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

BUDGET ACTIVITY: 2 PROGRAM ELEMENT: 0602114N
PROGRAM ELEMENT TITLE: Power Projection Applied Research

COST: (Dollars in Thousands)

PROJECT NUMBER/ TITLE	FY 2002 ACTUAL	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	FY 2006 ESTIMATE	FY 2007 ESTIMATE	FY 2008 ESTIMATE	FY 2009 ESTIMATE
Power Projection Applied Research	86,004	105,324	114,144	107,260	83,870	76,443	57,931	59,051

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 Program Element (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.

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

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B. PROGRAM CHANGE SUMMARY:

	FY 2002	FY 2003	FY 2004	FY 2005
FY 2003 President's Budget Submission:	83,413	76,612	63,221	61,206
Adjustments from FY 2003 President's Budget:				
Congressional Plus-Ups		31,075		
Cong. Rescissions/Adjustments/Undist. Reductions	-406	-1,220		
SBIR Reduction	-1,002			
S&T Program Adjustments		-1,143	54,141	48,784
NWCF Rate Adjustment			-222	-42
Execution Adjustments	3,999			
Efficiencies at NWCF Activities			-362	-375
Pay Raise/Inflation Adjustments			-2,634	-2,313
FY 2004/2005 President's Budget Submission:	86,004	105,324	114,144	107,260

PROGRAM CHANGE SUMMARY EXPLANATION:

Schedule: Not applicable
Technical: Not applicable

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

Budget Activity: 2
PROGRAM ELEMENT: 0602114N Project Title: Power Projection
PROGRAM ELEMENT TITLE: Power Projection Applied Research Applied Research

COST: (Dollars in Thousands)

PROJECT NUMBER/ TITLE	FY 2002 ACTUAL	FY2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	FY 2006 ESTIMATE	FY 2007 ESTIMATE	FY 2008 ESTIMATE	FY 2009 ESTIMATE
Power Projection Applied Research	86,004	105,324	114,144	107,260	83,870	76,443	57,931	59,051

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. In particular the technology developed in this project 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 project 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.

B. ACCOMPLISHMENTS/PLANNED PROGRAM:

Fleet Defense & Air Dominance	FY 02	FY 03	FY 04	FY 05
	8,312	10,037	5,575	3,045

The focus of this effort is on those technologies that will support defense of the fleet in the littoral area and to provide for air dominance in all of the operating areas that Naval forces will operate in the future. Technology areas include: advanced Air-to-Air (A-A) missile seeker and propulsion technologies, Infrared focal plane arrays (IRFPA) and hyperspectral algorithms for target detection, laser tracker and identification, automatic target recognition (ATR) for air targets, High Energy Lasers (HEL) and Directed Energy weapons, advanced warhead and fuzes for use against high speed maneuvering threats, Radio Frequency (RF) photonics to increase bandwidth and reduce size/weight of phased array detectors, radar detection technology in clutter, and advanced Counter-Counter Measure (CCM) techniques for improved missile performance.

FY 2002 ACCOMPLISHMENTS:

- The Long Wave Infrared (LWIR) task goal is to develop low loss, high strength fibers (8-12um) required for the Navy's threat warning system and infrared countermeasures. The LWIR fiber task produced fibers at 75 kpsi strength and multifiber coherent bundles up to 3m in length.

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

Budget Activity: 2

PROGRAM ELEMENT: 0602114N Project Title: Power Projection
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- The purpose of the Multispectral Infrared Focal Plane Array (IRFPA) effort is to develop advanced infrared detectors and focal plane arrays that will improve sensitivity, operating range, field of view (FOV), and counter measure hardness in Forward Looking Infrared Receivers (FLIR), missile seeker, missile warning and surveillance sensors. The IRFPA task demonstrated improved color detector materials, an improved long wavelength detector, and laser hardening approaches for uncooled detectors.
- The Electro Optic/Infrared (EO/IR) effort developed sensors, nanotechnology-based gyroscope/accelerometer sensor stabilization mechanisms to provide more accurate targeting, and identification of potential targets. The hyperspectral algorithm effort evaluated and improved the algorithm packages for a family of hyperspectral sensors to improve detection and identification of targets in camouflage and complex environments. The Laser tracker and identification Automatic Target Recognition (ATR) effort provides the ability to detect track and identify air targets. The task developed an approach that uses laser vibrometry to classify/identify threats. This effort flew a stabilized, eye safe laser on a gimbal to measure sensor and platform vibration. The purpose is to determine the impact of vibration and atmospheric turbulence on laser beam divergence and coherence. Completed work on Laser interrogator tracker. It will transition to the Fleet/Force Protection FNC to provide the DDX with fire control quality information on all target types, including the asymmetric threat.
- The Air-to-air weapons effort completed this year. The Aim Airframe control task fabricated and assessed an advanced high temperature missile section. The Surface Wave Antenna Guidance (SWAG) effort conducted field test and evaluation to evaluate the performance of the SWAG seeker in potential air-to-air environments. The Short Pulse Laser Target Detection Device (TDD) task completed demonstrations against targets in fog and clutter. A systems assessment for weapon needs addressing asymmetric threats was conducted. A systems assessment of high performance, solid state Radio Frequency (RF) seeker technology that is appropriate for the advanced cruise missile defense problem was initiated. The Reactive Material Warhead Target Interaction Lethality Vulnerability (TILV) effort continued.
- The High Energy Laser (HEL) weapons development effort initiated the fabrication of test equipment to be used for propagation measurements of beam coherence in aerosol rich environments. Analyzed existing climatology data for aerosol microphysical and meteorological properties in maritime and coastal environments. Develop multi-year climatologies and probabilities of severe propagation impacts in sensitive marine/coastal regions. A field test was conducted in a sensitive region of the world to provide a short term, detailed characterization of the vertical distribution of aerosols.
- The High Performance Turbine Engine Technology (IHPRPT) program demonstrated an air launched rocket with a high-pressure nozzle and composite motor case. The air-to-air project demonstrated a flight weight, high pressure; highly loaded, full scale air-to-air motor incorporating an end-burner motor with reduced smoke propellant, advanced composite case (T-1000 & Ultra High Modulus (UHM) fibers), dual movable nozzle, and thrust vector control (TVC). The gun launched motor project demonstrated in flight a high pressure, highly loaded, full scale, gun launched munition motor incorporating an end-burner motor with aluminized propellant, and advanced composite case (aluminum metal matrix) technologies. The surface launched effort conducted full scale testing of a 40 to 1 turndown ratio pintel motor with aluminized boost propellant.

