DEPARTMENT OF THE NAVY
FISCAL YEAR (FY) 2009
BUDGET ESTIMATES

JUSTIFICATION OF ESTIMATES
FEBRUARY 2008

RESEARCH, DEVELOPMENT, TEST & EVALUATION, NAVY
BUDGET ACTIVITIES 1-3

Research, Development, Test and Evaluation, Navy

For expenses necessary for basic and applied scientific research, development, test and evaluation, including maintenance, rehabilitation, lease, and operation of facilities and equipment, $19,337,238,000, to remain available for obligation until September 30, 2010: *Provided,* That funds appropriated in this paragraph which are available for the V-22 may be used to meet unique operational requirements of the Special Operations Forces: *Provided further,* That funds appropriated in this paragraph shall be available for the Cobra Judy program.

"In accordance with the President's Management Agenda, Budget and Performance Integration initiative, this program has been assessed using the Program Assessment Rating Tool (PART). Remarks regarding program performance and plans for performance improvement can be located at the Expectmore.gov website."

DEPARTMENT OF DEFENSE

FY 2009 RDT&E PROGRAM

SUMMARY
($ IN THOUSANDS)

22 JAN 2008

APPROPRIATION	FY 2007	FY 2008	FY 2009
Research, Development, Test & Eval, Navy	19,724,109	17,799,176	19,337,238
Total Research, Development, Test & Evaluation	19,724,109	17,799,176	19,337,238

DEPARTMENT OF DEFENSE

FY 2009 RDT&E PROGRAM

SUMMARY
($ IN THOUSANDS)

22 JAN 2008

Summary Recap of Budget Activities	FY 2007	FY 2008	FY 2009
Basic Research	482,290	497,677	528,276
Applied Research	772,812	801,020	633,338
Advanced Technology Development	751,242	722,352	678,683
Advanced Component Development & Prototypes	3,636,508	3,050,591	3,440,400
System Development & Demonstration	8,774,390	7,977,139	8,682,052
RDT&E Management Support	1,182,081	1,075,823	954,672
Operational Systems Development	4,124,786	3,674,574	4,419,817
Total Research, Development, Test & Evaluation	19,724,109	17,799,176	19,337,238

Summary Recap of FYDP Programs			
Strategic Forces	204,012	140,042	169,130
General Purpose Forces	1,089,434	871,741	995,326
Intelligence and Communications	1,448,501	1,418,383	1,707,653
Research and Development	16,886,721	15,272,228	16,380,293
Central Supply and Maintenance	86,578	91,812	79,688
Training Medical and Other	5,049	4,970	5,148
Administration and Associated Activities	3,814		
Total Research, Development, Test & Evaluation	19,724,109	17,799,176	19,337,238

DEPARTMENT OF THE NAVY

FY 2009 RDT&E PROGRAM

SUMMARY
($ IN THOUSANDS)

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Total Research, Development, Test & Eval, Navy	19,724,109	17,799,176	19,337,238

DEPARTMENT OF THE NAVY
FY 2009 RDT&E PROGRAM EXHIBIT R-1

APPROPRIATION: 1319N Research, Development, Test & Eval, Navy Date: 22 JAN 2008

Line No	Program Element Number	Item	Act	Thousands of Dollars FY 2007	FY 2008	FY 2009	SEC
1	0601103N	University Research Initiatives	01	87,134	98,057	103,707	U
2	0601152N	In-House Laboratory Independent Research	01	15,575	16,403	17,298	U
3	0601153N	Defense Research Sciences	01	379,581	383,217	407,271	U
	Basic Research			482,290	497,677	528,276	
4	0602114N	Power Projection Applied Research	02	112,088	106,667	79,913	U
5	0602123N	Force Protection Applied Research	02	154,217	194,477	131,310	U
6	0602131M	Marine Corps Landing Force Technology	02	40,822	31,813	36,480	U
7	0602234N	Materials, Electronics and Computer Technology	02	971	1,987		U
8	0602235N	Common Picture Applied Research	02	86,852	103,751	77,054	U
9	0602236N	Warfighter Sustainment Applied Research	02	114,975	107,564	93,862	U
10	0602271N	RF Systems Applied Research	02	52,059	52,529	54,830	U
11	0602435N	Ocean Warfighting Environment Applied Research	02	56,462	53,967	47,278	U
12	0602651M	Joint Non-Lethal Weapons Applied Research	02	5,875	5,997	6,084	U
13	0602747N	Undersea Warfare Applied Research	02	92,456	71,764	58,658	U
14	0602782N	Mine and Expeditionary Warfare Applied Research	02	56,035	70,504	47,869	U
	Applied Research			772,812	801,020	633,338	
15	0603114N	Power Projection Advanced Technology	03	111,176	85,977	60,360	U
16	0603123N	Force Protection Advanced Technology	03	142,925	119,562	55,099	U
17	0603235N	Common Picture Advanced Technology	03	63,076	92,401	104,578	U

DEPARTMENT OF THE NAVY
FY 2009 RDT&E PROGRAM

EXHIBIT R-1

APPROPRIATION: 1319N Research, Development, Test & Eval, Navy

Date: 22 JAN 2008

Line No	Program Element Number	Item	Act	Thousands of Dollars FY 2007	FY 2008	FY 2009	SEC
18	0603236N	Warfighter Sustainment Advanced Technology	03	92,732	101,007	112,520	U
19	0603271N	RF Systems Advanced Technology	03	94,653	41,204	37,058	U
20	0603640M	USMC Advanced Technology Demonstration (ATD)	03	82,521	77,760	100,787	U
21	0603651M	Joint Non-Lethal Weapons Technology Development	03	1,400	10,736	11,020	U
22	0603729N	Warfighter Protection Advanced Technology	03	55,533	49,418	12,129	U
23	0603747N	Undersea Warfare Advanced Technology	03	34,239	75,422	81,490	U
24	0603758N	Navy Warfighting Experiments and Demonstrations	03	49,191	40,612	70,216	U
25	0603782N	Mine and Expeditionary Warfare Advanced Technology	03	23,796	28,253	33,426	U
		Advanced Technology Development		751,242	722,352	678,683	

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

BUDGET ACTIVITY: 01
PROGRAM ELEMENT: 0601103N
PROGRAM ELEMENT TITLE: UNIVERSITY RESEARCH INITIATIVES

COST: (Dollars in Thousands)

Project Number & Title	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
UNIVERSITY RESEARCH INITIATIVES	87,134	98,057	103,707	97,580	97,425	107,365	117,279

A. MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: This program includes support for multidisciplinary basic research in a wide range of scientific and engineering disciplines that enable the U.S. Navy to maintain technological superiority, and for university research infrastructure to acquire research instrumentation needed to maintain and improve the quality of university research important to the Navy. Multidisciplinary University Research Initiative (MURI) efforts involve teams of researchers investigating high priority topics and opportunities that intersect more than one traditional technical discipline. For many military problems this multidisciplinary approach serves to stimulate innovations, accelerate research progress and expedite transition of results into Naval applications. The Defense University Research Instrumentation Program (DURIP) supports university research infrastructure essential to high quality Navy relevant research. The instrumentation program complements other Navy research programs by supporting the purchase of high cost research instrumentation that is necessary to carry out cutting-edge research. The program supports Presidential Early Career Awards for Scientists and Engineers (PECASE), single investigator research efforts performed by outstanding academic scientists and engineers early in their research careers. This program provides the knowledge base, scientific concepts, and technological advances for the maintenance of Naval power and national security.

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

BUDGET ACTIVITY: 01
PROGRAM ELEMENT: 0601103N
PROGRAM ELEMENT TITLE: UNIVERSITY RESEARCH INITIATIVES

B. PROGRAM CHANGE SUMMARY:

	FY 2007	FY 2008	FY 2009
FY 2008/FY 2009 President's Budget Submission	91,724	76,637	73,037
Congressional Action	0	23,200	0
Congressional Undistributed Reductions/Rescissions	0	-635	0
Execution Adjustments	-1,219	0	0
Program Adjustments	-1,092	0	30,671
Rate Adjustments	0	0	-1
SBIR Assessment	-2,279	-1,145	0
FY 2009 President's Budget Submission	87,134	98,057	103,707

PROGRAM CHANGE SUMMARY EXPLANATION:
Technical: Not applicable.

Schedule: Not applicable.

C. OTHER PROGRAM FUNDING SUMMARY:
Not applicable.

D. ACQUISITION STRATEGY:
Not applicable.

E. PERFORMANCE METRICS:
This University Research Initiative seeks to improve the quality of defense research conducted by universities and supports the education of engineers and scientists in disciplines critical to national defense needs. The initiative is a collection of specialized research programs performed by academic research institutions. Individual project metrics are tailored to the needs of specific applied research and advanced development programs. Example metrics include extending the life of Thermal Barrier Coatings for transition to Total Ownership Cost Future Naval Capability program. It is projected that the life time of Thermal Barrier Coating on Turbine Blades can be doubled. The National Research Council of the National Academies of Science and

BUDGET ACTIVITY: 01
PROGRAM ELEMENT: 0601103N
PROGRAM ELEMENT TITLE: UNIVERSITY RESEARCH INITIATIVES

Engineering's Congressionally directed "Assessment of Department of Defense Basic Research" concluded that the DoD is managing its basic research program effectively.

BUDGET ACTIVITY: 01
PROGRAM ELEMENT: 0601103N PROGRAM ELEMENT TITLE: UNIVERSITY RESEARCH INITIATIVES
PROJECT TITLE: UNIVERSITY RESEARCH INITIATIVES

COST: (Dollars in Thousands)

Project Number & Title	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
UNIVERSITY RESEARCH INITIATIVES	87,134	98,057	103,707	97,580	97,425	107,365	117,279

A. MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: This project includes support for multidisciplinary basic research in a wide range of scientific and engineering disciplines that are important for maintaining the technological superiority of the U.S. Navy and for university research infrastructure to acquire instrumentation needed to maintain and improve the quality of university research important to the Navy. MURI efforts involve teams of researchers investigating high priority topics that intersect more than one traditional technical discipline. For many military problems this multidisciplinary approach serves to stimulate innovations, accelerate research progress and expedite transition of results into Naval applications. The DURIP project supports university research infrastructure essential to high quality Navy relevant research. The instrumentation project complements other Navy research programs by supporting the purchase of high cost research instrumentation that is necessary to carry out cutting-edge research. The PECASE project supports single investigator research efforts performed by outstanding academic scientists and engineers early in their research careers. This project provides the knowledge base, scientific concepts, and technological advances for the maintenance of Naval power and national security.

B. ACCOMPLISHMENTS/PLANNED PROGRAM:

	FY 2007	FY 2008	FY 2009
MULTIDISCIPLINARY UNIVERSITY RESEARCH INITIATIVE (MURI)	48,817	55,965	67,500

Research efforts include high priority topics that intersect more than one traditional discipline. MURI topics are selected to address Naval S&T Focus Areas as described in the Naval S&T Strategic Plan.

The MURI program is an OSD interest item and OSD directs that funding for the MURI efforts be awarded after OSD announces the awardees, which typically takes place towards the second half of the fiscal year. Since the MURI program funds academic researchers, execution of the efforts typically ramps up during the summer

BUDGET ACTIVITY: 01
PROGRAM ELEMENT: 0601103N PROGRAM ELEMENT TITLE: UNIVERSITY RESEARCH INITIATIVES
PROJECT TITLE: UNIVERSITY RESEARCH INITIATIVES

academic break months.

Fluctuations in the program value between fiscal years reflect the maturation of existing awards. MURIs are a 3-year grant award, with a 2-year executable option. The start of a large number of MURI awards in the second half of FY 2007 created a large tail in FY 2008 where full year funding is required to execute the FY 2007 starts. This results in a significant increase from FY 2007 to FY 2008. The increase between FY 2008 and FY 2009 results from the continued need to fund the FY 2007 projects and an increase in FY 2009 due to expansions of efforts.

FY 2007 Accomplishments:

- Conducted competition for $7,282K of new MURI awards to address selected high priority Naval science and technology areas, transformational initiatives, and grand challenges, including strategically important DoD research areas. Eleven topics were identified for publication via Broad Agency Announcement (BAA) to solicit proposals. These topics addressed human-unmanned systems interactions, trust management, light cellular structures for force protection, underwater acoustic communications, radiation belt dynamics and energetics, thermal management, processing and production science, exploiting nonlinear dynamics, disparate sensor networks, reactive material dynamic response, and exploiting the documented plasticity of the adult brain. Remaining balance was spent to continue MURI projects begun in prior years.

FY 2008 Plans:

- Conduct competition for $5,250K of new MURI awards to address selected high priority Naval science and technology areas, transformational initiatives, and grand challenges, including strategically important DoD research areas. About seven high priority research topics will be identified for publication in a BAA to solicit proposals. Remaining balance will be spent to continue MURI projects begun in prior years.

FY 2009 Plans:

- Conduct competition for new MURI awards to address selected high priority Naval science and technology areas, transformational initiatives, and grand challenges, including strategically important DoD research areas. About six high priority research topics will be identified for publication in a BAA to solicit proposals. Remaining balance will be spent to continue MURI projects begun in prior years.

BUDGET ACTIVITY: 01
PROGRAM ELEMENT: 0601103N PROGRAM ELEMENT TITLE: UNIVERSITY RESEARCH INITIATIVES
PROJECT TITLE: UNIVERSITY RESEARCH INITIATIVES

	FY 2007	FY 2008	FY 2009
DEFENSE UNIVERSITY RESEARCH INSTRUMENTATION PROGRAM	18,911	17,630	33,407

DURIP funds are provided to universities to purchase relatively high cost research instrumentation that is normally not included in single-investigator type research grants. Individual grants range from $50K to $1M.

The DURIP program is an OSD interest item and OSD directs that funding for the DURIP efforts be awarded after OSD announces the awardees, which typically takes place towards the second half of the fiscal year. In turn, universities need to purchase the instrumentation and take delivery before any billings are generated. It frequently takes several months for delivery and billing to be completed.

The number of awards from FY 2008 to FY 2009 is due to the number of awards increasing from 74 to approximately 134.

FY 2007 Accomplishments:

- Conducted competition for 67 research instrumentation awards to universities.

FY 2008 Plans:

- Conduct competition for approximately 74 research instrumentation awards to universities.

FY 2009 Plans:

- Conduct competition for research instrumentation awards to universities.

	FY 2007	FY 2008	FY 2009
PRESIDENTIAL EARLY CAREER AWARDS	727	1,410	2,800

PECASE awards are made to academic scientists early in their research career for extremely prestigious single-investigator research in areas of vital importance to DON. Awards provide national recognition and research grants of $200K per year for five years.

BUDGET ACTIVITY: 01
PROGRAM ELEMENT: 0601103N PROGRAM ELEMENT TITLE: UNIVERSITY RESEARCH INITIATIVES
PROJECT TITLE: UNIVERSITY RESEARCH INITIATIVES

The increase in funding between FY 2007 and FY 2008 reflects initial ramp up of these five year awards from $100K per year to $200K per year. The increase in funding between FY 2008 and FY 2009 reflects the initial increase from two award selections in FY 2008 to nine award selections in FY 2009.

FY 2007 Accomplishments:

- Selected two outstanding university researchers to receive the five-year PECASE research award to conduct research of importance to the Navy. Continued PECASE programs begun in earlier years.

FY 2008 Plans:

- Select two outstanding university researchers to receive the five-year PECASE research award to conduct research of importance to the Navy. Continue PECASE programs begun in earlier years.

FY 2009 Plans:

- Select nine outstanding university researchers to receive the five-year PECASE research award to conduct research of importance to the Navy. Continue PECASE programs begun in earlier years.

CONGRESSIONAL PLUS-UPS:

	FY 2007	FY 2008
BLAST AND IMPACT RESISTANT COMPOSITES STRUCTURES FOR NAVY SHIPS	996	1,589

FY 2007 Accomplishments: This effort supported development of an improved understanding of the response of composite materials and structures to blast, shock and fire effects, and provided guidance for the design of affordable Navy ship structures with greater survivability characteristics and enhanced performance.

FY 2008 Plans: This effort will continue to investigate response of composite materials and structures to blast.

BUDGET ACTIVITY: 01
PROGRAM ELEMENT: 0601103N PROGRAM ELEMENT TITLE: UNIVERSITY RESEARCH INITIATIVES
PROJECT TITLE: UNIVERSITY RESEARCH INITIATIVES

	FY 2007	FY 2008
CELL-BASED SENSORS FOR CHEMICAL THREATS	0	1,192

This work supports cell-based sensors for chemical threats.

	FY 2007	FY 2008
CENTER FOR HETERO-FUNCTIONAL MATERIALS	0	1,987

Equipment and facilities will be acquired and commissioned, faculty and students will be hired, and work commenced to grow, characterize and subsequently apply thin film functional oxide and oxide/nitride heterostructures to device applications for improved Navy electronics platforms.

	FY 2007	FY 2008
CENTER FOR NANOSCIENCE AND NANOMATERIALS (CNN)	996	1,193

FY 2007 Accomplishments: The CNN center has developed a process by which they are growing one of the largest Carbon Nanotubes (CNTs) in the world. The center has also developed new gold/alumina nanocatalists that show remarkable activity, even at room temperature.

FY 2008 Plans: The CNN will continue to investigate, optimize and characterize the growth of the CNTs. It will also explore other nanocatalyst formulations for enhanced catalytic activity.

