FIBER LASERS	958	0

This effort developed highly efficient beam combined fiber laser system to demonstrate traceability to tactical air deployable high energy weapon system.

	FY 2006	FY 2007
THERMAL MANAGEMENT SYSTEMS FOR HIGH DENSITY ELECTRONICS	5,408	4,979

FY 2006: Continued modification of the single-phase model to a three-phase model, continued testing and evaluation. Deliverables: Passive Spot Cooler Prototype used to cool components in a high-density electronic system; Active Refrigeration Spot Cooler prototype used to support the heat transfer using thermo-electric, vapor compression, and absorption cooling techniques; Heat Spreader Prototype to profile temperature load and heat rejection on condensers; Electronic Cooling System prototype capable of operating at various loads and ambient temperatures; Active Cooling System prototype capable of operating in harsh environments of up to +55C

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and shock conditions.

FY 2007: This effort supports thermal management systems for high density electronics.

	FY 2006	FY 2007
ULTRA HD PROJECTION DISPLAY	1,437	0

Continued development of new large screen Ultra High Definition displays.

This type of large format, high resolution display provides an image analyst the capability to view high-resolution images within context. Currently, trade-offs are made between viewing a high-resolution segment of a larger image or seeing the whole image at lower resolution. This display compliments the development of the Quad HDTV at Florida Atlantic University.

	FY 2006	FY 2007
WORK FLOW ENGINE FOR OFF-LINE IMAGERY	958	0

This effort developed a non-real-time data exploitation system for remote-sensing data that would be easily transitioned to a near-real-time capability for on-plane or ground-station use. The workflow software will significantly improve the analysts' effectiveness and efficiency in detecting, identifying, and locating items of interest in the imagery. The exploitation system includes the general areas of image quality analysis, target detection, target identification, geocorrection, image co-registration, change detection, and atmospheric correction. The system should accept data from hyperspectral pushbroom sensors, hyperspectral whiskbroom sensors, panchromatic framing cameras, and panchromatic line scanners.

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

PE 0602131M Marine Corps Landing Force Technology

PE 0602235N Common Picture Applied Research

PE 0603114N Power Projection Advanced Technology

PE 0603640M USMC Advanced Technology Demonstration (ATD)

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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 0602702E Tactical Technology

PE 0603739E Advanced Electronics Technologies

PE 0602203F Aerospace Propulsion

PE 0602601F Space Technology

PE 0602602F Conventional Munitions

PE 0603216F Aerospace Propulsion and Power Technology

D. ACQUISITION STRATEGY:

Not Applicable.