FY 2003 PLANS:

- The LWIR fiber development will produce 8-12 um fiber at greater than 100 kpsi strength and 1 micron core material in lengths greater than 1 km.
- The Multispectral IRFPA will demonstrate color techniques for air to surface targeting and transition IRFPA hardening techniques to industry.
- The gyro stabilization portion of the EO/IR effort will fabricate and test the gyroscope, accelerometer, and inertial measurement unit designs. The hyperspectral task will demonstrate the algorithm packages in operational exercises. The ATR effort will upgrade a high coherence eye safe laser and demonstrate laser vibrometry ATR of airborne platforms and target discrimination (threat vice non-threat). Demonstrate extended range laser tracker and identification of air targets.
- Conduct subsystem concept definition trade studies of the weapon control, launcher, weapon guidance and control, and warheads for the asymmetric threat defense effort. Development of high performance solid state RF seeker technology for defeat of advanced anti-ship cruise missiles will continue. A study of technology requirements to enable hit-to-kill missile defense against anti-ship cruise missiles will be performed. The Reactive Material TILV effort will conclude. The HEL weapons development effort will continue to make detailed propagation measurements to evaluate the performance of the HEL when conducting shipboard operations in the ocean/littoral environment.
- The Advanced Reactive Material effort will continue development of advanced Reactive Material compositions. Reactive Materials are warhead material formulations that result in warhead fragments that combine both kinetic and chemical energy. This combination of kinetic and chemical energy produces structural kills rather than the component kills that inert fragments generate.
- The IHPRPT program will be terminated at the end of FY03. The FY03 efforts will include full scale testing of an aluminized boost propellant. Concept evaluation will conclude for the advanced Thrust Vector Control (TVC) concepts incorporating pitch, yaw, and roll control along with thrust magnitude control capability. Propellant ingredient and formulation investigations will be completed for advanced reduced smoke propellant for air-launched applications.

FY 2004 PLANS:

- The Advanced Imaging Seeker Countermeasure effort will develop imaging infrared countermeasures (IRCM) against imaging missiles using a unique state of the art hybrid approach. The FY04 work will implement preprocessing and track algorithms into imaging surrogates. The Millimeter Wave (MMW) threat detection technology effort will develop preliminary hardware and software designs for channelized and photonic Ka/W band Electronic Warfare (EW) receiver designs.

- Develop high-performance, low-cost EO/IR airborne surveillance sensors for unmanned aerial vehicles. Develop ultra-high performance EO/IR Imagers. Develop auto-target identification techniques for Laser Range-gated imagers.
- Perform subsystem design studies for the asymmetric threat defense effort. Identify key subsystem technology challenges and develop subsystem level demonstration goals.

FY 2005 PLANS:

- The Advanced Imaging Seeker Countermeasure effort in 05 will develop new generic cooperative imaging IRCM techniques and verify and refine existing concepts. The MMW threat detection technology task will fabricate channelized and photonic prototype receivers.
- Fabricate components and integrate subsystems for the asymmetric threat defense effort.

	FY 02	FY 03	FY 04	FY 05
Free Electron Laser (FEL)	1,508	4,380	10,000	10,000

The goal of this work is to complete and commission upgrades to the infrared (IR) Free Electron Laser (FEL) and develop technologies related to average power scaling. If the FEL can be successfully scaled up to weapons level power it could be considered for shipboard applications as a defense weapon against advanced cruise missiles and asymmetric threats.

FY 2002 ACCOMPLISHMENTS

- Initiated commissioning of the 10 kW Free Electron Laser (FEL).

FY2003 PLANS:

- Develop an optical klystron to extend the FEL performance into the Infrared (IR) bands. Complete commissioning and demonstrate a 10 kW FEL.

FY 2004 PLANS:

- Conduct beam quality experiments at the 10 kW level. Conduct design and cost studies evaluating multiple design alternatives for development, fabrication, and demonstration of a 100 kW FEL.

FY 2005 PLANS:

- Initiate detailed design and component fabrication for the 100 kW demonstration FEL.