	FY 2007	FY 2008
CENTER FOR SOUTHEASTERN TROPICAL ADVANCED REMOTE SENSING (CSTARS)	3,984	1,987

FY 2007 Accomplishments: CSTARS worked with Office of Naval Research (ONR) and Unites States Southern Command (USSOUTHCOM) to evaluate methods for detecting and tracking ships with satellite synthetic aperture radar. They also provided data for ONR oceanographic experiments in the western Pacific Ocean.

FY 2008 Plans: CSTARS will expand its capability to receive and process radar, optical, and infrared sensors from commercial and governmental satellites. They will support ONR, USSOUTHCOM, and National Geospatial-Intelligence Agency (NGA) in efforts to classify ships at sea.

BUDGET ACTIVITY: 01
PROGRAM ELEMENT: 0601103N PROGRAM ELEMENT TITLE: UNIVERSITY RESEARCH INITIATIVES
PROJECT TITLE: UNIVERSITY RESEARCH INITIATIVES

	FY 2007	FY 2008
DEFENSE COMMERCIALIZATION RESEARCH INITIATIVE TECHNOLOGY, RESEARCH, EDUCATION AND COMMERCIALIZATION CENTER (TRECC)	3,288	0

This effort supported basic research support in microelectronics and display technologies, and visualization and analysis of large-scale sensor and model-base data through collaborations with the National Science Foundation and the Office of Naval Research. Videoconferencing and portal technologies were developed with a successful "Professors to Schools" effort to provide an expanding menu of cutting-edge interactive, inter-organizational opportunities to Illinois students. This effort also supported broad technology education and research support missions including the TRECC Accelerator program and the TRECC facility in DuPage County to provide technology transfer services.

	FY 2007	FY 2008
LOW ACOUSTIC AND THERMAL SIGNATURE BATTLEFIELD POWER SOURCE	0	1,987

Investigate development of a low acoustic and low thermal signature power source for potential battlefield use.

	FY 2007	FY 2008
MULTIFUNCTIONAL MATERIALS FOR NAVAL STRUCTURES	996	0

Marine composite materials and composite sandwich structures were modified to incorporate multifunctional capabilities, through the introduction of nanoparticles, and through use of alternate core materials. Affordable, fly-ash based, fire-resistant eco-core material was modified and used in composite sandwich structures to enhance fire resistance and energy absorption capacity under dynamic loading.

	FY 2007	FY 2008
NATIONAL SECURITY TRAINING	1,096	1,987

FY 2007 Accomplishments: This effort enhanced the pool of talented applicants for Defense Department national security positions by providing students with the credentials for these careers through their participation in

BUDGET ACTIVITY: 01
PROGRAM ELEMENT: 0601103N PROGRAM ELEMENT TITLE: UNIVERSITY RESEARCH INITIATIVES
PROJECT TITLE: UNIVERSITY RESEARCH INITIATIVES

the Serrano Scholars Program at Hostos Community College of the City University of New York and the Schools of General Studies and International and Public Affairs at Columbia University.

FY 2008 Plans: This work will continue to support enhancement of pool of applicants for Defense Department national security positions.

	FY 2007	FY 2008
NEUROTECHNOLOGY CENTER	1,644	0

This effort addressed fundamental issues affecting the creation of safer, more effective human-machine interfaces by elucidating the neural computational processes that lead to movement and by developing interfaces that take advantage of this knowledge.

	FY 2007	FY 2008
RESEARCH INFRASTRUCTURE FOR THE APPLIED PHYSICS LABORATORY	3,288	3,180

FY 2007 Accomplishments: This effort supported research and other engineering related work leading to the design and development of acoustic, photonic, electro-optic and other related systems for intelligence collection, for self-noise integrity, and for ship/submarine systems monitoring; and acoustic, photonic, electro-optic and related systems for reconnaissance and for fleet needs, including medical acoustic and electro-optic systems at the Applied Physics Laboratory at the University of Washington.

FY 2008 Plans: These appropriated funds will assist the Navy, DoD and APL with additional necessary research infrastructure upgrades at APL in the area of photonics and electro-optics.

	FY 2007	FY 2008
SMART, REMOTE SENSING SYSTEMS USING NANOTECHNOLOGY	2,391	0

This effort promoted the understanding of the surface mechanisms of charge transfer in photo induced charge movement sensors, surface nanocrystal structure in thin film gas sensors and surface enhanced raman scattering-based sensors to further the understanding of sensor capabilities in the detection of explosives and their components.

BUDGET ACTIVITY: 01
PROGRAM ELEMENT: 0601103N PROGRAM ELEMENT TITLE: UNIVERSITY RESEARCH INITIATIVES
PROJECT TITLE: UNIVERSITY RESEARCH INITIATIVES

	FY 2007	FY 2008
UNIVERSITY RESEARCH INITIATIVES	0	7,950

This effort supports university research initiatives.

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

OTHER PROGRAM FUNDING SUMMARY - NON-NAVY RELATED RDT&E:
PE 0601103A University Research Initiatives
PE 0601103F University Research Initiatives

D. ACQUISITION STRATEGY:
Not applicable.

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

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

COST: (Dollars in Thousands)

Project Number & Title	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
IN-HOUSE LABORATORY INDEPENDENT RESEARCH (ILIR)	15,575	16,403	17,298	18,285	18,261	18,762	18,863

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

The vision of the DON S&T strategy is "to inspire and guide innovation that will provide technology-based options for future Navy and Marine Corps Capabilities", where "Innovation is a process that couples Discovery and Invention with Exploitation and Delivery". DON Basic Research, which includes scientific study and experimentation, directed toward increasing knowledge and understanding in national-security related aspects of physical, engineering, environmental, and life sciences is the core of Discovery and Invention. Basic research projects are developed, managed, and related to more advanced aspects of research in some hundred-plus technology and capability-related 'thrusts', which are consolidated in thirteen research focus areas: Power and Energy; Operational Environments; Maritime Domain Awareness; Asmmetric and Irregular Warfare; Information, Analysis and Communication; Power Projection; Assure Access and Hold at Risk; Distributed Operations; Naval Warfighter Performance and Protection; Survivability and Self-Defense; Platform Mobility; Fleet/Force Sustainment; Affordability, maintainability and Reliability.

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

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

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

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

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

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

B. PROGRAM CHANGE SUMMARY:

	FY 2007	FY 2008	FY 2009
FY 2008/FY 2009 President's Budget Submission	15,856	16,556	17,221
Congressional Undistributed Reductions/Rescissions	0	-105	0
Program Adjustments	-238	0	0
Rate Adjustments	0	0	77
SBIR Assessment	-43	-48	0
FY 2009 President's Budget Submission	15,575	16,403	17,298

PROGRAM CHANGE SUMMARY EXPLANATION:
Technical: Not applicable.

Schedule: Not applicable.

C. OTHER PROGRAM FUNDING SUMMARY:
Not applicable.

D. ACQUISITION STRATEGY:
Not applicable.

E. PERFORMANCE METRICS:
The ILIR initiative seeks to improve the quality of defense research conducted predominantly through the Naval Warfare Centers/Laboratories. It also supports the development of technical intellect and education of engineers and scientists in disciplines critical to national defense needs through the development of new knowledge in a military laboratory environment. Initial research focus is often conducted in an unfettered environment since it is basic research, but many projects focus on applying recently developed theoretical knowledge to real world military problems with the intention of developing new capabilities and improving the performance of existing systems. Individual project metrics then become more tailored to the needs of specific applied research and advanced development programs. The National Research Council of the National Academies of Science and Engineering’s Congressionally directed "Assessment of Department of Defense Basic

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

Research" concluded that the DoD is managing its basic research program effectively.

FY 2009 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2008
Exhibit R-2a

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

COST: (Dollars in Thousands)

Project Number & Title	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
IN-HOUSE LABORATORY INDEPENDENT RESEARCH (ILIR)	15,575	16,403	17,298	18,285	18,261	18,762	18,863

A. MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: This project sustains U.S. Naval S&T superiority, provides new technological concepts for the maintenance of naval power and national security, and mitigates scientific surprises, while exploiting scientific breakthroughs and providing options for new Future Naval Capabilities. It responds to S&T directions of the Naval S&T Strategic Plan for long term Navy and Marine Corps improvements. It is in consonance with future warfighting concepts and doctrine developed at the Naval Warfare Development Command (NWDC) and the Marine Corps Combat Development Command (MCCDC), and enables technologies to significantly improve the Joint Chiefs of Staff's Future Joint Warfighting Capabilities. It is managed by the ONR Director of Research and executed by the COs and TDs of the Naval Warfare Centers, Bureau of Medicine and Surgery laboratories.

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

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

B. ACCOMPLISHMENTS/PLANNED PROGRAM:

	FY 2007	FY 2008	FY 2009
OCEAN/SPACE SCIENCES	3,974	4,289	4,658

FY 2007 Accomplishments:

• Continued research into Beaked Whale bioacoustic and spatial/temporal habitat characterization in the Tongue of the Ocean, Bahamas.
• Continued research into in the field of Nonparametric Tolerance Intervals to construct a distribution-free method to generalize the performance of decision trees and neural networks. This work allows for effective adaptive classification in uncertain environments.
• Continued research into 3D elastic wave propagation in layered prolate spheroids with losses using the vector wave equation in prolate spheroidal coordinates for sonar array applications.
• Continued Naval Research Enterprise Intern Program (NREIP) to support undergraduate and graduate students performing Navy-related research at Naval R&D Centers under the supervision and mentorship of DON scientists, thus exposing them to interesting and challenging work done at these centers.
• Continued investigation into and application of level sets to the problem of acoustic propagation in shallow water regimes, providing a robust theoretical and numerical foundation for accurate range-dependent acoustic modeling at a feasible computational cost. This will provide greater flexibility for simulating propagation in littoral environments, and improved accuracy.
• Continued research to determine whether chaos based communication can be applied to typical range tracking scenarios. Challenges that have not been previously explored include the differences in littoral environments and the higher range of Doppler encountered when tracking underwater vehicles like torpedoes and submarines.
• Continued research to develop methods to automatically segment and characterize data using Bayesian networks. Resulting algorithms will be verified with data collected from a new Airborne-Laser Swath Mapping (ALSM) system for Unmanned Aerial Vehicles (UAVs) called photon-counting ALSM.

FY 2008 Plans:

ILIR projects are intended to be roughly three years long. Typically 30% of ILIR projects turn over each year. Projects selected for FY 2008 will focus on supporting the Naval S&T Strategic Plan in naval focus areas such as: Operational Environments; Martime Domain Awareness; Asymmetric and Irregular Warfare; Assure

BUDGET ACTIVITY: 01
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Access and Hold at Risk; Survivability and Self-Defense; Platform Mobility; Affordability, Maintainability and Reliability. Projects selected for FY 2008 will also support National Naval Responsibility (NNR) initiatives in Ocean Acoustics and Undersea Weaponry.

FY 2009 Plans:

ILIR projects are intended to be roughly three years long. Typically 30% of ILIR projects turn over each year. Projects selected for FY 2009 will focus on supporting Naval S&T Strategic Plan in naval focus areas such as: Operational Environments; Martime Domain Awareness; Asymmetric and Irregular Warfare; Assure Access and Hold at Risk; Survivability and Self-Defense; Platform Mobility; Affordability, Maintainability and Reliability. Projects selected for FY 2009 will also support NNR initiatives in Ocean Acoustics and Undersea Weaponry.

	FY 2007	FY 2008	FY 2009
ADVANCED MATERIALS	2,953	3,117	3,343

FY 2007 Accomplishments:

• Continued exploration of high performance nanocomposite barrier coatings for next generation acoustic sensors.
• Continued studies applying synthetic chemistry techniques to ferromagnetic materials to control their properties and then elucidate the roles they play in microwave absorption.
• Continued research into applying refined scattering measurement techniques to a range of suitable sample media in order to investigate the sensitivity and range of applicability (e.g., from the single scattering limit to multiple scattering and beyond).
• Continued development of a fracture criterion for piezocrystals (piezoelectric single crystals). The traditional stress intensity factor and energy release rate are not suitable as a fracture criteria for piezoelectric materials. The energy density theory shows qualitative promise for piezoelectric materials, but recent work indicates possible shortcomings in the existing the theory.
• Continued research to seek a substrate to maximize the Surface enhanced Raman Spectroscopy (SERS) effect. The SERS effect has been shown to be dependant on nanostructure size and distance between neighbors. SERS has been studied using roughened surfaces, nanocolloids, deposited films, electrode tips, metal islands, and a few other variations. This research seeks to deposit self-assembled monolayers (SAMs) of conducting organic

molecules on a gold surface and then attach gold nanoparticles to the SAMs. The distance between the nanoparticles will be optimized to create more SERS "hot spots" by varying the concentration and lengths of the molecules used for the SAMs.
• Continued research to identify a method of protecting underwater structures from bio-fouling without using toxins. Recent advances in conductive polymers (which can also be piezoelectric), plastic film technology, nano-release mechanisms and non-chromate metal finishing indicate that technology is now mature enough to mimic natural non-toxic antifouling methods on artificial structures with the added benefit of electric fields and piezoelectric movement.

FY 2008 Plans:

ILIR projects are intended to be roughly three years long. Typically 30% of ILIR projects turn over each year. Projects selected for FY 2008 will focus on supporting the Naval S&T Strategic Plan in: Power and Energy; Operational Environments; Assure Access and Hold at Risk; Naval Warfighter Performance and Protection; Survivability and Self-Defense; Platform Mobility; Fleet/Force Sustainment; and Affordability, Maintainability and Reliability. ILIR projects will also support Innovative Naval Prototypes (INP) initiatives in Electromagnetic Gun and Sea Basing, and NNR initiatives in Undersea Weaponry, Ocean Acoustics and Naval Engineering.

FY 2009 Plans:

ILIR projects are intended to be roughly three years long. Typically 30% of ILIR projects turn over each year. Projects selected for FY 2009 will focus on supporting the Naval S&T Strategic Plan in Power and Energy; Operational Environments; Assure Access and Hold at Risk; Naval Warfighter Performance and Protection; Survivability and Self-Defense; Platform Mobility; Fleet/Force Sustainment; and Affordability, Maintainability and Reliability. ILIR projects will also support INP initiatives in Electromagnetic Gun and Sea Basing, and NNR initiatives in Undersea Weaponry, Ocean Acoustics and Naval Engineering.

	FY 2007	FY 2008	FY 2009
ELECTRONICS SENSOR SCIENCES	2,401	2,384	2,455

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PROGRAM ELEMENT: 0601152N PROGRAM ELEMENT TITLE: IN-HOUSE LABORATORY INDEPENDENT RESEARCH (ILIR)
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FY 2007 Accomplishments:

• Continued research to numerically model the reduction of semicondutor laser phase noise and linewidth through optical injection locking, and then experimentally verify the model.
• Continued research investigating Particle Filtering (PF) techniques to improve Global Positioning System/Inertial Navigation System (GPS/INS) navigation performance within an environment subject to platform motion and location constraints. This effort is particularly appropriate for combat in urban settings, the type of environment in which anti-terrorist operations are likely to be conducted.
• Continued research to extend negative index materials (NIM) wavelengths into the visible region. Near-field scanning optical microscopy (NSOM) lithography is utilized in the fabrication of nanophotonic component structures. The component structure of primary interest is layered parallel nanowire pair arrays separated by dielectric. According to recently published models, such layered nanowire pair arrays are NIMs.

FY 2008 Plans:

ILIR projects are intended to be roughly three years long. Typically 30% of ILIR projects turn over each year. Projects selected for FY 2008 will focus on supporting the Naval S&T Strategic Plan in: Power and Energy; Asymmetric and Irregular Warfare; Information, Analysis and Communication; Power Projection; Naval Warfighter Performance and Protection; Survivability and Self-Defense; and Affordability, Maintainability and Reliability. ILIR projects will also support INP initiatives in Electromagnetic Gun, Persistent Surveillance, and the NNR Initiative in Undersea Weaponry.

FY 2009 Plans:

ILIR projects are intended to be roughly three years long. Typically 30% of ILIR projects turn over each year. Projects selected for FY 2009 will focus on supporting the Naval S&T Strategic Plan in: Power and Energy; Asymmetric and Irregular Warfare; Information, Analysis and Communication; Power Projection; Naval Warfighter Performance and Protection; Survivability and Self-Defense; and Affordability, Maintainability and Reliability. ILIR projects will also support INP initiatives in Electromagnetic Gun, Persistent Surveillance, and the NNR Initiative in Undersea Weaponry.

	FY 2007	FY 2008	FY 2009
INFORMATION SCIENCES	1,901	2,015	2,081

BUDGET ACTIVITY: 01
PROGRAM ELEMENT: 0601152N PROGRAM ELEMENT TITLE: IN-HOUSE LABORATORY INDEPENDENT RESEARCH (ILIR)
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FY 2007 Accomplishments:

- Continued research into Wavelet inspirited data mining.
- Continued exploration of natural language communications between humans and information systems.
- Continued research to develop software mechanisms to be inserted between chat servers and their associated server-to-server communication transceivers to improve performance and user efficiency over low-bandwidth intermittent tactical links and to permit bridging between chat protocols in support of pending transition from current Internet Relay Chat (IRC) protocols to Extensible Messaging and Presence Protocol (XMPP).
- Continued research to develop Active Conceptual Modeling technology to enhance understanding how to model continual learning from past experiences and how to capture knowledge from transition of system states.
- Continued research focusing on abnormality detection/classification and blood vessel detection with respect to diabetes, a disease that affects blood vessels throughout the body. The goal is to advance development of an automated image analysis system, capable of detecting/diagnosing diabetic retinopathy to help improve quality of life for those at risk.