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

Budget Activity: 2

PROGRAM ELEMENT: 0602114N Project Title: Power Projection
PROGRAM ELEMENT TITLE: Power Projection Applied Research Applied Research

	FY 02	FY 03	FY 04	FY 05
Naval Precision Strike Operations	35,575	33,973	69,000	64,200

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. Some of the technologies employed to support the Navy strike capability include: Unmanned Air Vehicles (UAV) to locate, identify, and target critical enemy resources and weapons, rapid targeting technologies to enable rapid employment of long range precision strike weapons, smart/high speed weapons to support the attack of time critical targets, and improved explosives with energetic capabilities that will inflict greater damage against the target. This area also includes advanced navigation Science and Technology which is developing technologies in the areas of precision clock and time distribution, Precision Terrain Aided Navigation (PTAN), Laser light sources for fiber optic gyros (FOG), and Relative Navigation.

FY 2002 ACCOMPLISHMENTS:

- The purpose of the Autonomous Operations (AO) UAV task is to develop software to detect threats, collision situations and targets of opportunity with operator, and pre-programmed reaction. Developed secure jam resistant communications links and architecture for networking and multi-vehicle operations. Developed command, control and information display for multiple UAVs conducting simultaneous imaging missions using a single UAV operator. Developed software technologies that permit single frequency multi-point communications between multiple UAVs and their ground station.
- Initiated the UAV Radar effort with the goal of developing a radar concept and signal processing algorithms for the Navy's planned Tactical Ultra Light UAVs. This will provide the Navy with the ability to safely detect and direct weapons against over-the-horizon, slow moving, ground targets. Obtained and assembled components, and integrated and tested the UAV radar system and instrumentation hardware.
- The Micro Air Vehicles (MAV) program demonstrated autonomous flight, conducted mission demonstrations and integrated payloads and sensors/autopilots with MAV. The applied research portion of this program will transition to next-generation advanced single vehicle and distributed multiple-vehicle programs.
- Successfully completed the Distributed Time Standards (DTS) effort to develop a program to average various clock values in order to maintain system time as accurately as possible with respect to Universal Coordinated Time (UCT). The software developed will transition to the Navy Navigation Sensor System Interface (NAVSSI). The relative navigation task for Global Positioning System (GPS) and Link 16 to develop greater positional fix accuracy has identified the limits of time-code transmission accuracy. This effort completed a Kahlman filter software design for the NAVSSI. The High Precision Light source for the FOG of Inertial Navigation Systems (INS) task identified the laser parameters that will reduce system noise and developed an Engineering Development Model (EDM) of a laser light source to be included in the FOG. The Network Centric Navigation task was initiated. This effort exploits the wide bandwidth and low latency of proposed Department of Defense (DoD) communication networks to enable the new networks to carry extremely accurate position and precision time

information along with the communications info normally carried. Initiated a task to conduct a threat analysis of GPS and other navigational devices such as Micro-Electronic Mechanical Systems (MEMS) and Inertial Measurement Units (IMU). This effort began with identifying the vulnerabilities of the components.

- The Weapons Imagery Link (WIL) program is a Radio Frequency (RF) communications link, which will provide data bandwidth for the transport of moving imagery (video) and weapon control data for standoff weapons such as Standoff Land Attack Missile-Expanded Response (SLAM-ER). Conducted a test of a dynamic network using a complex array of terminals, a simulated weapons delivery under multiple scenarios, and a video relay through two terminals and a long distance video relay. This effort will transition to PE0603114N in FY03.
- The Mission Responsive Ordnance (MRO) effort performed Small Scale Penetrator Tests to quantify various design constraints against depth in concrete. Down selected to two structural concepts and two safe arm architectures. Selected baseline warhead size.
- The Hypersonic Weapons Development completed Leading Edge airframe component testing and test data analysis. The seeker window/dome task prototyped window/airframe integration. The air breathing hypersonic propulsion task integrated flow control algorithms and actuators into test hardware and demonstrated the ability to control combustion. Direct connect measurements of the Dual Combustion Ramjet (DCR) were completed and free jet tests performed.
- The Technology for the Sustainment of Strategic Systems (TSSS) program continued to upgrade Radiation Hardened (RAD HARD) models, codes and databases. The Solid Rocket Motor (SRM) effort produced structural and gas dynamic coupled models. The drag reduction device task finalized the database, identified Computational Fluid Dynamics (CFD) tool candidates, and identified the static stability method.
- The Weapons program Supersonic Airframe control effort selected and fabricated the control concept for the strike weapon, and investigated the extendibility of the concept into the hypersonic speed regime. The Configurable Automatic Target Recognition (CATR) effort defined the tasks necessary for the ATR Laser Radar (LADAR) identification of targets and evaluated reconfigurable architectures for the CATR system. The MEMS antenna task completed the fabrication of the demonstration seeker and investigated the applicability of MEMS in high power RF seeker applications.

FY 2003 PLANS:

- The UAV advanced technology task will develop single frequency, multi-UAV imaging ops capability using only the secondary UHF data link. Develop command, control and information display for multiple UAVs conducting simultaneous imaging missions using only a single UAV operator.
- Conduct field and lab tests of UAV radar system.
- Complete the relative Navigation task for GPS and Link 16. FY03 work will involve developing plans to implement the systems on Navy ships. Complete the High precision light source FOG task by developing the alternative laser design of the FOG system. The Network Centric Navigation task continues with the work of determining the latency of representative networks in the trial or planning stages of those networks. The GPS

and Navigation device task will also continue with the identification of specific GPS failure modalities and determine the potential for foreign forces and terrorist groups to exploit those vulnerabilities. The results will be factored into the Digital Signal Processing design and the development of a RF design to reduce front end vulnerabilities. New areas will be initiated in FY03 that will exploit the benefits of more current ephemeris data and of the existing phase coherence between CA, P(Y), and M-code signals. Also added are efforts to deliver more seamless and consistently precise time in a network context. This work involves the development of algorithms and hardware that can assess the quality of an ensemble of inputted clock data.

- The MRO effort will perform mid-scale penetration tests to validate survivability of structure. Demonstrate dispenser component functionality. Perform static arena tests of warhead against various targets.
- The TSSS program will involve upgrading and linking RAD HARD codes and evaluating the software. The SRM effort will perform code validation with legacy models and preliminary verification on new models. The drag reduction device task will develop a first order CFD model, complete the CFD model test trials, and integrate static stability models.
- The Ordnance Systems for High speed penetration work will develop advanced fuze, warhead and structural components that can be integrated into high speed strike weapons which are used to attack high value, deeply buried targets.
- The Advanced Reactive Weapons Task for Hard and Deeply Buried Targets (HDBT) will develop and examine alternate methods of production for advanced energetic materials that increase structural strength and performance, when compared to current state of the art materials, while maintaining high levels of exothermic energy in the forms of shock waves and high gas overpressures when initiated. These advanced reactive material structures appear to indicate that using filled lattice geometries provides higher structural strengths and produces superior lethality for penetration weapons than current explosive formulations.
- The HyFly National Aerospace Initiative effort will design and develop flight weight hardware that can be integrated into a hypersonic strike vehicle. The program will develop a lightweight Dual Combustion Ramjet (DCR) concept vehicle for the airframe integration task. The advanced air-breathing propulsion task will develop a full-scale test device and demonstrate full-scale combustion control. The supersonic inlet task will begin evaluation of inlet concepts and the preliminary inlet design.
- The Weapons program Supersonic Airframe control task will design for a ground test to demonstrate a section level integrated control concept extendable into the hypersonic speed regime. The Configurable ATR work, which has integrated a family of tunable algorithms, will continue with the development of a process oversight manager that will provide for the tuning of the ATR algorithms. The MEMS antenna task will evaluate the fabricated seeker and then begin development of the high power RF seeker. Initiate the development of moving target and ATR algorithms. An effort will be initiated to advance the technologies needed to further automate the management and control of several retargetable weapons and unmanned vehicles providing Intelligence, Surveillance and Reconnaissance (ISR)/targeting functions. Conduct subsystem concept definition trade studies of the weapon control, launcher, weapon guidance and control, and warheads for the asymmetric threat defense effort.

FY 2004 PLANS:

- The AO UAV technology task will complete development and perform simulation testing of software to detect threats, collision situations and targets of opportunity with operator, and pre-programmed reaction. Continue development of secure jam resistant communications links and architecture for networking and multi-vehicle operations. Continue development of command, control and information display for multiple UAVs conducting simultaneous imaging missions using a single UAV operator. Continue development of software technologies that permit single frequency multi-point communications between multiple UAVs and their ground station.
- Complete the UAV radar program by performing airborne testing using a Piper Aztec as a surrogate platform.
- GPS-Continue the Network Centric Navigation task by assessing the time synchronization and precision time transfer using the Naval Research Laboratory (NRL) Distributed Time Standards and Space and Naval Warfare Systems Command (SPAWAR) system center test beds. The GPS and Navigation Device threat analysis will review the proposed methods of eliminating the vulnerabilities and select the most promising approaches.
- The Naval Unmanned Combat Air Vehicle (UCAV-N) effort will continue operational concept development and analysis, design of combat subsystem components, and continue the design and development of Mission Control System (MCS) software.
- Increase program emphasis in Network-Centric areas in order to enable and widely distribute more accurate and precise data that will lead to rapid target location and rapid target-threat elimination. Work will focus on increased emphasis in GPS/INS. Continue GPS ephemeris updates, triad GPS signal coherence, KAS-1 update, GPS/INS refinement, Controlled Radiation Pattern Antenna (CRPA) isolation improvements.
- The MRO will conduct a Demonstration of multi-point timing showing that critical target data fusion can be accomplished. Initiation tests on the distributed safe and arming device for the munitions package will be conducted, leading to full scale demonstration test hardware being completed.
- Begin HyFly air vehicle and fuel system testing. Validate operational flight program software using hardware in-the-loop testing. Conduct interface testing between flight test vehicle and carry aircraft. Fully transitions to Power Projection Advanced Technology (Budget Activity 3) in FY 2005.
- In the TSSS effort, the RAD HARD System Design Tool task will continue efforts in upgrading and linking validated Commercial off the Shelf (COTS) RAD HARD codes with more emphasis software validation and verification in different platforms. The SRM ignition response effort will perform advanced nonlinear model comparisons with ground test data. The Drag Reduction Devices task will, by application of COTS, develop an advanced aerospike drag reduction model and verify and validate with ground test data. The advanced model will be integrated into a trajectory simulation via a simpler model adapted to trajectory simulation. Static stability models will be generated to complete the required models for a trajectory simulation of missiles with drag reduction devices. For the accelerometer task, two Proof of Concept, Superconducting and Atom Interferometer, Gravity Gradient Sensors fabricated and a Proof of Concept new technology accelerometer for

Fiber Optic Gyro-Navigation (FOGN) use designed. Plan to complete build 1 of the Electronic Design Advisor (EDA), complete load of documents and data into the Electronic Interactive Database (EID), and publish the beta version of the Integrated Underwater Launch (UWL) Technology System.