FY 2008 Plans:

ILIR projects are intended to be roughly three years long. Typically 30% of ILIR projects turn over each year. Projects selected for FY 2008 will focus on supporting the Naval S&T Strategic Plan in Asymmetric and Irregular Warfare; Information, Analysis and Communication; Power Projection; Assure Access and Hold at Risk; Naval Warfighter Performance and Protection; Survivability and Self-Defense; Fleet/Force Sustainment. ILIR projects will also support INP initiatives in Persistent Surveillance, the Electromagnetic Gun and Sea Basing, as well as NNR initiatives in Ocean Acoustic and Undersea Weaponry.

FY 2009 Plans:

ILIR projects are intended to be roughly three years long. Typically 30% of ILIR projects turn over each year. Projects selected for FY 2009 will focus on supporting the Naval S&T Strategic Plan in Asymmetric and Irregular Warfare; Information, Analysis and Communication; Power Projection; Assure Access and Hold at Risk; Naval Warfighter Performance and Protection; Survivability and Self-Defense; Fleet/Force Sustainment. ILIR

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projects will also support INP initiatives in Persistent Surveillance, the Electromagnetic Gun and Sea Basing, as well as NNR initiatives in Ocean Acoustic and Undersea Weaponry.

	FY 2007	FY 2008	FY 2009
HUMAN PERFORMANCE SCIENCES	1,909	2,019	2,056

FY 2007 Accomplishments:

• Continued investigation of the distribution of free subspace identification for data exploration and bi-clustering.
• Continued development of a specific and sensitive biological sensor for microbial agents employing a partial complement fixation reaction.
• Continued research into short-term statin administration that can reduce the volume or frequency of precordial bubbles detected immediately following decompression from a hyperbaric exposure.
• Continued research in the potentiation of B-cell immune responses to Enterotoxigenic Escherichia Coli Surface Antigen 3 (CS3) adhesin by genetic fusion with a binding peptide
• Continued research to develop and demonstrate a chemical and biological sensor based on the use of a miniature array of Micro-Electro-Mechanical Systems (MEMS) based Fabry-Perot Interferometers (FPIs). The goal of the research is to yield a very small, inexpensive (potentially disposable) arrayable device capable of rapidly detecting a variety of biological warfare agents (BWA) with low levels of false positives.
• Continued research proposing a series of experiments designed to prove a theory that adding spark arc conditions during the electrospin process will have tremendous impact on the chemistry of polymer formation and more accurately describe the electrospinning phenomena. A thorough understanding of the fundamental science of the electrospinning phenomena will allow for a more intelligent approach to the design of new formulations of nanotechnology based materials of military importance.

FY 2008 Plans:

ILIR projects are intended to be roughly three years long. Typically 30% of ILIR projects turn over each year. Projects selected for FY 2008 will focus on supporting the Naval S&T Strategic Plan in Asymmetric and Irregular Warfare; Information, Analysis and Communication; Naval Warfighter Performance and Protection; Survivability and Self-Defense; and Fleet/Force Sustainment. ILIR projects will also support INP initiatives in Sea Basing, and Naval interest in optimizing human performance in military environments.

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PROGRAM ELEMENT: 0601152N PROGRAM ELEMENT TITLE: IN-HOUSE LABORATORY INDEPENDENT RESEARCH (ILIR)
PROJECT TITLE: IN-HOUSE LABORATORY INDEPENDENT RESEARCH (ILIR)

FY 2009 Plans:

ILIR projects are intended to be roughly three years long. Typically 30% of ILIR projects turn over each year. Projects selected for FY 2009 will focus on supporting the Naval S&T Strategic Plan in Asymmetric and Irregular Warfare; Information, Analysis and Communication; Naval Warfighter Performance and Protection; Survivability and Self-Defense; and Fleet/Force Sustainment. ILIR projects will also support INP initiatives in Sea Basing, and Naval interest in optimizing human performance in military environments.

	FY 2007	FY 2008	FY 2009
NAVAL PLATFORM DESIGN SCIENCES	1,216	1,296	1,419

FY 2007 Accomplishments:

• Continued experimental investigation and theoretical modeling of microscale processes associated with phase change heat transfer.
• Continued development & integration of high-lift actuators and neuroscience based control for Maritime Reconnaissance Autonomous Vehicle (MRAV).
• Continued developing and validating analysis procedures to predict powering, cavitation and unsteady shaft forces for specific water jet designs.
• Continued activities to measure the Hugoniot shock wave equation of state and fracture strength for structural steels
• Continued research to extend the use of a well-developed fault detection algorithm, based on a multi-model identification, to apply to nonlinear models and models which have been designed in Simulink. Extending this algorithm will make it widely applicable to support Naval efforts in intelligent systems and Condition Based Maintenance (CBM), increasing both reliability and survivability of the systems.
• Continued research into basic understanding of the unsteady turbulent airwake flow field, necessary to support modeling and simulation of flight operations and the design of future Navy ships. In investigating these flows, a method for quickly identifying and tracking pertinent flow features would greatly aid in ship design, operational evaluation of aircraft deployed at sea, and simulation of new flow control concepts.
• Continued research to understand the influence of various metallurgical factors on the strengthening or softening mechanisms of iron-based friction stir welds. The ultimate goal is to develop a predictive tool

BUDGET ACTIVITY: 01
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that will interchangeably correlate process parameters to mechanical property requirements for any given material and thickness.

FY 2008 Plans:

ILIR projects are intended to be roughly three years long. Typically 30% of ILIR projects turn over each year. Projects selected for FY 2008 will focus on supporting the Naval S&T Strategic Plan in Operational Environments; Assure Access and Hold at Risk; Distributed Operations; Survivability and Self-Defense; Platform Mobility; Fleet/Force Sustainment; and Affordability, Maintainability and Reliability. ILIR projects will also support INP initiatives in Electromagnetic Gun and Sea Basing, and NNR initiatives in Undersea Weaponry and Naval Engineering.

FY 2009 Plans:

ILIR projects are intended to be roughly three years long. Typically 30% of ILIR projects turn over each year. Projects selected for FY 2009 will focus on supporting the Naval S&T Strategic Plan in Operational Environments; Assure Access and Hold at Risk; Distributed Operations; Survivability and Self-Defense; Platform Mobility; Fleet/Force Sustainment; and Affordability, Maintainability and Reliability. ILIR projects will also support INP initiatives in Electromagnetic Gun and Sea Basing, and NNR initiatives in Undersea Weaponry and Naval Engineering.

	FY 2007	FY 2008	FY 2009
ENERGY SCIENCES	1,221	1,283	1,286

FY 2007 Accomplishments:

• Continued research into kinetics measurement studies and understanding the reaction mechanisms of energetic and binder materials during the combustion process using T-Jump Fourier transform infrared (FTIR) spectroscopy.
• Continued the study of the effects of impurities and defects on the absorption spectra of material that exhibits a range of shock sensitivity.
• Continued the effort to develop structures that are conceptually the products of fusing rings such as nitrotriazole, 1,2,4,5-tetrazine, 1,2,3,5-tetrazine, and triazine.

BUDGET ACTIVITY: 01
PROGRAM ELEMENT: 0601152N PROGRAM ELEMENT TITLE: IN-HOUSE LABORATORY INDEPENDENT RESEARCH (ILIR)
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• Continued work to determine the effect of defects on properties of energetic materials from first principles calculations in conjunction with experimental measurements.
• Continued research into the cure chemistry and aging characteristics of Hydroxy Terminated PolyButadiene (HTPB) prepolymer. A characterization and accelerated aging program is being conducted on the polymer to determine the chemical and physical changes that occur as the material ages.
• Continued research to prepare and study new high-nitrogen heterocyclic anion-metal oxidizer complexes for use as initiating materials sensitive to LASER initiation.

FY 2008 Plans:

ILIR projects are intended to be roughly three years long. Typically 30% of ILIR projects turn over each year. Projects selected for FY 2008 will focus on supporting the Naval S&T Strategic Plan in Power and Energy; Asymmetric and Irregular Warfare; Power Projection; Survivability and Self-Defense; and Affordability, Maintainability and Reliability. ILIR projects will also support the INP in Electromagnetic Gun and Sea Basing, and NNR initiatives in Ocean Acoustics, Undersea Weaponry and Naval Engineering.

FY 2009 Plans:

ILIR projects are intended to be roughly three years long. Typically 30% of ILIR projects turn over each year. Projects selected for FY 2009 will focus on supporting the Naval S&T Strategic Plan in Power and Energy; Asymmetric and Irregular Warfare; Power Projection; Survivability and Self-Defense; and Affordability, Maintainability and Reliability. ILIR projects will also support the INP in Electromagnetic Gun and Sea Basing, and NNR initiatives in Ocean Acoustics, Undersea Weaponry and Naval Engineering.

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

OTHER PROGRAM FUNDING SUMMARY - NON-NAVY RELATED RDT&E:
PE 0601101A In-House Laboratory Independent Research
PE 0601102F Defense Research Sciences

D. ACQUISITION STRATEGY:
Not applicable.

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

BUDGET ACTIVITY: 01
PROGRAM ELEMENT: 0601153N
PROGRAM ELEMENT TITLE: DEFENSE RESEARCH SCIENCES

COST: (Dollars in Thousands)

Project Number & Title	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
DEFENSE RESEARCH SCIENCES	379,581	383,217	407,271	423,633	432,367	450,161	471,544

A. MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: This program element (PE) sustains U.S. Naval Science and Technology (S&T) superiority, provides new technological concepts for the maintenance of naval power and national security, and helps avoid scientific surprise. It is based on investment directions as defined in the Naval Science & Technology Strategy approved by the S&T Corporate Board (Jan 2007). This new strategy is based on needs and capabilities from Navy and Marine Corps guidance and input from the Naval Research Enterprise (NRE) stakeholders (including the Naval enterprises, the combatant commands, the Chief of Naval Operations (CNO), and Headquarters Marine Corps). It exploits scientific breakthroughs and provides options for new Future Naval Capabilities (FNCs) and Innovative Naval Prototypes (INPs). It is managed by the Office of Naval Research (ONR) through Program Officers at ONR Headquarters, and the base program of the corporate Naval Research Laboratory (NRL).

The vision of the DON S&T strategy is "to inspire and guide innovation that will provide technology-based options for future Navy and Marine Corps capabilities", where "Innovation is a process that couples Discovery and Invention (D&I) with Exploitation and Delivery". DON basic research is the core of D&I. It includes scientific study and experimentation directed toward increasing knowledge and understanding in national security related aspects of physical, engineering, environmental and life sciences. Basic research efforts are developed, managed, and related to more advanced aspects of research on the order of a hundred technology and capability-related 'thrusts', which are consolidated into about fifteen research areas. These in turn support the major research areas of the Navy and Marine Corps: Autonomous Systems; Command, Control, Communications and Computers (C4); Countermeasures and Counterweapons; Marine as a System; Information Analysis and Decision Support; Intelligence, Surveillance and Reconnaissance; Logistics; Materials; Operational Environments; Platforms; Power and Energy Technology; Sensors and Electronics; Warrior Performance and Protection; Weapons and Support (Education and Outreach).

BUDGET ACTIVITY: 01
PROGRAM ELEMENT: 0601153N
PROGRAM ELEMENT TITLE: DEFENSE RESEARCH SCIENCES

S&T investment in basic research also includes the National Naval Responsibilities (NNRs), fields upon which a wide range of fundamental Naval capabilities depend, and in which ONR is and likely will remain the principal US research sponsor. There are currently four NNR.

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

BUDGET ACTIVITY: 01
PROGRAM ELEMENT: 0601153N
PROGRAM ELEMENT TITLE: DEFENSE RESEARCH SCIENCES

B. PROGRAM CHANGE SUMMARY:

	FY 2007	FY 2008	FY 2009
FY 2008/FY 2009 President's Budget Submission	384,126	374,052	353,753
Congressional Action	1,000	14,900	0
Congressional Undistributed Reductions/Rescissions	0	-2,517	0
Execution Adjustments	950	0	0
Federal Technology Transfer	-21	0	0
Pay Raise Adjustments	0	0	21
Program Adjustments	0	0	53,531
Rate Adjustments	0	0	-34
SBIR Assessment	-6,474	-3,218	0
FY 2009 President's Budget Submission	379,581	383,217	407,271

PROGRAM CHANGE SUMMARY EXPLANATION:
Technical: As directed by the Secretary of Defense, a increase from FY 2008 to FY 2009 for Basic Research (6.1) to fund peer-reviewed research to develop innovative solutions and enhance the science and engineering base. The increase from FY 2008 to FY 2009 also includes the Basic Research Challenge which is a competitive investment based on proposed scientific activities within the Office of Naval Research Science and Technology (S&T) departments.

Schedule:

C. OTHER PROGRAM FUNDING SUMMARY:
Not applicable.

D. ACQUISITION STRATEGY:
Not applicable.

E. PERFORMANCE METRICS:

BUDGET ACTIVITY: 01
PROGRAM ELEMENT: 0601153N
PROGRAM ELEMENT TITLE: DEFENSE RESEARCH SCIENCES

Defense Basic Research seeks to improve the quality of defense research conducted predominantly through universities and government laboratories such as the Naval Research Laboratory. It also supports the education of engineers and scientists in disciplines critical to national defense needs through the development of new knowledge in an academic environment. Initial research focus is generally conducted in an unfettered environment because of the nature of basic research, but as more is learned and applications emerge, individual research projects take on a more applied focus. Individual project metrics then become more tailored to the needs of specific applied research and advanced development programs. Example metrics include a biporous wick structure for thermal management of power electric modules capable of removing 900 watts per square centimeter which was recently developed by an academia/industry team. The National Research Council of the National Academies of Science and Engineering's congressionally directed "Assessment of Department of Defense Basic Research" concluded that the DoD is managing its basic research program effectively.

FY 2009 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2008
Exhibit R-2a

BUDGET ACTIVITY: 01
PROGRAM ELEMENT: 0601153N PROGRAM ELEMENT TITLE: DEFENSE RESEARCH SCIENCES
PROJECT TITLE: DEFENSE RESEARCH SCIENCES

COST: (Dollars in Thousands)

Project Number & Title	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
DEFENSE RESEARCH SCIENCES	379,581	383,217	407,271	423,633	432,367	450,161	471,544

A. MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: This program element (PE) sustains U.S. Naval Science and Technology (S&T) superiority, provides new technological concepts for the maintenance of naval power and national security, and helps avoid scientific surprise. It is based on investment directions as defined in the Naval Science & Technology Strategy. This strategy is based on needs and capabilities from Navy and Marine Corps guidance and input from the Naval Research Enterprise (NRE) stakeholders (including the Naval enterprises, the combatant commands, the Chief of Naval Operations (CNO), and Headquarters Marine Corps). It exploits scientific breakthroughs and provides options for new Future Naval Capabilities (FNCs) and Innovative Naval Prototypes (INPs). It is managed by the Office of Naval Research (ONR) through Program Officers at ONR Headquarters, and the base program of the corporate Naval Research Laboratory (NRL).

The vision of the DON S&T strategy is "to inspire and guide innovation that will provide technology-based options for future Navy and Marine Corps capabilities", where "Innovation is a process that couples Discovery and Invention (D&I) with Exploitation and Delivery". DON basic research is the core of D&I. It includes scientific study and experimentation directed toward increasing knowledge and understanding in national security related aspects of physical, engineering, environmental and life sciences. Basic research efforts are developed, managed, and related to more advanced aspects of research on the order of a hundred technology and capability-related 'thrusts', which are consolidated into about fifteen research areas. These in turn support the major research areas of the Navy and Marine Corps: Autonomous Systems; Command, Control, Communications and Computers (C4); Countermeasures and Counterweapons; Marine as a System; Information Analysis and Decision Support; Intelligence, Surveillance and Reconnaissance; Logistics; Materials; Operational Environments; Platforms; Power and Energy Technology; Sensors and Electronics; Warrior Performance and Protection; Weapons and Support (Education and Outreach).

S&T investment in basic research also includes the National Naval Responsibilities (NNRs), fields upon which a wide range of fundamental Naval capabilities depend, and in which ONR is and likely will remain the principal US research sponsor. There are currently four NNR.

BUDGET ACTIVITY: 01
PROGRAM ELEMENT: 0601153N PROGRAM ELEMENT TITLE: DEFENSE RESEARCH SCIENCES
PROJECT TITLE: DEFENSE RESEARCH SCIENCES

B. ACCOMPLISHMENTS/PLANNED PROGRAM:

	FY 2007	FY 2008	FY 2009
AIR, GROUND AND SEA VEHICLES	40,066	43,015	50,476

Efforts include: Surface/subsurface reduced signatures; free-surface, subsurface, and propulsor hydromechanics; hull life assurance; advanced ship concepts; distributed intelligence for automated survivability; advanced electrical power systems; air vehicles; air platforms propulsion and power; air platforms survivability and signature control; special aviation projects; Unmanned Air Vehicle/Unmanned Combat Air Vehicle (UAV/UCAV); environmental quality; and logistics. In FY 2008, Power Generation, Energy Conversion, and Storage sub-activity efforts are transferred from the Materials and Processes Activity into this Activity. Beginning in FY 2009, this activity includes the Basic Research Challenge which is a competitive investment based on proposed scientific activities within the Office of Naval Research Science and Technology (S&T) departments. Accomplishments and plans described below are examples for each effort category.

As directed by the Secretary of Defense, this activity reflects a increase from FY 2008 to FY 2009 for Basic Research (6.1) to fund peer-reviewed research to develop innovative solutions and enhance the science and engineering base. The increase from FY 2008 to FY 2009 also includes the Basic Research Challenge which is a competitive investment based on proposed scientific activities within the Office of Naval Research Science and Technology (S&T) departments.

FY 2007 Accomplishments:

Air Vehicles
- Continued investigations into controlled initiation and recovery from aggressive non-linear aero-maneuvers conducted by unmanned air vehicles.
- Focused university research in rotorcraft technology areas such as tilt rotor aeromechanics, rotor flow field/ship air wake coupling during shipboard operations, flight simulation of advanced ducted fan air vehicles, active rotor control for enhanced ship board operations, autonomous rotorcraft operations in shipboard environment, and innovative rotor design concepts for naval applications.

BUDGET ACTIVITY: 01
PROGRAM ELEMENT: 0601153N PROGRAM ELEMENT TITLE: DEFENSE RESEARCH SCIENCES
PROJECT TITLE: DEFENSE RESEARCH SCIENCES

Ship Concepts and Hydrodynamics
- Continued modeling and optimization techniques for Naval design of multi-hulls, optimal functional arrangements for both ship and submarine design, and optimization for semi-displacement craft.
- Continued implementation of nationwide program to increase interest in naval engineering education.
- Continued experiments and modeling for rough-wall boundary layer noise.
- Continued the Research Tools Development Consortia Program under the University Research – Engineering Design Consortia.
- Continued modeling of multi-phase flow.
- Continued further examination of computational mechanics to address prediction of acoustic signatures in complex structures, modeling of structural failures and optimization, sensitivity analysis and error control.
- Continued experimental waterjet hydrodynamics and cavitation.
- Completed development of modeling of highly unsteady separated flow around ducted propulsor using Large-Eddy Simulation (LES).
- Completed development of unsteady field pressure measurement technique using Particle Image Velocimetry (PIV).
- Completed numerical modeling of propeller effects on bubble growth.
- Completed numerical modeling of vortical flow/propeller interaction.
- Initiated propeller tip vortex cavitation and sheet-to-cloud cavitation.
- Initiated and completed validation of six degrees of freedom (6DOF) Reynolds-Averaged Navier-Stokes (RANS) for surface ship motions (without capsize).
- Initiated validation of prediction of ship wave breaking and bubbly flow at full scale.
- Initiated Unsteady Reynolds-Averaged Navier Stokes (URANS) prediction of maneuvering effects on ship motion in waves including validation.

Ship Signatures, Structures, and Materials
- Continued development of computational mechanics to provide predictive capabilities of acoustics, linear and nonlinear dynamic response and failure mechanisms of structures.
- Continued the structural performance of hybrid ship hulls and hybrid joints subject to sea loads and weapons effects for application to high speed, low signature vessels.
- Continued studies of the structural acoustics of anisotropic propulsion ducts.
- Continued modeling of alternating current sources and propagation.
- Continued PIV/Laser Doppler Velocimetry (LDV) studies of multiphase bubble flows and interaction with elastic plates in a small quiet water tunnel.

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- Continued LDV of scaling effects studies of unsteady elastic duct and propulsor interaction in a wind tunnel.
- Continued effort on much higher strain rate loading and constitutive behavior of Explosion Resistant Coating (ERC) for strain rates appropriate to ballistic events.
- Continued work on cohesive elements for dynamic fracture under combined mode for application to failure in joints in ship structures under blast loading.
- Continued work on hybrid ship (no-magnetic stainless steel/composite) hull concepts.
- Continued further examination of computational mechanics in order to address prediction of acoustic signatures in complex structures, modeling of structural failures and optimization, sensitivity analysis, and error control.
- Continued concept for photonic band gap waveguide.
- Completed hull complexity acoustic measurements at small-scale using 3D acoustic holography.
- Completed evaluation of mechanical behavior of elastomeric coatings under ballistic and extreme dynamic loading.
- Initiated methods to model the mechanisms of interaction between an elastic duct wall and fluid-flow in a duct with a propeller.
- Initiated study to extend near-field acoustic holography measurement techniques to large-scale measurements in cluttered noisy environments.

Ship and Air Platform Machinery and Systems
- Continued evaluation of stability and control of electrical power systems.
- Continued efforts to understand and control the generation and propagation of far-field jet noise.
- Continued development of Pulsed Detonation Engine (PDE) Technology.
- Continued development and understanding of control capabilities and distributed intelligence strategies for shipboard systems.
- Initiated propulsion system cost-reduction efforts through reduction of vibration, noise and thermal fluctuation at the source by controlling combustion.
- Initiated passive and active high speed noise control.
- Initiated studies of alternate propulsion systems for Pulsed Detonation Engine (PDE) and generate prediction models.

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FY 2008 Plans:

Air Vehicles
- Continue all efforts of FY 2007.

Ship Concepts and Hydrodynamics
- Continue all efforts of FY 2007, less those noted as completed above.
- Complete experiments for rough-wall boundary layer noise.
- Complete modeling of multi-phase flow.
- Complete potential-flow modeling of waterjet propeller cavitation.
- Complete RANS predictions of surface ship motion for high speeds.
- Complete validation of prediction of ship wave breaking and bubbly flow at full scale.
- Initiate computational and experimental investigation into complex three-dimensional flow separation problems.
- Initiate measurement and modeling of small wave effects on wave breaking and bubble generation.

Ship Signatures, Structures, and Materials
- Continue all efforts of FY 2007, less those noted as completed above.
- Complete study to extend near-field acoustic holography measurement techniques to large-scale measurements in cluttered noisy environments.
- Complete studies of the structural acoustics of anisotropic propulsion ducts.
- Initiate investigation into methods to control airborne noise transmission using active control.
- Initiate development of metamaterial concepts for radio frequency (RF) signature control and photonic and acoustic applications.

Ship and Air Platform Machinery and Systems
- Continue all efforts of FY 2007.

Power Generation, Energy Conversion and Storage (transferred from Materials and Processes R-2 Activity)
- Continue evaluation of stability and control of electrical power systems.
- Continue analyzing synchronization of 19 diode lasers to produce intense beams.
- Continue efforts in nanostructures, novel electrolytes, and electrode materials to enable new 3D power source architectures to improve capacity of rechargeable lithium and lithium-ion batteries.

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- Continue exploration and development of materials for high energy density passive power electronics (Capacitors).
- Continue expanding the fundamental understanding of direct electrochemical oxidation and the use of logistic fuels in solid oxide fuel cells.
- Continue research tools design efforts in Chemical Dynamics and High Temperature Probes.
- Continue development of phase change cooling approaches for high power electronic devices.
- Continue development of multi-scale thermal modeling approaches.
- Continue development of non-vapor compression based refrigeration cycles.
- Continue research on the scientific basis of nanostructure enhancement of semiconductor and functional materials performance for power generation and thermal management.
- Continue research into new functional materials and new concepts to efficiently convert thermal, photonic, or vibrational energy to electric energy thermoelectric materials from primary or secondary sources.

FY 2009 Plans:

Air Vehicles
- Continue all efforts of FY 2008.

Ship Concepts and Hydrodynamics
- Continue all efforts of FY 2008, less those noted as completed above.
- Complete measurement and modeling of small wave effects on wave breaking and bubble generation.
- Initiate validation of URANS prediction on maneuvering effects on ship motion in waves.
- Initiate modeling of hydroacoustics of advanced materials propulsor.
- Initiate program to investigate renewable energy technologies for navy applications.
- Initiate computational and experimental investigations of wakes in stratified fluids.
- Initiate LES modeling of crashback of underwater vehicle with propulsor.

Ship Signatures, Structures, and Materials
- Continue all efforts of FY 2008, less those noted as completed above.
- Complete methods to model the mechanisms of interaction between and elastic duct wall and fluid flow in a duct with a propeller.
- Complete PIV/LDV studies of multiphase bubble flows and interaction with elastic plates in a small quiet water tunnel.
- Initiate study of droplet & volume scattering phenomena.

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- Initiate the development of predictive models for infrared emission and reflection from breaking waves.
- Initiate development of computational electromagnetic (CEM) tools for electromagnetic materials design & optimization.
- Initiate development of a methodology for highly reliable composite to metallic joints.
- Initiate fundamental efforts in multi-scale, time-varying, hull structural reliability models and processes for structural performance analysis.

Ship and Air Platform Machinery and Systems
- Continue all efforts of FY 2008.
- Initiate studies of advanced air-breathing propulsion concepts.
- Initiate study of advanced materials for Pulsed Detonation Engine (PDE) Applications.
- Initiate a review of shipboard electrical system monitoring and control technology and identify and evaluate algorithms and techniques to resolve identified or predicted performance gaps.

Power Generation, Energy Conversion and Storage
- Continue all efforts of FY 2008.
- Complete development of multi-scale thermal modeling approaches.
- Initiate the investigation of the long-term durability effects of coating/substrate systems from combustion chemistries and products derived from current petroleum-based fuel and from petroleum-based/synthetic fuel blends that lead to predictive models.

	FY 2007	FY 2008	FY 2009
ATMOSPHERE AND SPACE SCIENCES	22,516	19,867	30,742

Efforts include: Marine Meteorology and Prediction and Space Sciences. Beginning in FY 2009, this activity includes the Basic Research Challenge which is a competitive investment based on proposed scientific activities within the Office of Naval Research Science and Technology (S&T) departments. Accomplishments and plans described below are examples for each effort category.

As directed by the Secretary of Defense, this activity reflects a increase from FY 2008 to FY 2009 for Basic Research (6.1) to fund peer-reviewed research to develop innovative solutions and enhance the science and engineering base. The increase from FY 2008 to FY 2009 also includes the Basic Research Challenge which is a competitive investment based on proposed scientific activities within the Office of Naval Research Science and Technology (S&T) departments; and efforts to plan a field program supporting numerical weather

forecasting/prediction for WESTPAC, which would provide strategic information for military efforts in the geographical areas of Korea and Taiwan.

FY 2007 Accomplishments:

Marine Meteorology and Prediction
- Continued analysis of results from major field projects on air-sea interaction and transition improvements into applied research to improve the treatment of fluxes in coupled atmosphere-ocean prediction systems.
- Continued the development of next-generation ocean-atmosphere coupled models.
- Continued effort to investigate and better understand the bulk exchanges, aerosol-cloud interaction, and physical processes that take place at the atmospheric boundary layer interface. (Includes NRL investment/performance in this effort.)
- Continued theoretical and observational effort to improve understanding of the fundamental dynamics of mountain waves, including generation, propagation, nonlinear interaction, and wave breaking. (Includes NRL investment/performance in this effort.)
- Continued effort to gain a fundamental understanding of the flow-dependent limits of predictability by combining research in data assimilation and atmospheric instability. (Includes NRL investment/performance in this effort.)
- Continued investigation into the near-earth environmental effects on electromagnetic propagation. (NRL)
- Continued investigation of sub-grid-scale processes that influence marine boundary layer turbulence, aerosol production and removal, and marine stratocumulus cloud and drizzle formation and dissipation with the goal of improving the predictability of these phenomena in high-resolution mesoscale prediction systems.
- Continued investigation of Western Pacific tropical cyclone dynamics in order to improve the predictability of storm genesis, structure and intensity changes, radii of maximum winds and effects on sea surface waves.
- Continued investigation of the effects of radioactively important aerosols on cloud dynamics and thermal structure of the lower atmosphere for the purpose of improving the treatment of these processes in numerical weather prediction models.
- Continued effort to assimilate WindSat wind vector, Ozone Mapping and Profiler Suite (OMPS) ozone profiles, and Global Positioning System (GPS) temperature and water vapor profile retrievals into NOGAPS (Navy Operational Prediction System). (NRL)
- Continued effort to derive sea foam coverage from WindSat and to use this information in microphysical aerosol models to derive marine optical properties. (NRL)
- Completed solar heliospheric-ionospheric investigations of effects of selected solar activities on ionospheric disturbances. (NRL)

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- Initiated assessment of the status of aerosol observation, prediction, and understanding for use in slant-range visibility and electro-optical performance prediction models.

Space Sciences
- Continued calibration/validation of meteorological satellite wind (WindSat) polarimetric passive microwave data, and developed the version 1 of the WindSat wind vector retrieval algorithm. WindSat wind vectors have been released to the science community for evaluation. (NRL)
- Continued effort to exploit the polarametric aspect of WindSat for non-ocean surface wind vector Meteorological and Oceanographic Command (METOC) retrievals. Effort this year focused on soil moisture and sea ice. (NRL)
- Continued the development of 3D magnetohydrodynamic code for simulations of solar filament eruptions leading to flare and coronal mass ejection (CME) activity. (NRL)
- Continued studies of the major October-November 2003 solar activity events and the associated effects on the near-Earth space environment. (NRL)
- Continued effort to improve understanding of tropospheric and stratospheric bulk exchanges through observations and modeling. Effort this year focused on finding individual thunderstorm cells spawned by forest fires (pyro-cumulonimbus clouds) which have injected material into the stratosphere. (NRL)
- Continued assessment of advanced techniques and algorithms for remote sensing of ocean and atmospheric properties including winds, waves, currents, and surface topography.
- Continued development and evaluation of techniques for remote sensing of upper atmosphere phenomena including neutral density, winds and bulk exchange cycles. (NRL)
- Initiated program to develop advanced improvements to specification and prediction of the space environment to improve space system performance and their on-call availability.
- Initiated monitoring of other-agency efforts for 'Naval Harvest' of advanced techniques and algorithms for remote sensing of ocean and atmospheric properties including winds, waves, currents, and surface topography.
- Initiated a focused program to develop a predictive, operational capability for the onset and evolution of equatorial spread-F that limits space-based communications and navigation capabilities. (NRL)
- Initiated a program to use large high frequency/very high frequency (HF/VHF) arrays to investigate fine scale ionospheric phenomena with associated improvements in ionospheric modeling and the performance of current and future DoD capabilities impacted by ionospheric disturbances. (NRL)

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FY 2008 Plans:

Marine Meteorology and Prediction
- Continue all efforts of FY 2007, less those noted as completed above.

Space Sciences
- Continue all efforts of FY 2007.
- Initiate program to extend magnetohydrodynamic models of solar activity, and related effects on the near-Earth space environment, toward an improved predictive capability on communication and navigation systems, and other related effects on DoD operations.
- Initiate effort to develop better physical understanding of small-scale atmospheric wave dynamics in the middle and upper atmosphere.(NRL)
- Initiate effort to develop understanding of how multi-scale interactions impact the predictability of tropical cyclones and their downstream effects.(NRL)
- Initiate effort to develop understanding to forecast the sun's changing extreme ultraviolet (EUV) radiation and the responses of the upper atmosphere and ionosphere one-to-ten days in advance.(NRL)
- Initiate effort to develop and validate numerical models of high-energy solar energetic particle (SEP)and solar gamma-ray (SGR) emissions. (NRL)
- Initiate effort to develop a quantitative standard model for solar flares that satisfies UV-X-ray observations; understand the origin, dynamics, and evolution of plasma in active region magnetic flux tubes. (NRL)

FY 2009 Plans:

Marine Meteorology and Prediction
- Continue all efforts of FY 2008.

Space Sciences
- Continue all efforts of FY 2008.

FY 2009 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2008
Exhibit R-2a

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	FY 2007	FY 2008	FY 2009
COUNTER IMPROVISED EXPLOSIVE DEVICE (IED) SCIENCES	14,800	24,169	24,418

The ONR Basic Research Counter IED program seeks to develop innovative scientific concepts that will form the foundation for future technologies that may be developed and implemented to efficiently and effectively address the IED threat. The effort will emphasize fundamental scientific concepts that can be applied to the detection, neutralization, destruction and mitigation of the effects of these devices and to advance prediction of the occurrence or potential occurrence of IED events. The program also seeks to establish and nurture a multi-disciplinary counter-IED Science and Technology community of Government, academic and industry researchers to accelerate the transition of new science and technology into fielded systems. Beginning in FY 2009, this activity includes the Basic Research Challenge which is a competitive investment based on proposed scientific activities within the Office of Naval Research Science and Technology (S&T) departments.

This activity also includes Secretary of Defense directed peer-review basic research to develop innovative solutions and enhance the science and engineering base.

Increase from FY 2007 to FY 2008 reflects increased emphasis in Counter IED program. FY 2007 reflected the impact of a specific Congressional Reduction against this PE.

FY 2007 Accomplishments:

- Continued effort in the area of Prediction to develop theoretical and technical approaches that permit prediction and analysis of IED emplacement as well as the assembly of IEDs. This included recognition of emplacement patterns, human activity recognition from video and other sensing systems, human intelligence and social network analysis of terrorist networks, modeling and simulation of the full spectrum of IED activities, analysis of communications, and knowledge management systems to combine diverse data sources.
- Continued effort in the area of Detection to develop concepts that would permit stand-off detection and localization of the explosive, the case materials, the environment in which the device is located, and other components of the IED.
- Continued effort in the area of Neutralization to develop scientific concepts that may be applied to remotely render an IED ineffective without necessarily having to detect or destroy it.
- Continued effort in the area of Destruction to develop scientific concepts that may be applied to quickly and remotely destroy IEDs without necessarily having to detect them.