- The Strategic Systems Infrastructure (SSI) effort will consist of 5 tasks. Missile propulsion technology task will increase performance and reduce costs on solid rocket motor systems. The advanced Post Boost Control System (PBCS) will develop advanced variable thrust Post Boost system technologies. The Ordnance system task will develop replacement technology for Exploding Bridgewire (EBW) detonator systems. The Missile Electronics task will develop a capability to model the electrical behavior of components in strategic missile environments. The Navigation Sonar Task will develop advanced technology acoustic sensors for Navigation Sonar Systems (NSS). The FY04 Missile propulsion effort will formulate high performance propellants and conduct subscale static motor tests of composite materials and begin subscale chamber design and hydroburst tests. The Advanced PBCS effort will develop a preliminary design and conduct parametric testing. The ordnance initiation task will develop a preliminary design, conduct subscale tests, and perform theoretical bus dynamics analysis. The Missile electronics task will evaluate test data of the effects of the external environment on the operation and reliability of missile electronics. The effort will then begin the development of models to predict and track those effects. The Navigation Sonar task will transition ONR's advanced transducer and design and develop a new hydrophone array.
- The Supersonic Cruise Missile (SSCM) National Aerospace Initiative (NAI) technology base program supports the development of high speed (supersonic to hypersonic) turbine and airframe technologies for expendable weapons applications. Component areas include inlets, compression, combustion, turbine, controls, exhaust nozzles, airframe materials and controls. Turbine engine component designs will be initiated that will increase the performance of components such as a high temperature lightweight compressor, a high fuel air ratio combustor, and a reduced length shear layer mixed augmentor. Cost reduction efforts will focus on a reduced parts count turbine, and an advanced exhaust nozzle.

FY 2005 PLANS:

- The AO UAV technology task will analyze simulation test of software to detect threats, collision situations and targets of opportunity with operator, and pre-programmed reaction. Continue development of operations. Continue development of command, control and information display for multiple UAVs conducting simultaneous imaging missions using a single UAV operator. Continue development of software technologies that permit single frequency multi-point communications between multiple UAVs and their ground station.
- Complete the Network-Centric Navigation task by demonstrating the transfer of the Precision Time and Time Interface (PTTI) using a suitable DoD Communications Network such as the Advanced Digital Network System (ADNS) using Network Time Protocol (NTP) and other protocols. The GPS and Navigation Device threat analysis will continue the investigation of the most promising approaches for the elimination of the threats to the use of GPS and other navigation devices. The FY05 plan involves further development of Network-Centric areas focused

on implementation. GPS/INS and GPS CRPA efforts will address plans for field testing and work needed for transition to fleet implementation.

- The UCAV-N effort will continue operational concept development and analysis, complete design of subsystem components, and continue design and development of MCS software.
- The MRO will conduct a Demonstration of component survivability through a system demonstration test of all hardware, including the dynamic dispense and control of a sub warhead capable of penetration. Also demonstrated will be the ability to use adaptive control to adjust the in-flight retargeting and control of a sub-warhead after release from the missile.
- In the TSSS effort, the RAD HARD System Design Tool task completes with beta trials of the software deliverable and emphasis will be placed on final documentation and future software maintenance. The SRM ignition response effort completes code validation and verification with flight test data. A flight of opportunity will be planned to acquire necessary flight data for comparison. The Drag Reduction Devices task completes the development of an aero elasticity tool suited for performance prediction of missiles with drag reduction devices. Emphasis will be on making predictions for future aerospike concepts, model documentation and future software maintenance. For the accelerometer task, Proof of Concept, Superconducting and Atom Interferometer, Gravity Gradient Sensors and a new technology accelerometer for FOGN will be tested and final reports published. Plan to complete integration of the UWL handbook, complete Validation and Verification (V&V) of the Integrated Launch Models, and begin final V & V of the Intelligent systems (EDA).
- The FY05 Missile propulsion effort continue subscale static motor test to measure erosion and continue subscale chamber design and hydroburst tests. The Advanced PBCS effort will develop thermal/mechanical valve and flow impingement models. The Ordnance Initiation technology effort will conduct design reviews and purchase prototype systems for evaluation. The Missile electronics task will continue the development of models to track and predict the effects of physical, chemical, and nuclear effects on the operation and reliability of the missile electronics. The Navigation Sonar task will develop a common electronics architecture to accommodate affordable hardware.
- The SSCM NAI technology base program will fabricate turbine engine components using rapid prototyping techniques and advanced materials and manufacturing approaches. Rig testing will be started to validate component design predictions under simulated engine conditions using highly instrumented test articles. Airframe components will be tested under realistic conditions. Manufacturability and affordability of airframe and engine components will be assessed.

	FY 02	FY 03	FY 04	FY 05
Support for Naval Expeditionary Forces Ashore	23,448	26,543	29,569	30,015

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

Budget Activity: 2

PROGRAM ELEMENT: 0602114N Project Title: Power Projection
PROGRAM ELEMENT TITLE: Power Projection Applied Research Applied Research

The focus of this effort is on those technologies that will support expeditionary operations of marines operating in the littoral areas. Some of the technologies developed in this effort include: advanced gun launched seekers and propulsion techniques that will provide more accurate Naval Fire Support (NFS) at longer ranges, Unmanned Ground Vehicles (UGV) development to provide improved surveillance/targeting support to marines on the ground, smart sensor networks to link UAVs in urban environments, and improved explosive formulations that will provide greater lethality against NFS type targets.

FY 2002 ACCOMPLISHMENTS:

- The Autonomous Operations (AO) Unmanned Undersea Vehicle (UUV) task developed enabling technologies in autonomy, navigation, sensors, energy, and communication in support of UUV missions. Initiated development of UUV-deployed Intelligence, Surveillance and Reconnaissance (ISR) electro-magnetic and electro-optic (EM/EO) sensors; software to detect, evaluate and avoid obstacles and threats using various sensor inputs; sensor data fusion for situational awareness; and integrated autonomous UUV control approaches for Maritime Reconnaissance mission capabilities. Developed multi-vehicle undersea search and survey and communication link.
- The AO UAV propulsion and power technology development task for the Navy UAV refined Navy UAV propulsion technologies through individual component design, fabrication and component rig testing under realistic operational conditions under the Integrated High Performance Turbine Engine Technology (IHPTET) program. Demonstrated the UAV engine component technologies that will provide high performance and robust operational utility, reduce parts count and decrease component costs when integrated into an advanced UAV turbine engine.
- The AO Intelligent Autonomy task developed system and associated sensor processing for unmanned vehicles to enable adaptation and independent actions. Developed architecture for combining reactive and deliberative behaviors for autonomous vehicles.
- The Unmanned Ground Vehicle (UGV) program worked on developing technologies that address capability gaps in robotic communications and control, mobility, survivability, durability, modularity, and signature reduction in support of the Marine Corps Gladiator Tactical Unmanned Ground Vehicle (TUGV) program.
- The Micro UAV sensor program demonstrated a magnetic fiber micro sensor and completed the development of a radiometer.
- Smart sensor network effort evaluated and demonstrated different sensor packages linked to form a grid for surveillance and tracking of targets in urban environments.
- The Enhanced Target Acquisition & Location System (ETALS) effort developed an advanced, affordable, azimuth sensing Micro-Electro-Mechanical-Sensor (MEMS) based gyroscope. ETALS will enable improved and more rapid targeting when operating in urban environments and areas of high iron concentration. Developed a gyrocompass model for ETALS. Performed ETALS Selective Availability Anti-Spoofing Module (SAASM) integration test and MAGU-1 (Miniature Azimuth Gyrocompass Unit) gyrocompass test.
- The Weapons program Precise Tactical Targeting (PTT) task began ground and aircraft testing. The Energetic gun propulsion began preliminary support to the barrel wear and advanced propulsion FY03 tasks. The High

Energy Density Materials (HEDM) task continued performance enhancement evaluation of selected HEDM candidates.

FY 2003 PLANS:

- Continue development of AO UUV-deployed ISR electro-magnetic and electro-optic (EM/EO) sensors; software to detect, evaluate and avoid obstacles and threats using various sensor inputs; sensor data fusion for situational awareness; and integrated autonomous UUV control approaches for Maritime Reconnaissance mission capabilities. Continue multi-vehicle undersea search and survey and communication link development.
- The AO UAV propulsion and power technology development effort for the Navy UAV will continue refining Navy UAV propulsion technologies through individual component design, fabrication and component rig testing under realistic operational conditions under the IHPTET program. Demonstrate the UAV engine component technologies that will provide high performance and robust operational utility, reduce parts count and decrease component costs when integrated into an advanced UAV turbine engine. Develop and rig test a high flow combustor under Mach 3.5 conditions. Rig test low pressure spool component of the demonstrator turbine engine.
- The AO Intelligent Autonomy task will develop system and associated sensor processing for unmanned vehicles to enable adaptation and independent actions. Develop architecture for combining reactive and deliberative behaviors for autonomous vehicles.
- The UGV program will develop technologies that address capability gaps in robotic communications and control, mobility, survivability, durability, modularity, and signature reduction in support of the Marine Corps Gladiator Tactical Unmanned Ground Vehicle (TUGV) program.
- Develop ETALS Target Location Designation and Handoff system (TLDHS) interface prototype. Develop AN/GVS-5 production interfaces for ETALS. Perform a Limited User Test for the AN/GVS-5 and TLDHS.
- To complete the Micro UAV Sensor program, a micro acoustic sensor will be demonstrated and, along with the other sensors developed by the program, they will be made available for Micro UAV applications.
- To complete the Smart sensor Network, sensors will be linked into a grid to demonstrate different sensor packages observing and tracking targets in urban environments.
- Initiate the Advanced Gun Barrel and propulsion task which will develop a complete, next generation, gun barrel design for current and future Naval gun systems. This system will yield significant improvement in barrel life and gun system performance. Tasks will involve analysis of thermal transfer between materials and load transfer between layers. Structural and thermal predictive models will be developed.
- The Weapons program PTT task will complete ground and aircraft testing and begin the 1-meter targeting effort. The HEDM task will continue performance enhancement evaluation of selected HEDM candidates and continue fabrication and testing of HEDM structural composites. An effort will be initiated to address moving targets using tactical/expeditionary assets such as tactical UAVs and guided projectiles. An effort will be initiated to further the technologies needed for next-generation high performance gun systems for land attack (light gas or EM).