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- Continued effort in the area of Mitigation to develop scientific concepts that may be applied to protect people and/or equipment from the destructive effects of an IED that may be detonated.
- Continued computational fluid dynamics (CFD) CT-Analyst technology that provides a sensitive operational-quality capability to backtrack airborne detections of the chemical signatures and taggants of explosives instantly to their source. (NRL)
- Continued reactive flow dynamics study of multiphase reactive flow modeling and simulation that can be applied to investigate mitigation strategies to counter the IED threat. (NRL)
- Continued laboratory-on-a-chip studies of molecular dynamics and recognition including complex, integrated separations performed on a rapid timescale for DoD target analytes such as toxic industrial chemicals and chemical warfare agents which may be used in IEDs. (NRL)
- Continued flame suppression mechanism investigation of additives to fine water mist to provide the scientific basis to guide search for suitable fine water mist based fire suppression strategies for DOD platforms, and to mitigate explosive blast effects. (NRL)
- Continued investigating neutron-sensitive glass materials for remote radiation sensing to develop novel approaches for detection of radiological threats: special nuclear materials, dirty bombs, IEDs. (NRL)
- Continued the study of radar for active detection of suicide bombers. (NRL)
- Continued exploration into advanced microarchitectures for bioprocessing and sensing to develop and characterize cellular microarrays expressing G-protein coupled receptors (GPCRs) and other proteins as targets for environmental detection. (NRL)
- Continued the study of molecular motions & physical properties under stress to develop better elastomers for applications of flexible materials (blast resistant coatings, sonar domes, appliqués). (NRL)
- Continued studies of the fundamental issues in processing of quartz-crystal microbalance arrays directed to making micro-arrays of quartz crystals, each working at different frequencies. (NRL)
- Continued investigation and development of nonlinear methods to more effectively describe and analyze hyperspectral and multi-sensor data to improve characterization using nonlinear (manifold) methods. (NRL)
- Continued activities to devise and demonstrate chemical templates for assembling/ positioning nanoclusters and nanowire leads with nanometer precision to better understand the chemical & biochemical assembly of nanocluster-based electronics/sensors. Investigated ultra-fine electroless deposition for forming electrical leads. Explored early applications to single-electron devices and high-sensitivity sensors. (NRL)
- Continued study of metal nanoparticles for insensitive munitions (IM) with high energy density and low sensitivity to hazardous conditions, operational environment and countermeasures. (NRL)
- Continued development of rapid identification of biological aerosols, a novel method that allows specific biological aerosols to be identified within a background of others and that can fulfill the criteria of continuous sampling, real time performance, use of a small amount of consumables, and portability. (NRL)

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- Continued a systems biology approach for the interrogation of marine microorganisms to describe and predict the functioning of an entire marine bacterial system in response to certain stimuli which will provide the ability to comprehensively model and manipulate microbiological systems for the development of next generation sensors for biological, chemical and explosive agent detection. (NRL)
- Continued synthetic nanopores for single molecule identification to demonstrate a novel synthetic-nanopore-based strategy for real-time, label-free, single molecule detection of chemical and biological threats. (NRL)
- Initiated development of high-power mid-Infrared (IR) lasers for IR countermeasures, explosives detection (ED), biological detection, remote chemical sensing, etc. (NRL)
- Initiated creation of new spectroscopy for sensitive characterization of semiconductor nanostructures, ultra-thin molecular films and chemical/biological threat materials and explosives. (NRL)
- Initiated development of product that will provide the warfighter protection against blast pressure wave and complements efforts in ballistic/projectile protection and combat casualty care communities. (NRL)

FY 2008 Plans:

- Continue all efforts of FY 2007.
- Initiate effort to develop a chemically strengthened Visible infrared (Vis-IR) composite window made from Spinel ceramic and germanate glass.(NRL)
- Initiate development of nonlinear methods to significantly improve the differentiation of targets from background scenes in multivariate data sets of hyperspectral imagery.(NRL)
- Initiate development of a new chemical explosive detection concepts based on pump/probe UltrashortPulse Lasers(NRL)
- Initiate research on characterizing background noise in urban and riverine environments in support of IED signature detection.

FY 2009 Plans:

- Continue all efforts of FY 2008.
- Initiate increased emphasis on standoff wide area neutralization and pre-detonation of IEDs
- Initiate increased emphasis on stronger lightweight armor including nanoparticle designs
- Initiate increased emphasis on sociological and cultural aspects of defeating insurgent networks.

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	FY 2007	FY 2008	FY 2009
HUMAN SYSTEMS	7,655	8,532	9,785

Efforts include: human factors and organizational design; manpower, personnel, and training; integrated avionics, displays, and advanced cockpit; and pattern recognition. Beginning in FY 2009, this activity includes the Basic Research Challenge which is a competitive investment based on proposed scientific activities within the Office of Naval Research Science and Technology (S&T) departments.

As directed by the Secretary of Defense, this activity reflects a increase from FY 2008 to FY 2009 for Basic Research (6.1) to fund peer-reviewed research to develop innovative solutions and enhance the science and engineering base. The increase from FY 2008 to FY 2009 also includes the Basic Research Challenge which is a competitive investment based on proposed scientific activities within the Office of Naval Research Science and Technology (S&T) departments.

FY 2007 Accomplishments:

- Continued research of social networks for counterterrorism.
- Continued expansion of the cognitive architectural modeling capability to increase coverage, including spatial reasoning, multi-tasking, and impact of physiological and stress variables, etc.
- Continued research on human cognition and performance to create more realistic simulations for training.
- Continued program to combine cognitive architectures with computational neuroscience to better predict human performance.
- Continued program on implantable electronics for performance enhancement.
- Continued research of hierarchical, cellular, and hybrid organization structures for command and control.
- Continued schema theory applications to multi-echelon command decision making.
- Continued investment in natural language interaction capability for artificially intelligent training systems.
- Continued research of neuro-control of high-lift bioinspired Unmanned Underwater Vehicles and active vision and cognitive navigation skills in mobile robots.
- Continued computational neuroscience for novel pattern recognition and sensory augmentation.
- Continued social-science based computational toolsets for terror network analysis at PACOM'S Joint Intelligence Center and on the USS TARAWA (LHA-1) to support Expeditionary Strike Group One in the Global War on Terrorism.

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- Continued investigations to support new missions for Expeditionary Strike Groups in three areas: 1) analysis and diagnosis of Command and Control Organizational structures; 2) effects-based operations and development of reach-back capability for course of actions analysis; and 3) decision support systems for management of Battle Rhythm.
- Continued research of human-robot interaction to support team collaboration.
- Completed studies of the interaction of auditory and visual displays.
- Completed development of novel multidisciplinary approaches to human-activity inference from video imagery to enable force protection and counterterrorism.
- Completed expansions to cognitive models to include spatial reasoning.
- Initiated computational and agent-base modeling and experimentation to explore options for Effects-Based Operations.
- Initiated models of operational decision making for component commanders of an Expeditionary Strike Group with special emphasis on elaboration and planning knowledge.
- Initiated research of integrated parallel optimization models of adaptive function and responsibility reallocation between commanders/staff and reconfiguration of the command, control, and communication organizational structures.

FY 2008 Plans:

- Continue all efforts of FY 2007, less those noted as completed above.
- Complete research on adaptive command and control architectures in support of the Navy's new Maritime Strategy.
- Initiate systematic program of perceptual research to fill in information that cognitive architectural modeling has revealed to be missing from the research literature.
- Initiate the output human performance usability models with actual human performance results obtained in usability testing on systems under development. These systems include future Naval Combat Systems and Homeland Security Operation Centers.
- Initiate investigation of human sensory performance for optimizing video and audio human-electronic device interfaces.

FY 2009 Plans:

- Continue all efforts of FY 2008, less those noted as completed above.

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- Initiate research to create new social modeling tools for understanding the responses of adversaries, determining the best practices for containing and deterring the adversary, and developing effective course of action in non-Western environments for humanitarian and civilian-military operations.
- Initiate research on advanced biometrics such as biodynamic signatures to support spiral 2 and 3 of Navy Identity Dominance System Maritime Domain.
- Initiate efforts to extend the representational capabilities of cognitive architectures to accommodate aspects of social cognition and teamwork.
- Initiate efforts to develop an empirical understanding and prediction of the behaviors of individuals and social groups and networks, computational approaches to social network theory and the co-evolution of adversarial tactics and strategies, algorithms for exploring scenarios that take into account socio-cultural factors; political and economic factors; local attitudes, values, and social structure.
- Initiate research focused towards cognitive and neural sciences, virtual/immersive environment simulators, decision models for improved warfighter performance.

	FY 2007	FY 2008	FY 2009
INFORMATION SCIENCES	20,938	23,176	31,298

Efforts include: Mathematical foundation and computational theory and tools for design, communication, and control of intelligent autonomous systems; decision theory, algorithms, and tools; heterogeneous information integration, management, and presentation; information assurance, secure and reliable information infrastructure for Command and Control; mathematical optimization for optimal resource allocation and usage; modeling and computation of complex physical phenomena; modeling and computation for electromagnetic and acoustic wave propagation and scattering; seamless, robust connectivity and networking; and expeditionary operations Command, Control, Communications, Computers Intelligence Surveillance and Reconnaissance (C4ISR). Beginning in FY 2009, this activity includes the Basic Research Challenge which is a competitive investment based on proposed scientific activities within the Office of Naval Research Science and Technology (S&T) departments.

As directed by the Secretary of Defense, this activity reflects a increase from FY 2008 to FY 2009 for Basic Research (6.1) to fund peer-reviewed research to develop innovative solutions and enhance the science and engineering base. The increase from FY 2008 to FY 2009 also includes the Basic Research Challenge which is a competitive investment based on proposed scientific activities within the Office of Naval Research Science and Technology (S&T) departments; and an increased level of investment and effort for information technology for software systems.

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FY 2007 Accomplishments:

- Continued development of mathematical optimization framework and heuristic algorithms that serve as theoretical and computational basis for network design, resource allocation, and logistics.
- Continued development of improved tactical and battlespace decision aids.
- Continued to refine techniques for extracting maximum knowledge from multi-modal imagery, text, and multi-source signal data.
- Continued to investigate methods to deal with light dispersion on image formation underwater to enable precise navigation, station keeping, and mapping capabilities for unmanned underwater vehicles.
- Continued efforts for enabling teams of autonomous systems to work together and work on representations for evolution of cooperative behaviors, including efforts in multi-modal interactions with autonomous systems.
- Continued developing framework for dealing with effect of variable latencies in communication within teams of humans and autonomous systems.
- Continued efforts on development of mathematical foundations for image enhancement, feature extraction, feature-based/texture-based compression, denoising, and segmentation; data representation and metrics, content-based indexing and retrieval; reconstruction, interpolation, and registration; and scene analysis and image understanding.
- Continued efforts on quantum computing and cryptography.
- Continued efforts on model checking and automated theorem prover technologies.
- Continued efforts on biometric technologies for authentication.
- Continued efforts in physics-based modeling of natural phenomena.
- Continued efforts in mathematical techniques for inverse problems, including reliable approximate solutions in 3 dimensions (3D); adequate representation of the physics of the media and the scatterer; and improved resolution of structural and material properties.
- Continued development of computational framework for integrating information of disparate sources.
- Continued development of a systematic approach that will serve as a theoretical and computation basis for automated image understanding and automatic object recognition.
- Continued development of technology for maximizing information delivery in tactical networks via encoding information under speech. (NRL)
- Continued development of technology for improving behavior of coordinated teams of autonomous systems. (NRL)
- Continued development of technology to re-engineer legacy code. (NRL)
- Continued development of technology to improve analysis of distributed systems. (NRL)

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- Completed the development of technology to improve tactical wireless ad hoc networks via development of cross-layer design approaches. (NRL)
- Initiated development of mathematical, statistical, and computational framework leading to robust underlying approaches for automated information integration of disparate sources of data.
- Initiated development of technology for assessing effectiveness of automatic translation programs. (NRL)
- Initiated development of technology for analyzing functionality of executable software code. (NRL)

FY 2008 Plans:

- Continue all efforts of FY 2007, less those noted as completed above.
- Complete development of technology to improve analysis of distributed systems. (NRL)
- Initiate the development of a theory of traffic security in communication networks. (NRL)
- Initiate research in methods to visually represent and explore large, diverse, dynamic data sets. (NRL)
- Initiate the development of the mathematical framework and algorithms for a new Multi-Scale timekeeping and Synchronization (MSTS) technique as an enabling technology for synchronous operation of disparate battlespace systems. (NRL)

FY 2009 Plans:

- Continue all efforts of FY 2008, less those noted as completed above.
- Complete development of technology for assessing effectiveness of automatic translation programs. (NRL)
- Complete development of technology for analyzing functionality of executable software code. (NRL)
- Initiate research in cognitive radio and networking protocols.
- Initiate research on novel switched mode techniques to overcome radiation efficiency limit in electrically small antennas.
- Initiate research in cross-layer wireless protocols for delay sensitive network traffic.
- Initiate development of computational methods for software producibility of complex software systems.
- Initiate research into Anti-Tamper Approaches, Complex Software Systems, and Information Assurance: research focused on protection techniques, architectures, algorithms, protocols that allow for security and cyber situational awareness.
- Initiate multidisciplinary research efforts to focus on intelligent control systems, cooperative behavior modeling and response, UxV-human interactions and adaptive mission methodologies.
- Increase basic research into the extraction of information from large data sets.

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	FY 2007	FY 2008	FY 2009
MATERIALS/PROCESSES	59,548	57,555	59,948

Efforts include: Structural materials; functional materials; maintenance reduction; and Environmental Sciences. Power Generation, Energy Conversion, and Storage sub-activity efforts previously reported in this Activity are transferred to the Air, Ground and Sea Vehicles Activity in FY 2008. Beginning in FY 2009, this activity includes the Basic Research Challenge which is a competitive investment based on proposed scientific activities within the Office of Naval Research Science and Technology (S&T) departments. Accomplishments and plans described below are examples for each effort category.

This activity also includes Secretary of Defense directed peer-review basic research to develop innovative solutions and enhance the science and engineering base.

FY 2007 Accomplishments:

Structural Materials
- Continued development of physics-based models of thermal and materials flow during friction stir welding of steels, including the development of residual stresses that will lead to distortion.
- Continued development of first-principles based methodologies for predicting the thermodynamics and kinetics controlling microstructural evolution for the design of advanced weldable, naval steels.
- Continued development of understanding and constitutive models of dynamic behavior of naval steels.
- Continued development of theoretical basis for composite materials behavior based on x-ray computed micro-tomography.
- Continued investigation of continuous growth of single and multi-wall nanotubes for next generation polymer matrix composite materials.
- Continued development of models and simulations to understand and predict high deformation rate blast behavior for engineered topological structures.
- Continued development of materials and fabrication science for fugitive phase processes for engineered topological structures for ship blast protection.
- Continued development of nanocomposites for enhancing mechanical properties of marine composites.
- Continued evaluation of new high temperature resin for potential Unmanned Combat Air System (UCAS) high temperature composite applications.
- Continued research tools design efforts in dynamic three dimensional control of structures.

BUDGET ACTIVITY: 01
PROGRAM ELEMENT: 0601153N PROGRAM ELEMENT TITLE: DEFENSE RESEARCH SCIENCES
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- Continued exploration of high strain rate superplasticity in advanced nanostructured ceramic composites to provide the basis for the development of such materials for Naval applications.
- Continued to advance the understanding of processing and deformation mechanisms in nanostructured ceramic composites and metal alloys to provide new high strength-high toughness materials for Naval platforms.
- Continued investigation of the role of hydrogen and nitrogen on mechanical properties of titanium alloys. (NRL)
- Continued studies on microstructure, mechanical, fatigue crack growth, and corrosion properties of friction stir welded Aluminum 5456. (NRL)
- Continued research on first-principles and experimental data to develop iron-nickel (Fe-Ni) atomistic potentials which will be used in the study of austenitic steels, currently we can show that Ni segregates on high Sigma grain boundaries. (NRL)
- Continued investigation of joining dissimilar ceramics and sintering of light metal composites. (NRL)
- Continued exploration into the processing and microstructures of novel titanium alloys that may be enabled by new co-reduction of mixed metallic oxide processes.
- Continued exploration of microstructural evolution during solid-state joining and localized processing of weldments in titanium alloys for improved toughness and fatigue resistance.
- Continued development of progressive damage models for blast effects on composite marine structures.
- Continued research in the area of fusing carbon nanotubes together to produce 3D networks of single and/or multiwall carbon nanotubes for structural applications.
- Continued research into the area of transforming bio-fibrillose material into carbon nanotubes.
- Continued effort to support DARPA development of ceramic nanocomposite infrared (IR) windows and domes for high speed missile applications utilizing the understanding of processing, mechanical and optical properties of ceramic nanocomposites gained from ongoing ONR research.
- Continued investigation of continuous growth of single and multiwall nanotubes for next generation polymer matrix composite materials.
- Completed development of hybrid composites incorporating glass fibers and high strength steel fibers for joining application.
- Completed research into dynamic slamming load effects on marine composites.
- Completed the development of understanding of deformation mechanisms in nanometer scale aluminum.
- Completed efforts to understand links between complex reaction paths and atomic diffusion in the formation of environmental and diffusion barrier coatings for high temperature thermal and environmental barrier coatings.
- Completed analysis of dynamic response for marine composites and sandwich structures.
- Completed loads analysis of physics-based models for fatigue damage in naval alloys.