FY 2004 PLANS:

- Continue development of AO UUV-deployed ISR EM/EO sensors; software to detect, evaluate and avoid obstacles and threats using various sensor inputs; sensor data fusion for situational awareness; and integrated autonomous UUV control approaches for Maritime Reconnaissance mission capabilities. Continue multi-vehicle undersea search and survey and communication link development.
- The AO UAV propulsion and power technology development effort for the Navy UAV will complete refining Navy UAV propulsion technologies through individual component design, fabrication and component rig testing under realistic operational conditions under the IHPTET program. (The program will continue to leverage IHPTET technologies until the program's completion in FY 04.) Rig test the forward swept fan and the high flow combustor for the demonstrator engine under simulated engine conditions. Bench test the low pressure spool power generator and distribution system.
- The AO Intelligent Autonomy task will continue development of system and associated sensor processing for unmanned vehicles to enable adaptation and independent actions. Continue development of architecture for combining reactive and deliberative behaviors for autonomous vehicles.
- The UGV program will complete development and demonstrate technologies that address capability gaps in robotic communications and control, mobility, survivability, durability, modularity, and signature reduction in support of the Marine Corps Gladiator TUGV program.
- ETALS will complete the full mechanical, electrical, and software interfaces between MAGU-1 and the TLDHS Lightweight Laser Designator/Rangefinder (LLDR) and will be documented so as to be suitable for full production. The MAGU-1 gyroscope replacement will leverage the AN/GVS-5 operational testing to verify that the MAGU-1 is operationally suitable for the planned replacement for the AN/GVS-5. Complete test reports and demonstrations will be conducted as part of the operational testing. Full Operational Capability will occur when base system fielding and personnel training is complete.
- The Autonomous Mobile Platform program develops and refines technologies to enable creation of small sensor platforms capable of extended endurance and relocation after initial deployment. Develop propulsion/energy storage/replenishment, and navigation/guidance systems. Begin locomotion experiments.
- The Advanced Gun Barrel Technology effort develops technologies in refractory materials, coating/liner application processes, metal matrix composites, and integrates them into two advanced barrel concepts for use on the DD(X) ship. A subscale gun barrel will be fabricated and tested to demonstrate the capabilities for enhanced barrel life using advanced interior coatings operating at high temperatures and pressures, and will be used to validate models and determine life cycle design constraints. Additionally, composite barrel designs

will be completed showing the fabrication techniques required for industry to produce composite large caliber gun barrels, and validation testing of these models will be conducted on various structural subcomponents.

FY 2005 PLANS:

- Continue development of AO UUV-deployed ISR EM/EO sensors; software to detect, evaluate and avoid obstacles and threats using various sensor inputs; sensor data fusion for situational awareness; and integrated autonomous UUV control approaches for Maritime Reconnaissance, Undersea Search and Survey, and Communication and Navigation Aid mission capabilities. Continue multi-vehicle undersea search and survey and communication link development.
- The AO UAV propulsion and power technology plans to leverage and refine naval UAV propulsion technologies. Leverage the commercial advanced core (high-pressure spool technologies) engine efforts being developed for the next generation business/regional jet engines Ground test UAV demonstrator engine. Demonstrate low pressure spool electrical generator. Ground test a Mach 3.5 capable expendable turbine engine for missile applications and achieve IHPTET phase III Thrust/Air Flow and cost goals.
- The AO Intelligent Autonomy task will continue development of system and associated sensor processing for unmanned vehicles to enable adaptation and independent actions. Continue development of architecture for combining reactive and deliberative behaviors for autonomous vehicles.
- Autonomous Mobile Platform effort will integrate energy replenishment and storage with a refined mobile platform and demonstrate replenishment and relocation operation.
- The Advanced Gun Barrel Technology program develops technologies in refractory materials, coating/liner application processes, metal matrix composites, and integrates them into two advanced barrel concepts for use on the DD(X) ship. Preparations for full scale fabrication of a prototype 155mm gun barrel with advanced interior coatings will begin in the manufacturing process. A series of production tests and checks will be performed in preparation in using the resulting test barrel in life fire testing. Additionally, preparations for more advanced functionally graded material designs will be completed and prepared for manufacture, including the fabrication of a composite barrel test section to validate design models and tools. Preparations for a full scale advanced composite gun barrel with advanced coatings will be determined prior to the end of the fiscal year.

Congressional Plus-Ups:

	FY 02	FY 03
Combustion Light Gas Gun	3,363	N/A

Combustion Light Gas Gun: Developed options for cryogenic storage and handling, gas fuzing and electronic ignition of the propellant gas used in the gun. In addition Computational Fluid Dynamic (CFD) modeling and systems analysis was performed to identify scaling parameters for future gun systems.

	FY 02	FY 03
Fast Pattern Processor, SLAM-ER	1,921	N/A

Fast Pattern Processor, SLAM-ER: This effort developed a dedicated Application Specific Integrated Circuit (ASIC) implementation of algorithms that perform correlation based Automatic Target Recognition (ATR). These pattern recognition algorithms will perform rapid comparison of stored and real time images, using gradient and frequency transformations, to emphasize features of military targets that can be correlated.

	FY 02	FY 03
Hybrid Fiber Optic/Wireless System for Secure Communications	1,348	977

Hybrid Fiber Optic/Wireless System: Developed a millimeter wave, optical transmitter that will generate the optical and millimeter carriers within a mode-locked microchip laser. The laser will operate an eye safe optical wavelength of 1.55mm with a millimeter modulation of 60 GHz for covert communications.

	FY 02	FY 03
Interrogator for High Speed Retro Reflectometer and Hyperspectral SAR	4,046	1,663

Hyperspectral SAR: Develops a retro-reflector modulator for laser data link that can support megabit per second data rates for hyperspectral electro-optical and infrared sensors and synthetic aperture radar data.

Furthermore adapt this technology to small (4') unmanned aerial vehicles to allow exchange of space-time information for geolocation and time sensitive targeting.

	FY 02	FY 03
Integrated Biological & Chemical Warfare Defense Technology Platform/ Phase II	2,401	3,914

Integrated Biological & Chemical Warfare Defense Technology Platform: This effort supports development of a small, low powered chemical sensor and expands the Research and Development to include a biological detection capability. Semi-conducting Metal Oxides (SMO's) will be used for chemical detection and it is anticipated that molecular beacons will be developed for biological weapon detection.

	FY 02	FY 03
Real World Based Immersive Imaging	1,200	1,956

Real World based Immersive imaging: Developed a low power optimized single instruction multiple data (SIMD) system processor for enhanced real-time hyperspectral image processing on-board a small (4') unmanned aerial vehicle. The processor will also support hyperspectral data compression/de-compression and encryption/decryption.

	FY 02	FY 03
Naval Precision Strike (SAR for All Weather Targeting)	2,882	6,846

Naval Precision Strike (SAR for All Weather Targeting): This effort will develop a time critical targeting system using Global Positioning System (GPS) information to provide an all weather precision target location and weapon guidance capability that will significantly increase the accuracy of precision weapons. Developed a prototype relative GPS system for guided weapons and integrated the Stereo Synthetic Aperture Radar (SAR) targeting package into the Lynx targeting system.

	FY 02	FY 03
Accelerate Development of Low Cost SWARM UAV	N/A	2,444

Accelerate the development of low cost SWARM UAV: This effort will accelerate the development of Smart Warfighting Array Reconfigurable EO/IR RF modules (SWARM) for long endurance Small Unmanned Aerial Vehicles (UAV).

	FY 02	FY 03
High Efficiency Piezoelectric Crystals	N/A	1,711

High Efficiency Piezoelectric Crystals: Development of piezoelectric devices based on new growth techniques to dither infrared focal plane arrays for extremely high resolution.

	FY 02	FY 03
Millimeter Wave Infrared Imaging	N/A	1,663

Millimeter Wave Infrared Imaging: Work will be performed 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 02	FY 03
Panoramic Night Imaging System	N/A	3,326

Panoramic Night Imaging Systems: This effort will develop large area infrared focal plane arrays and associated signal processing, including imaging systems and sensor evaluation.

	FY 02	FY 03
Tunable Oxide Film and Capacitor Tech & Integration of Oxide Film and Wide Bandgap Semiconductor Tech for the Adv Multi function RF system	N/A	1,663

Tunable Oxide Film and Capacitor Tech & Integration of Oxide Film and Wide Bandgap Semiconductor Tech for the Adv Multi function RF system: Develops the feasibility of integrating electro-optic films into semiconductor microwave device structures.

	FY 02	FY 03
Ultra Short Pulse Laser Micromachining	N/A	1,247

Ultra Short Pulse Laser Micromachining: This effort will develop near-term, ultra short laser micromachining for electronics and fuel injectors.

	FY 02	FY 03
Low Cost Fused Remote Sensors	N/A	977

Low Cost Fused Remote Sensors: Develop the feasibility of using fused low cost remote sensing technology sensors such as hyperspectral imaging sensors, Synthetic Aperture Radar (SAR) and Lidar Sensors for the identification of targets for Navy power projection missions.

	FY 02	FY 03
Miniaturized High Definition Digital Camera	N/A	977

Miniaturized High Definition Digital Camera: Develop flight worthy, high definition, color video surveillance camera for a small (4 ft) unmanned aerial vehicle.

	FY 02	FY 03
Pulse Detonation Engine Risk Reduction	N/A	1,027

Pulse Detonation Engine (PDE) Risk Reduction: Design, fabricate and test a compound flow nozzle system for a 5 combustor test vehicle. Conduct structural and thermal analysis of alternative engine configurations.

	FY 02	FY 03
Printed Wiring Board Manufacturing	0	*

(*$3,325 appropriated in PE 0602234N)

The printed wiring board (PWB) effort will focus on computer aided design/computer aided manufacturing using three process technologies (a) laser ablation and metallization, (b) high velocity particle consolidation of metal powers, and (c) acoustic microscopy for PWB that will revolutionize PWB manufacturing and reverse engineering for Navy systems.

	FY 02	FY 03
Real Time Infra-Red Scene Generator	0	*

(*$977 appropriated in PE 0603712N)

Development of a real-time infrared scene simulator integrated circuit for infrared sensors and missile seekers performance testing and built in test.

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 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