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- Initiated investigation of a rapid annealing of surface layers and their effects. (NRL)
- Initiated quantification of the Corrosion effects on fatigue to be incorporated into the Unified Damage Model and validate in a few environmental cases on P-3 aircraft real loads data.

Functional Materials
- Continued extension of first principle calculations of sonar materials tensor piezoelectric and dielectric properties to complex solid solutions to provide the basic understanding and predictive capability for ultra high strain materials.
- Continued research tools design efforts in electromagnetic and acoustic bandgap materials.
- Continued development of a theoretical model that describes coherent multiexciton generation by one photon in PbSe and PbS nanocrystals for new solar cells. (NRL)
- Continued studies on the electron doped cuprate superconductors (Nd2-xCexCuO4 and Pr2-xCexCuO4) by temperature dependent polarized electronic Raman spectroscopy across a wide region of the doping (Cerium) phase diagram. (NRL)
- Continued a project for the determination of a critical structural phase transition in a new class of superconducting materials. (NRL)
- Continued a theoretical study on a variety of novel superconductors where superconductivity coexists with magnetism or spin fluctuations. (NRL)
- Continued construction of a unique facility for exploring static electrical contact phenomena consisting of a servohydraulic load frame with an insulated load train. This equipment will enable studies on transmission of electrical current across dissimilar metal interfaces at extreme pressures and current densities beyond those investigated before. (NRL)
- Continued studies on dielectric breakdown strength of ferroelectric glass-ceramics to show that it is an order of magnitude higher than conventional ceramic dielectrics while maintaining high dielectric constant. (NRL)
- Continued exploration and prediction of new sonar materials based on first principle methods.
- Continued study of new transduction mechanisms.
- Continued examination of the effects of acoustic perturbations and interactions in reacting flows and determine how they can be used. (NRL)
- Continued investigation of radically new hierarchical polymer lenses that mimic the focusing of an eye. (NRL)
- Continued single molecule binding detection using optical trap. (NRL)
- Continued effort to fabricate extended 2D left handed materials (LHM) structures. (NRL)

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PROGRAM ELEMENT: 0601153N PROGRAM ELEMENT TITLE: DEFENSE RESEARCH SCIENCES
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- Completed development of first principle methods to calculate second and third rank tensor properties of sonar materials such as lead zirconate titanate and lead magnesium niobate.
- Completed the piezo electric fracture analysis with experimental and model for verification.
- Initiated synthesis and property measurement of new sonar materials predicted by first principle methods.
- Initiated development of compact, multifunctional and biologically active conjugates that are composed of luminescent quantum dots and functional peptides. (NRL)
- Initiated investigation into the properties and fabrication of novel ceramics which have potential to combine hardness, strength, and high transmission in the long wave infrared (LWIR) spectral region. (NRL)
- Initiated development of the science and technology base for a highly efficient and stable flexible organic solar cell. (NRL)

Maintenance Reduction
- Continued to develop the science of sliding contact and lubrication using physical and chemical first principles.
- Continued to investigate the use of photorefractive crystals for the demodulation of a distributed fiber optic Bragg gratings structural health monitoring system.
- Continued exploration of multienergy processes for zero maintenance coatings.
- Continued first lubrication-by-design experiments.
- Continued high temperature, low frictional sliding coefficient materials for elevated operating temperature gas turbine engine bearings.
- Continued development of corrosion models.
- Continued mechanistic studies of materials deterioration under chemical environment for ship materials and their interfaces.
- Continued to identify stress corrosion control methods for friction stir welded high-strength aluminum alloys using advanced thermal treatments, chemical modifications, and surface mechanical processes to tailor compressive stresses.
- Continued mechanism-based modeling of H-assisted cracking in ultra high strength steels.
- Continued multi-scale (atomic to microscopic) physics/chemistry-modeling of friction, wear, and lubrication for the rational design of high performance bearings, gears, seals, and lubricants.
- Continued stainless steel carburization study to enhance corrosion performance.
- Continued testing of a statistically relevant number of combinatorial specimens to rank defects, microstructure and their interactions for fatigue crack initiation and growth. (NRL)
- Completed exploration of advanced coatings with multifunctional corrosion/fouling properties.
- Completed exploration of theoretical concepts for corrosion control.

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- Completed development of a Giant Magnetoresistance (GMR) array Nondestructive Evaluation (NDE) system for detection of hidden cracks in Navy aircraft.

Power Generation, Energy Conversion and Storage
- Continued analyzing synchronization of 19 diode lasers to produce intense beams.
- Continued efforts in nanostructures, novel electrolytes, and electrode materials to enable new 3D power source architectures to improve capacity of rechargeable lithium and lithium-ion batteries.
- Continued exploration and development of materials for high energy density passive power electronics (Capacitors).
- Continued expanding the fundamental understanding of direct electrochemical oxidation and the use of logistic fuels in solid oxide fuel cells.
- Continued identification of new approaches to efficiently convert thermal, electrical and optical energy from primary sources (optical-photovoltaics).
- Continued research tools design efforts in Chemical Dynamics and High Temperature Probes.
- Continued development of phase change cooling approaches for high power electronic devices.
- Continued development of multi-scale thermal modeling approaches.
- Continued development of non-vapor compression based refrigeration cycles.
- Completed efforts in fundamental understanding of novel solid polymer electrolytes.
- Completed work on developing the scientific basis of nanostructure enhancement of direct energy conversion materials performance for power generation.
- Completed expanding research into new thin-film and bulk materials and processes for converting thermal to electric energy such as identifying new high figure of merit thermoelectric materials.
- Initiated efforts developing science base for optimized combustion of alternative fuels.

Environmental Sciences
- Continued examination of scientific methods for pollution prevention, waste reduction, and hazardous material reduction for Naval Operations.
- Continued assessment of the fate and effects of chemical and biological contaminants in marine/estuarine environments.
- Continued broad based program in anti-fouling and fouling release coatings including investigation of effect of new polymers, materials, processes, and novel testing methodologies for coating efficacy.
- Continued effort to determine most promising foul-release approaches based on silicones to meet Navy durability requirements.
- Continued research tools design efforts in Sampling and Analytical Methodologies.

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PROGRAM ELEMENT: 0601153N PROGRAM ELEMENT TITLE: DEFENSE RESEARCH SCIENCES
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- Completed efforts to increase strength in silicone based polymers for anti-fouling/friction reduction coatings.
- Completed research on ultra-filtration membranes for bioreactors.
- Initiated effort to develop Reverse Osmosis (RO) pre-treatment strategies to allow water recycling on ships.

FY 2008 Plans:

Structural Materials
- Continue all efforts of FY 2007, less those noted as completed above.
- Complete development of physics-based models of thermal and materials flow during friction stir welding of high-strength low-alloy (HSLA-65) grade steel.
- Complete research into the area of transforming bio-fibrillose material into carbon nanotubes.
- Complete evaluation of new high temperature resin for potential Unmanned Combat Air System (UCAS) high temperature composite applications.
- Initiate research on new hybrid composites that integrate polymers, structural fibers, carbon nanotubes, ceramics and metals, with improved blast, ballistic, fire resistance and mechanical characteristics with special emphasis at the interfacial aspects of the new materials.
- Initiate efforts to understand and predict salt chemistry effects on high temperature coatings and materials in naval gas turbine environments.
- Initiate understanding for development of modeling tools for enhancing dynamic response and projectile resistance for sandwich structures.
- Initiate efforts to understand the thermomechanical links during complex chemical reaction paths and atomic diffusion during the degradation of high temperature thermal and environmental barrier coatings.
- Initiate the exploration of naval titanium alloys designed a priori for both performance and friction stir weldability.

Functional Materials
- Continue all efforts of FY 2007, less those noted as completed above.
- Complete investigation of radically new hierarchical polymer lenses that mimic the focusing of an eye. (NRL)
- Initiate high temperature, low frictional sliding coefficient coating materials for gas turbine bearing at high operating temperatures.

BUDGET ACTIVITY: 01
PROGRAM ELEMENT: 0601153N PROGRAM ELEMENT TITLE: DEFENSE RESEARCH SCIENCES
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- Initiate exploration of innovative technologies such as capacitive micro-machined acoustic transducers for naval sonar systems.
- Initiate study of standoff detection of explosive materials and devices. (NRL)
- Initiate development of methods for the intentional, controlled, impurity doping of semiconductor nanocrystal wires.(NRL)
- Initiate effort to synthesize beta-SiC power suitable for subsequent densification into transparent beta-SiC ceramic.(NRL)
- Initiate meta-materials effort to develop negative index materials with dynamic frequency response.(NRL)

Maintenance Reduction
- Continue all efforts of FY 2007, less those noted as completed above.
- Initiate the concept study of multiscale corrosion modeling on naval ship materials.
- Initiate fundamental theoretical and experimental studies on nanoscale corrosion of metals and alloys.
- Initiate corrosion prediction using an integrated deterministic-based model.

Power Generation, Energy Conversion and Storage (Transferred to Air, Ground and Sea Vehicles R-2 Activity).

Environmental Science
- Continue all efforts of FY 2007, less those noted as completed above.
- Initiate efforts on treatment strategies of oily water containing synthetic lubricants.

FY 2009 Plans:

Structural Materials
- Continue all efforts of FY 2008, less those noted as completed above.
- Complete development of physics-based models of thermal and materials flow during friction stir welding of steels, including the development of residual stresses that will lead to distortion.
- Complete research tools design efforts in dynamic three dimensional control of structures.
- Complete research tools design efforts in chemical dynamics.
- Complete development of progressive damage models for blast effects on composite marine structures.
- Initiate alloy modeling for advanced material optimization for high temperature gas turbine applications.
- Initiate development of understanding and constitutive models of competing and complementary microstructural factors influencing both dynamic behavior and weldability of high strength steels and naval titanium alloys.

BUDGET ACTIVITY: 01
PROGRAM ELEMENT: 0601153N PROGRAM ELEMENT TITLE: DEFENSE RESEARCH SCIENCES
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- Initiate expansion of first-principles methods devised to calculate piezoelectric properties of materials for sonar transducers to calculate additional materials properties for other applications.
- Initiate multi-energy processing approaches for the room temperature cure of polymeric materials with high temperature thermoxidative stability and fire resistance.
- Initiate the fatigue life prediction model analysis on high temperature engine materials.
- Initiate fundamental research on catalytic activation via tuned lasers for optimized fuel generation.
- Initiate development of new methods for room temperature curing and processing of polymer composites with high temperature oxidative stability and fire resistance.
- Initiate investigation of advanced materials contributions to blast and projectile resistance of cellular structures.
- Initiate assessment of the blast resistance of cellular structures as functions of soil characteristics.

Functional Materials
- Continue all efforts of FY 2008, less those noted as completed above.
- Initiate design, processing, and measurements to fashion the new generation of high-strain, high coupling piezoelectric single crystals into high-performance acoustic transducers for naval sonar systems.
- Initiate basic research into material technology associated with the development of active and conventional armor.

Maintenance Reduction
- Continue all efforts of FY 2008.
- Complete identification of stress corrosion control methods for friction stir welded high-strength aluminum alloys using advanced thermal treatments, chemical modifications, and surface mechanical processes to tailor compressive stresses.
- Initiate the investigation of processing science (single crystals, coatings, thermal barrier coatings (TBC), heat treatment, etc) to materials performance to develop relevant process protocols to optimize and control quality.
- Initiate research on innovative concepts for effective radiation barrier coatings and ultra-low thermal conductivity barrier coatings.
- Initiate studies of the interfacial reactions between coatings and evolving substrates (Mo-Si-B, CMCs) involving first principal calculations leading to predictive living models at temperatures from 2400F to 3600F.

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- Initiate the investigation of the influence of environments (thermal, oxidation, corrosion, temperature gradients, and contaminants) on oxide growth rates, stress generation, coating adherence, durability, and lifing for aircraft and ship applications.
- Initiate grain boundary engineering to improve corrosion resistance of marine grade aluminum alloys.
- Initiate studies of surface microstructure optimization to enhance corrosion properties of navy marine alloys
- Initiate sensor development for monitoring microstructural changes on alloys under thermal and mechanical stresses.
- Initiate research focused on modeling and simulation for platform and system affordability, lifetime materials, shipboard wireless capability, automation to reduce manning.

Environmental Science
- Continue all efforts of FY 2008.
- Complete assessment of the fate and effects of chemical and biological contaminants in marine/estuarine environments.
- Complete research tools design efforts in Sampling and Analytical Methodologies.

Manufacturing Science
- Initiate a multidisciplinary research task into furthering the sciences associated with advances in manufacturing processes

	FY 2007	FY 2008	FY 2009
MEDICAL/BIOLOGY	13,459	14,838	14,787

Efforts include: biosensors, biomaterials, bioprocesses; marine mammals; casualty care and management; healthy and fit force; casualty prevention; undersea medicine/hyperbaric physiology; biorobotics; expeditionary operations training and education; and chemical-biological defense. These efforts are coordinated with the Army and Air Force through joint program reviews and are complementary, not duplicative. Beginning in FY 2009, this activity includes the Basic Research Challenge which is a competitive investment based on proposed scientific activities within the Office of Naval Research Science and Technology (S&T) departments. Accomplishments and plans described below are examples for each effort category.

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This activity also includes Secretary of Defense directed peer-review basic research to develop innovative solutions and enhance the science and engineering base.

FY 2007 Accomplishments:

Medical Sciences
- Continued research to understand individual variability in stress response.
- Continued non-lethal weapons bioeffects research.
- Continued work on stress physiology, hyperbaric physiology, and biological effects of Naval operational exposures (e.g., directed energy).
- Continued work in understanding the mechanisms of decompression illness and hyperbaric oxygen toxicity.
- Continued work on genomics/genetics of infectious organisms of military relevance and signal of transduction.
- Continued research in casualty care and management, healthy and fit force, and casualty prevention, including investigations of mechanisms of hemorrhagic shock, blast injury, tissue repair, and the biomedical effects of military operational exposures such as directed energy, hazardous chemicals, and sound.
- Continued research in Genetic Polymorphisms, the stress response and their Interaction with the Immune System.
- Initiated research to explore systematic relationships between cognitive and physiological responses to laboratory tasks under operational conditions.

Biological Sciences
- Continued studies of effects of man-made sound on marine mammal hearing and behavior.
- Continued research to understand physiological effects of Naval sonar exposures on marine mammals.
- Continued work to power naval ocean instruments with sediment biofuel cells and to elucidate the microbial processes that drive energy harvesting in these systems.
- Continued research on biofouling with emphasis on barnacle adhesion studies using molecular biology tools.
- Continued genetic analysis and genomics to facilitate efforts to understand anaerobic microbial transformation of polycyclic aromatic hydrocarbons and polychlorinated biphenyls in estuarine sediments, and eelgrass-mediated degradation under aerobic conditions.
- Continued work on microbial synthesis of energetic materials.
- Continued efforts to develop next-generation and supramolecular antibiotics.
- Continued research of toxicity and enzymatic pathways of biodegradation of Royal Demolition Explosive (RDX), High Melting Point Explosive (HMX) and Dinitrotoluene (DNT) in marine benthos.

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PROGRAM ELEMENT: 0601153N PROGRAM ELEMENT TITLE: DEFENSE RESEARCH SCIENCES
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- Continued dolphin microarray and gene-based studies to facilitate immunobiology studies of stress response.
- Continued efforts focused on microbe-materials interfacial interactions to detect materials defects/failures.
- Continued research on biofouling microbial community succession and invertebrate larval settlement in response to biofilms.
- Continued biogeochemical research of Mississippi Sound sediments: Hurricane Katrina effects and recovery.
- Continued research to understand physiological effects of sound exposure on marine mammals from Navy sound sources other than sonar.
- Initiated efforts in "smart cell engineering" to design microbes that can sense and destroy other microbes through antibiotic production, or can "sense" and qualify their surrounding environment and provide information back to the user.
- Initiated efforts in biomolecular materials, to include 2D self-assembled bioorganic/inorganic arrays as functional materials; biomimetic adhesives for underwater use; bioelectrochemistry and electrode studies associated with microbial fuel cells; self-assembling nano-sculpted surfaces polymers for biofouling studies; stochastic protein-quantum dot nanoswitches.
- Initiated combinatorial chemical screens for bacterial communication pathway inhibitors as potential antibiotics or fouling-control agents.

FY 2008 Plans:

Medical Sciences
- Continue all efforts of FY 2007.
- Initiate research in the mechanism/effects of underwater thermal stress.

Biological Sciences
- Continue all efforts of FY 2007.
- Complete efforts directed at genomics-enabled anaerobic transformation of polycyclic aromatic hydrocarbons (PAHs) and polychlorinated biphenyls (PCBs) in estuarine sediments.
- Complete efforts focused on eelgrass-mediated degradation of PAHs and PCBs.
- Complete efforts to develop next-generation and supramolecular antibiotics.
- Initiate efforts to engineer plants to produce high value naval materials.
- Initiate efforts utilizing metagenomic screens to identify novel bacterial activities related to nitration or synthesis of high-N heterocycles.

BUDGET ACTIVITY: 01
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FY 2009 Plans:

Medical Sciences
- Continue all efforts of FY 2008.

Biological Sciences
- Continue all efforts of FY 2008, less those noted as completed above.
- Initiate increased emphasis in efforts focused on microbe-materials interfacial interactions for detection of materials defects/failures, including corrosion, and for improved energy harvesting.
- Initiate increased emphasis in research on invertebrate larval settlement and metamorphosis in response to biofilms and various inhibitors of adhesion.
- Initiate increased advanced medical research for battlefield trauma.
- Complete research on biofouling microbial community succession.
- Complete dolphin miroarray and gene-based studies to facilitate immunobiology studies of stress response.
- Complete efforts on biomimetic adhesives for underwater use.
- Complete biogeochemical research of Mississippi Sound sediments: Hurricane Katrina effects and recovery.
- Complete research on toxicity and enzymatic pathways of biodegradation of Royal Demolition Explosive (RDX), High Melting Point Explosive (HMX) and Dinitrotoluene (DNT) in marine benthos.
- Initiate research on molecular biomimetics for naval applications.
- Initiate efforts to identify molecular biomarkers for battlefield injuries, and high-fidelity biosensors for detection in vivo.
- Initiate research into biomolecular 'logic controllers' for in vivo biosensor and in vivo drug delivery systems
- Initiate research on engineered cells for infection detection and treatment in wounds
- Initiate work to identify plasma biomarkers of domoic acid toxicosis and leptospirosis in California sea lions, and develop a multiplexed assay to measure those plasma biomarkers.
- Initiate research to identify inhibitors of lateral DNA transfer in bacteria
- Initiate research to explore novel dressings that mitigate burn pain and will control infection.
- Initiate research efforts focused on developing bio-inspired sensors, vehicles and systems for local ISR, WMD detection, personnel protection and affordability. Research elements include advances in microfabrication, biological materials, processing techniques, robustness and efficiency of systems.

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	FY 2007	FY 2008	FY 2009
OCEAN SCIENCES	80,836	84,710	88,840

Efforts include: Littoral Geosciences, Optics, and Biology; Marine Mammals; Physical Oceanography and Prediction; and Ocean Acoustics. Beginning in FY 2009, this activity includes the Basic Research Challenge which is a competitive investment based on proposed scientific activities within the Office of Naval Research Science and Technology (S&T) departments. Accomplishments and plans described below are examples for each effort category.

This activity also includes Secretary of Defense directed peer-review basic research to develop innovative solutions and enhance the science and engineering base.

FY 2007 Accomplishments:

Littoral Geosciences, Optics, and Biology
- Continued field programs to understand physical and biological processes responsible for the formation, maintenance, and breakdown of thin oceanographic layers which have a significant impact on undersea warfare sensors and weapons.
- Continued field, laboratory, and numerical studies of seafloor sand ripple genesis, evolution, and destruction and their effect on acoustical penetration of the sea floor.
- Continued efforts to investigate the effects of oceanic biota on the propagation and inversion of multi-frequency acoustical energy.
- Continued investigations of sources and properties of light scatter within the coastal ocean.
- Continued to investigate the physical processes that control re-suspension of bottom sediments and the resulting impact on optical and acoustical propagation.
- Continued investigations of oceanic processes within the surface boundary layer that control high-frequency variability in image propagation and distortion.
- Continued to investigate and characterize the impact of riverine sources of optically-important matter on underwater visibility, navigation, and surveillance.
- Continued field program to infer sea floor characteristics from observations of surface gravity waves.
- Continued effort to improve accuracy of the "5-cm gravimetric geoid" and precise geodesy. (NRL)
- Continued effort to use time sequencing NRL PHILLS (Portable Hyperspectral Imager for Low-light Spectroscopy) images of the same scene to derive dynamical properties of the ocean surface. (NRL)

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- Continued effort to investigate the use of combining Light Detection and Ranging and passive hyperspectral sensing to derive bottom characteristics and water column optical properties over water and terrestrial vegetation and trafficability maps over land. (NRL)
- Continued effort to understand and predict coastal dynamics in environments where significant sediment heterogeneity occurs, impacting on hydrodynamic and morphodynamic processes, including six week, April-May, field efforts off Cassino Beach, Brazil, subject to sudden, large muddy beach deposits. (NRL)
- Continued effort to understand the extent and intensity of seafloor gas hydrate accumulations and coastal bio-optical response to air-ocean forcing. (Includes NRL investment/performance in this effort.)
- Continued programs to estimate optical properties of coastal ocean water from above-surface sensing, using in-situ data for validation.
- Initiated studies to predict tidal flat evolution in coastal/riverine/estuarine systems.
- Initiated incorporation of improved understanding of tropospheric and stratospheric bulk exchanges, air-sea interface, boundary layer interface, coastal ocean dynamics, gas hydrate accumulation, and biological responses into atmospheric and ocean prediction models and tactical aids. (Includes NRL investment/performance in this effort.)

Marine Mammals
- Continued field trials of an integrative ecosystem study to provide environmental predictors of whale presence or absence to reduce impacts of Naval systems to marine mammals.
- Continued new efforts on tracking of marine mammals using data fusion based on tags and remote sensing.
- Completed study of an integrative ecosystem study to provide environmental predictors of whale presence or absence to reduce impacts of Naval systems to marine mammals.

Physical Oceanography and Prediction
- Continued field studies/modeling to predict propagation and effect on acoustics of non-linear internal waves in the western Pacific.
- Continued studies to understand how to sample ocean processes with gliders and other autonomous and remote sensing systems to support tactical oceanography.
- Continued development of a ship wave radar driven wave model to allow high resolution studies of near surface ocean processes and to support Sea Basing.
- Continued to develop state of the art numerical model assimilation and initialization techniques, improved physical parameterizations, air-sea interactions, and fidelity for atmospheric and ocean prediction systems. (Includes NRL investment/performance in this effort.)

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- Continued extensive internal wave field program off the New Jersey Shelf; field work will coincide with and complement the Shallow Water Acoustics Program.
- Continued an assessment of the role of emerging sub-mesoscale parameterization techniques for improving next generation high resolution/high accuracy environmental models.
- Continued design evaluation for a persistent mobile sampling network based on autonomous undersea vehicle platform and sensor technologies.
- Continued extensive 3-year field program on prediction of internal waves; Spring FY 05 field work in the South China Sea collected unique data sets on extremely large internal waves, acoustics in internal wave fields, transmission loss, and dissipation in areas of internal wave breaking.
- Continued first field test of the Optimal Deployment Dri (ODDAS) in the South China Sea.
- Continued 5-year program on the analysis of coherent structures in rivers and estuaries in support of the prediction and characterization of denied areas.
- Continued effort to understand the bio-optical response to dynamical forcing processes and how to assimilate optical properties into a physical ocean model for predictive purposes. (NRL)
- Continued a field and modeling program to predict mesoscale structures and rapidly-varying currents in the Philippine Archipelago using Synthetic Aperture Radar (SAR), Hyperspectral and other remote data together with new data assimilation methods.
- Continued field programs that demonstrate “persistent monitoring and measurement of environmental structures using gliders.
- Continued workshops to define science needs for Sea Basing.
- Continued the field experiment in Monterey Bay to examine the role of unresolved processes in model parameterizations.
- Continued the development of breaking wave detection techniques using Hilbert transformation of the space-time series of surface waves and the capability of establishing empirical functions connecting wave breaking properties to the generation and entrainment of bubble clouds. (NRL)
- Initiated a Coupled Oceanographic-Acoustics modeling and field program to demonstrate the use of a fully coupled system in optimizing tactical reduction of uncertainty.
- Initiated an integrated modeling and field experiment on determining custom self-learning wave databases and forecast systems/ship-movement and engineering systems for Sea Basing.
- Initiated the pilot test of the novel data (synthetic aperture radar and Hyper-spectral) assimilation forecast system developed under Philippine experiment.
- Initiated an Estuarine-Littoral Processes Interaction field study in muddy and tidal flat dominated regimes including a data assimilative prediction capability.

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Ocean Acoustics
- Continued analysis of deep-water acoustic transmissions made in the North Pacific to understand the scattered sound field due to ocean volume variability and bathymetric features.
- Continued field experiments and modeling efforts to examine the performance of Acoustic Vector Sensors.
- Continued a field and modeling effort to simultaneously study shallow-water medium fluctuations and develop time-reversal communications using adaptive channel equalizers.
- Continued analysis and modeling to understand the physics of buried mine detection though broadband and synthetic aperture sonar.
- Continued shallow-water, shelf-break measurements and analysis to characterize the effects of the ocean water column and seabed variability on low- and mid-frequency acoustic propagation and scattering.
- Continued a field and modeling effort to establish the capabilities of underwater acoustic communications for Forcenet and persistent undersea surveillance.
- Continued the development and testing of geo-acoustic inversion and extrapolation methods.
- Continued investigations into quantifying, predicting and exploiting uncertainty in acoustic prediction models.
- Continued to research effect of solitons and internal wave bores on acoustic propagation and buoyancy. (Includes NRL investment/performance in this effort.)
- Continued studies of adaptive beam-forming using mobile, autonomous sensors.
- Continued development of realistic seismo-acoustic model for sediment geology. (NRL)
- Continued investigation of acoustically induced magnetic fields using modern experimental equipment and numerical techniques. (NRL)
- Continued development of source waveform design for rough littoral seafloors. (NRL)
- Continued development of "time-reversal" characterization of bubble field dynamics. (NRL)
- Completed development of the Nonlinear Progressive Wave Equation model. (NRL)
- Completed investigations of analogs of condensed matter physics phenomena in ocean acoustics. (NRL)
- Initiated research to develop complex analytic equations that couple oceanographic modes, both horizontal and vertical, to their corresponding frequency-dependent acoustic modes to give direct acoustic prediction capability. (NRL)
- Initiated research to enhance understanding of the vibrational response of elastic structures to flow-induced excitation while developing a first-principles model for the induced structural acoustic response and reradiated acoustic field. (NRL)
- Initiated research to quantify uncertainty in acoustic field computations for multi-scale ocean environments using novel approaches involving Bayesian prediction and polynomial chaos expansions to embed environmental uncertainty into multi-scale ocean dynamics and acoustic propagation. (NRL)

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- Initiated assessment of "time-reversal" propagation techniques for mitigation of environmental variability.
- Initiated field work on adaptive beam-forming using mobile, autonomous sensors.

FY 2008 Plans:

Littoral Geosciences, Optics, and Biology
- Continue all efforts of FY 2007.
- Initiate development of prediction models for distributary deltaic coastal environments.

Marine Mammals
- Continue all efforts of FY 2007, less those noted as completed above.

Physical Oceanography and Prediction
- Continue all efforts of FY 2007.
- Enhance studies of internal waves and strait dynamics emphasizing field studies in the Celebes, Philippine, and Sulu Seas.
- Enhance studies of complex ocean currents in the Indian Ocean using gliders and remote sensing methods being developed to support tactical oceanography.
- Initiate development of expert system methods to characterize and predict Riverine/estuarine systems to support Naval Special Warfare, Marine Expeditionary Forces and new Riverine units.

Ocean Acoustics
- Continue all efforts of FY 2007, less those noted as completed above.
- Complete development of realistic seismo-acoustic model for sediment geology. (NRL)
- Complete investigation of acoustically induced magnetic fields using modern experimental equipment and numerical techniques. (NRL)
- Complete development of source waveform design for rough littoral seafloors. (NRL)
- Complete development of ""time-reversal"" characterization of bubble field dynamics. (NRL)
- Initiate effort to understand synoptic scale ocean variability in the strategic Turkish Straits System including water mass exchange between basins and vertical mixing. (NRL)
- Initiate effort to develop a methodology for expressing the semantics of physics-based environmental models to support automated computer applications. (NRL)
- Initiate development of algorithms for accurate acoustic predictions in dispersive, turbulent, turbid water. (NRL)

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- Initiate effort to understand how mudflat sediments respond to dynamic processes. (NRL)

FY 2009 Plans:

Littoral Geosciences, Optics, and Biology
- Continue all efforts of FY 2008.
- Initiate studies of tidal flat evolution in wave dominated environments.

Marine Mammals
- Continue all efforts of FY 2008.

Physical Oceanography and Prediction
- Continue all efforts of FY 2008.
- Complete studies of internal wave propagation in the South China Sea.
- Initiate studies of ocean and wave response to typhoons and monsoons in the Western Pacific.
- Initiate studies of how to predict the 'full battle space environmental cube' using networked sensors and multiply coupled ocean/wave/atmosphere/acoustic prediction systems to provide sea base and fleet force protection.

Ocean Acoustics
- Continue all efforts of FY 2008, less those noted as completed above.
- Enhance deep-water acoustic transmission measurements with emphasis on the Northern Philippine Sea.
- Complete development of complex analytic equations that couple oceanographic modes, both horizontal and vertical, to their corresponding frequency-dependent acoustic modes to give direct acoustic prediction capability. (NRL)
- Complete development of enhanced understanding of the vibrational response of elastic structures to flow-induced excitation while developing a first-principles model for the induced structural acoustic response and reradiated acoustic field. (NRL)

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Exhibit R-2a

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	FY 2007	FY 2008	FY 2009
SCIENCE AND ENGINEERING EDUCATION, CAREER DEVELOPMENT AND OUTREACH	40,820	36,404	33,699

Science and Engineering Education and Career Development activities include DON participation in science fairs, summer research interns/fellows at Navy laboratories, graduate fellowships for individuals expected to become members of the engineering faculty at Historically Black Colleges and Universities and Minority Institutions (HBCU/MIs), and curricular enrichment programs. Outreach includes the encouragement, promotion, planning, coordination and administration of Naval Science and Technology.

FY 2007 Accomplishments:

- Continued awarding prizes at 400 regional high school science fairs and three national competitions.
- Continued supporting 203 high school summer interns at Navy laboratories.
- Continued supporting 230 undergraduate/graduate students as summer research interns at Navy laboratories.
- Continued providing graduate fellowship support to nine HBCU engineering faculty candidates.
- Continued funding Young Investigator research grants including 7 new three-year research grants.
- Continued the encouragement, promotion, planning, coordination and administration of naval Science and Technology.

FY 2008 Plans:

- Continue all efforts of FY 2007.

FY 2009 Plans:

- Continue all efforts of FY 2008.

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	FY 2007	FY 2008	FY 2009
SENSORS, ELECTRONICS AND ELECTRONIC WARFARE (EW)	40,085	42,974	49,474

Efforts include: Sensing, diagnostics, and detectors; navigation and timekeeping; nano-electronics; wide band gap power devices; real-time targeting; Electro-Optical/Infra Red (EO/IR) electronics; EO/IR electronic warfare; EO/IR sensors for surface/aerospace surveillance; Radio Frequency (RF) sensors for surface/aerospace surveillance; solid state electronics; vacuum electronics; Integrated Topside Innovative Naval Prototype (ITS INP); and RF electronic warfare. Beginning in FY 2009, this activity includes the Basic Research Challenge which is a competitive investment based on proposed scientific activities within the Office of Naval Research Science and Technology (S&T) departments.

Change from FY 2007 to FY 2008 reflects a increased level of investment and effort for networked sensors (+$3M), nanoelectronics (+$1M), and solid state electronics (+$1M) increased . Most other areas within this activity underwent minor shifts in emphasis that are reflected in the distribution of funds. These year-to-year continuations do not remain perfectly flat, but rather fluctuate depending on the required investment profile necessary to achieve the program's objectives and schedule.

As directed by the Secretary of Defense, this activity reflects a increase from FY 2008 to FY 2009 for Basic Research (6.1) to fund peer-reviewed research to develop innovative solutions and enhance the science and engineering base. The increase from FY 2008 to FY 2009 also includes the Basic Research Challenge which is a competitive investment based on proposed scientific activities within the Office of Naval Research Science and Technology (S&T) departments.

FY 2007 Accomplishments:

- Continued the evaluation and assessment of hardware-compatible space-time algorithms for Digital Signal Processor (DSP) applications to T/R arrays.
- Continued monolithic integration of multifunctional materials to enable passive devices and sensors into wide bandgap semiconductor circuits.
- Continued investigation of temporal-spatial noise shaping circuits and architectures for high power digital-to-analog conversion with objectives of doubling spectral bandwidth, reduction of element density (15%), and extension of multidimensional Nyquist limits to both linear and planar arrays.
- Continued project to develop linear higher power microwave wide bandgap semiconductor bipolar transistors based on distributed polarization effect (graded composition) base growth and processing technology.

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- Continued effort to increase power conversion efficiency in an organic plastic solar cell based on Carbon 60 and a transparent hole transporter, and a conducting polymer electrode with achievement of > 4%
- Continued the analysis and characterization of micro-motion Doppler modulation.
- Continued investigation of extension of interference model and adaptive structures to produce waveforms that are transparent to non-users.
- Continued investigation of physical basis for improved time and frequency standards using quantum-entangled ions and atoms.
- Continued project to explore physical behavior of full arrays of nanoscale devices for logic, memory, and imaging, with a first step being the integration of Cellular Nonlinear Network (CNN) fast image processor with multi-spectral focal plane array sensors.
- Continued development of sensitive miniature fluxgate magnetometers.
- Continued studies to optimize power and efficiency of compact, high power, electron beam pumped Argon-Xenon (Ar-Xe) laser for Navy directed energy weapons (DEW). (NRL)
- Continued to analyze effects of maritime and urban aerosols on thermal blooming of high energy laser beams. (NRL)
- Continued investigation of super-resolution signal processing techniques for closely spaced and unresolved targets in Doppler, range and direction of arrival spaces for a variety of radars.
- Continued non-cooperative target identification from multiple aspects.
- Continued investigation of ultra high speed logic and multiple-quantum-well devices with a goal of >500 giga-hertz (GHz) samplers, in support of mixed signal circuits for receiver analog-to-digital converters (ADC's).
- Continued program to extend device performance and architectures to frequencies approaching tera hertz (THz).
- Continued program to incorporate Magnesium Diboride (MgB2) tunnel junctions into simple electronic logic structures.
- Continued development of stabilized optical sources and low-noise photodetectors for the fabrication of an ultrastable microwave-frequency source. (NRL)
- Continued development of a blind adaptive beamforming approach for the HF radar case and compare with both the conventional and traditional approaches. (NRL)
- Continued research to improve integrated nanomechanical device arrays to include scaling down resonator architecture and quantifying properties which establish phononic crystal properties. (NRL)
- Continued research to develop electromagnetic ultra-near-field holography. (NRL)
- Continued study to determine if the coupling between spins in quantum dots mediated by the virtual excitons is sufficiently strong for use in solid state implementations for quantum information. (NRL)

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- Continued development of approaches for probability of detection for deterministic signals in stationary noise and quantify for non-stationary noise. (NRL)
- Continued program on advanced epitaxial growth for novel Si-based detector applications. (NRL)
- Completed advanced height finding and detection algorithms for high frequency radar.
- Completed exploitation of atom condensates to reach physical limit of frequency precision and control.
- Completed investigation of extension of interference model and adaptive structures to produce waveforms that are transparent to non-users.
- Completed investigations of the modification of metal surfaces by nitriding and other processes to maximize hardness, wear and corrosion resistance for Navy gun barrel applications using the large area plasma processing system (LAPPS). (NRL)
- Completed analysis and characterize observed micro-motion features and components obtained in experiments. Create a framework for analysis of Doppler modulations. (NRL)
- Completed material and structural improvements in type-II superlattice IR photodiodes operating in the long wavelength and very long wavelength IR ranges. (NRL)
- Completed development of multi-time and length scale step modeling of heat propagation in bare and packaged wide bandgap power amplifiers, experimental verification of the models, and testing of the role of temperature in observed history effects, non-linearity, and device failure mechanisms.
- Initiated study of the feasibility of a solid state implementation of a quantum computer. (NRL)
- Initiated research of a novel extension of the Generalized Radon Transform to establish appropriate wavenumber representations for arbitrarily oriented wave guides, surfaces, and structures. (NRL)
- Initiated development of a general mathematical framework for developing advanced infrared countermeasures and analyzing/optimizing their effectiveness. (NRL)
- Initiated work on optical manipulation of ultra-cold atoms. (NRL)
- Initiated a program on the study of Quantum Dots and their application to coherent wavefunction control and quantum information. (NRL)
- Initiated a program on the control of deleterious defects in silicon carbide (SiC). (NRL)
- Initiated a program on the tailoring of the optical, structural and electronic properties of semiconductor quantum wires. (NRL)
- Initiated a program to apply innovative mass nanofabrication techniques to previously developed nanodevice arrays.
- Initiated a program to demonstrate non-volatile memory, based on spin-torque MRAM, with switching speed > 1 GHz and write currents small enough (<1 mA) to be driven by superconducting Rapid Single Flux Quantum (RSFQ) logic.

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- Initiated a program to determine if the newly invented Reciprocal Flux Quantum Logic in fact delivers 2x higher speeds with 5x fewer Josephson junctions and power, while using the same underlying devices so that single chip hybrid circuits between it and the dominant RSFQ logic are feasible.
- Initiated a program to investigate whether pattern dependent RF currents during plasma etching are responsible for observed variability in Josephson junction characteristics in complex circuits and, if so, define design rule changes to avoid the effects.
- Initiated demonstrations of tunable analog filters made in a digital Nb device foundry.
- Initiated development of techniques to observe directly the electrical properties of pair states in high temperature superconductors.

FY 2008 Plans:

- Continue all efforts of FY 2007, less those noted as completed above.
- Transition Cellular Nonlinear Network (CNN) fast image processor with multi-spectral focal plane array sensors to 6.2 research.
- Complete the analysis and characterization of micro-motion Doppler modulation.
- Complete the evaluation and assessment of hardware-compatible space-time algorithms for Digital Signal Processing (DSP) applications to T/R arrays.
- Complete investigation of temporal-spatial noise shaping circuits and architectures for high power digital-to-analog conversion with objectives of doubling spectral bandwidth, reduction of element density (15%), and extension of multidimensional Nyquist limits to both linear and planar arrays.
- Complete project to explore physical behavior of full arrays of nanoscale devices for logic, memory, and imaging.
- Complete investigation of super-resolution signal processing techniques for closely spaced and unresolved targets in Doppler, range and direction of arrival spaces for a variety of radars.
- Complete development of sensitive miniature fluxgate magnetometers.
- Complete development of approaches for probability of detection for deterministic signals in stationary noise and quantify for non-stationary noise. (NRL)
- Complete development of a blind adaptive beamforming approach for the HF radar case and compare with both the conventional and traditional approaches. (NRL)
- Complete analyzing effects of maritime and urban aerosols on thermal blooming of high energy laser beams. (NRL)
- Complete the initial study of the coherent control of wavefunctions in quantum dots. (NRL)

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- Complete the demonstration of control of the concentrations of the defects that limit the minority carrier lifetime in SiC. (NRL)
- Complete the growth of semiconductor quantum wires with controlled doping and heterostructure interfaces. (NRL)
- Complete improvements to integrated nanomechanical device arrays to include scaling down resonator architecture and quantifying properties which establish phononic crystal properties. (NRL)
- Complete development of electromagnetic ultra-near-field holography. (NRL)
- Initiate investigation of temporal-spatial noise shaping circuits and architectures for analog-to-digital conversion.
- Initiate research effort to investigate target and signal characteristics based on non-Archimedean geometry.
- Initiate research effort to investigate multiple input multiple output (MIMO) signal analysis and characterization with application to wide area surveillance.
- Initiate research to improve mixed signal III-V device and circuit modeling with objectives of achieving a 30 dB dynamic range improvement for complex circuits containing over 100,000 devices.
- Initiate investigation of impedance properties and harmonic noise canceling for highly efficient digital and mixed signal amplifiers which operate in an electronically scanned array environment.
- Initiate project to explore semiconductor nanowire transport phenomena, doping and heterostructure characterization.
- Initiate carbon nanotube based electron device exploration.
- Initiate investigation of optical techniques to coherently manipulate, control, and guide ultra-cold atoms, studying their dynamics and interactions experimentally and theoretically. (NRL)
- Initiate growth of graphene using Molecular Beam Epitaxy (MBE) and metalorganic chemical vapor deposition (MOCVD) methods. (NRL)
- Initiate extraction of signal-network patterns from mammalian cells to use as unique identifiers of toxin, viral, or bacterial stimuli. (NRL)
- Initiate development of a novel Domain Decomposition (DD) technique to analyze performance of large electromagnetic surface critical to future Navy radar systems. (NRL)

FY 2009 Plans:

- Continue all efforts of FY 2008, less those noted as completed above.
- Complete investigation of extension of interference model and adaptive structures to produce waveforms that are transparent to non-users.

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- Complete non-cooperative target identification from multiple aspects.
- Complete wide band gap semiconductor materials growth and characterization research
- Complete development of a general mathematical framework for developing advanced infrared countermeasures and analyzing/optimizing their effectiveness. (NRL)
- Complete the demonstration of single and two-qubit operations of spins in quantum dots. (NRL)
- Complete the study of defects involved in limiting the minority carrier lifetime in SiC. (NRL)
- Complete the study of the use of InAs, Ga2O3 quantum wires for optical, structural and electronic applications. (NRL)
- Initiate thermal management technology research for power electrical and power RF devices, circuits, integrated circuits (ICs), systems and platforms utilizing low temperature grown conformal diamond heat-spreader/sinking technologies
- Initiate program of investigation of Transductors, Transpacitors and Transponents utilizing hetero-structural, hetero-functional and graded multi-functional thin film systems.
- Initiate magneto-electric component investigation for electrically tuned magnetic RF components based on Terfenol and Terfenol semiconductor hetero-junction device concepts
- Initiate quantitative study of system performance expected from using various superconductive RF components in several naval surveillance systems.
- Initiate materials studies of low temperature regenerator (high thermal capacity) materials and/or controlled flow microstructures.
- Initiate project to explore graphene based nanoelectronic devices.
- Initiate atomic scale spin manipulation effort.
- Initiate project to reduce heat transfer through electrical leads in cryogenic packaging.
- Initiate project to explore development of devices, sigma delta and time encoder circuits for near THz switching with objectives of enabling analog and digital conversion at millimeter wave frequencies.
- Initiate high-sensitivity magnetometry using quantum logic.

	FY 2007	FY 2008	FY 2009
WEAPONS	11,043	13,172	13,804

Efforts include: Undersea Weaponry; Energetic Materials and Propulsion; Expeditionary Operations; and Directed Energy. Beginning in FY 2009, this activity includes the Basic Research Challenge which is a competitive investment based on proposed scientific activities within the Office of Naval Research Science and Technology (S&T) departments. Accomplishments and plans described below are examples for each effort category.

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This activity also includes Secretary of Defense directed peer-review basic research to develop innovative solutions and enhance the science and engineering base.

FY 2007 Accomplishments:

Undersea Weaponry
- Continued conducting basic research related to critical S&T (including vehicle control, maneuverability, and stability) associated with the development of high-speed supercavitating vehicles (HSSV).
- Continued expansion of the University Laboratory Initiative (ULI) Program to provide a further infusion of educated and career-minded scientists and engineers in support of the National Naval Responsibility (NNR) for Undersea Weapons Research.
- Continued computer code refinements and investigation of supercavitating vehicle dynamics and instability.
- Continued evaluation of viable synthesis methodologies and characterization of candidate explosive ingredients suitable for undersea weapons applications.
- Continued development of diagnostic capabilities to accurately determine aluminum combustion characteristics in oxidizing environments.

Energetic Materials and Propulsion
- Continued development of a fundamental understanding of initiation mechanisms of explosive crystals subjected to shock stimulus.
- Continued exploring the use of quantum mechanics and molecular dynamics to provide fundamental properties for energetic materials to predict initiation/detonation criteria for insensitive munitions applications.
- Continued investigation of JP-10 combustion-based Proton-Exchange-Membrane (PEM) fuel cells.
- Continued investigation of multi-tube multi-nozzle Pulse Detonation Engines (PDEs) and multi-tube common nozzle PDEs.
- Continued investigation of nanometallic-hydrocarbon hybrid catalytic combustion for increased energy release rates.
- Continued investigation of novel initiation techniques, optimize injection parameters, and demonstrate integrated single tube operation for PDEs.
- Continued Advanced Energetics research in reactive, explosive, and propulsive energetic materials, including high energy ingredient synthesis & characterization, and fundamentals of initiation and decomposition mechanisms, to tailor energy release processes in order to achieve substantial performance gains and/or enhanced survivability in harsh environments.

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- Continued to develop fundamental understanding of nitramine and perchlorate decomposition mechanisms for propellant applications.
- Continued to develop organometallic-based highly energetic ingredients.
- Continued efforts to explore alternative fuel concepts for Naval applications to include hydrogen, synthetic diesel, and biodiesel.
- Continued development of multi-parameter sensor for multi-phase combustion flows (UAV and underwater PDEs).
- Continued implementation of new & nanostructured materials design concepts for direct energy conversion and waste energy conversion.
- Continued investigation of integrated pulse detonation engine-airframe for autonomous vehicles, and pulse detonation for passive weapons (noise, jamming).
- Completed transition portion of the HSSV ventilation requirements, control, and maneuvering approaches to the Defense Advanced Research Projects Agency (DARPA) Underwater Express Program.
- Initiated studies to determine the best investment of technologies for Unmanned Undersea Vehicle (UUV) Guidance and Control (G&C).
- Initiated hydroacoustics models and experiments to reduce the self noise on cavitator acoustic array.
- Initiated acoustic signal processing algorithms for HSSV guidance and control.
- Initiated development of new concepts for underwater power generation.
- Initiated development of non-lethal undersea warheads for Global War on Terror (GWOT).

Energetic Materials and Propulsion
- Initiated development of PDE for underwater applications.

Expeditionary Operations
- Continued investigation of catalysts that reduce the pre-processing requirements for using logistic fuels in solid oxide fuel cells.
- Completed investigation of modeling and exploiting the nonlinear seismic interactions between buried land mines and their surrounding soil for purposes of landmine detection.
- Initiated research in quantum optics, nano-microscale self assembly and molecular recognition for active forensic sensing

Directed Energy
- Continued research thrust in Directed Energy weapons.

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FY 2008 Plans:

Undersea Weaponry
- Continue all efforts of FY 2007.
- Complete computational fluid mechanics computer codes for supercavitating vehicles.
- Complete studies to determine the best investment of technologies for Unmanned Undersea Vehicle (UUV) Guidance and Control (G&C).

Energetic Materials and Propulsion
- Continue all efforts of FY 2007.

Expeditionary Operations
- Continue all efforts of FY 2007, less those noted as completed above.

Directed Energy
- Continue all efforts of FY 2007.
- Initiate directed energy development in the areas of advanced optical components and coatings for high energy lasers, high power injector and photocathode development, beam control and tracking research, terahertz source development and applications, femtosecond laser application studies, and the modeling and simulation of high power laser operation.

FY 2009 Plans:

Undersea Weaponry
- Continue all efforts of FY 2008, less those noted as completed above.
- Complete efforts in nonlinear control laws, gas ventilation, and vehicle stability associated with the development of high-speed supercavitating vehicles (HSSV).
- Complete hydroacoustics models and experiments to reduce the self noise on cavitator acoustic array.
- Initiate validation of hydroacoustic models and test and evaluate acoustic array signal processing algorithms.
- Initiate study on propulsion and its interaction with supercavitating cavity, and control surfaces.
- Initiate efforts to assess and expand electro-optical technology to enhance undersea warhead fuzing systems.
- Initiate acoustic concepts formulation and modeling for low-noise propulsion systems.

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Energetic Materials and Propulsion
- Continue all efforts of FY 2008.

Expeditionary Operations
- Continue all efforts of FY 2008.

Directed Energy
- Continue all efforts of FY 2008.
- Initiate multi-disciplinary efforts to include coherent beamforming, beam correction, turbulence effects on propagation, materials for high energy systems and sources.
- Initiate basic research in support of Electromagnetic railgun projectile.
- Initiate basic research into mechanisms supporting the defeat of speed of light weapons.

CONGRESSIONAL PLUS-UPS:

	FY 2007	FY 2008
BIO-INSPIRED MATERIALS - APPLICATIONS IN CATALYSIS, MAGNETICS, ELECTRONICS & MEDICINE	3,288	0

FY 2007 Accomplishments:

Completed studies of magnetic nanobiomaterial confinement to yield increased magnetic moment and modified surface anisotropy effects. Completed studies of nanoprotein cage platforms to rapidly detect and treat microbial biofilms, including marine biofilms. Conducted studies of efficient biological or bio-inspired catalysts coupled to specifically engineered semi-conductors to allow production of hydrogen gas from light.

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	FY 2007	FY 2008
CARBON NANOTUBE-BASED RADIATION-HARD NON-VOLATIVE RAM	5,877	0

FY 2007 Accomplishments:

Conducted research and testing of carbon nanotube based rad-hard non-volatile memory (NRAM). Demonstrated NRAM array operating at 5V and approaching Mbit in density. NRL conducted rad-hard qualification testing of small (16bit) NRAM arrays at MRad level.

	FY 2007	FY 2008
DOD AGILE MANUFACTURING CTR FOR CASTINGS TECHNOLOGY (AMCAST)	971	0

FY 2007 Accomplishments:

Completed efforts to develop the Rapid Cast Technology to produce high value metal castings on-demand for Navy and DoD applications. This technology involved using a rapid prototyping technique to fabricate sand molds and cores for rapid casting of metallic parts and components. The capability will become a part of the Naval Undersea Warfare Center - Keyport's efforts to integrate new repair and fabrication technologies for Fleet maintenance applications.

	FY 2007	FY 2008
ENERGETICS TECHNOLOGY CENTER/S&T WORKFORCE	4,982	2,384

FY 2007 Accomplishments:

Initiated research focus on design, processing, and implementation of micro/nano scale energetic systems, both for performance and reduced sensitivity applications. Initiated revitalization of workforce initiative.

FY 2008 Plans:

This effort supports energetics technology center/S&T workforce.

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	FY 2007	FY 2008
EVALUATING ELF SIGNALS IN MARITIME ENVIRONMENT	996	1,590

FY 2007 Accomplishments:

Initiated development and experimental evaluation of mathematical models of extremely low frequency (ELF) electromagnetic field propagation from underwater electric and magnetic sources. These models are important to the US Navy as applied to mine warfare, submarine detection and survivability, underwater communications, special operations and homeland security.

FY 2008 Plans:

This effort supports evaluating ELF signals in maritime environment.

	FY 2007	FY 2008
MARITIME DOMAIN AWARENESS	1,594	0

FY 2007 Accomplishments:

Completed efforts to provide analytical tools on automated information system information pertaining to maritime events performing motion based pattern analysis techniques. This effort focused on tracking large numbers of sea vessels and understanding those ships' normal behavior, detecting changes in their behavior and deriving threat intentions based upon deviations from known non hostile threat behaviors.

	FY 2007	FY 2008
MOBILE AD HOC DATA COMMUNICATIONS FOR UNMANNED SYSTEMS	1,262	795

FY 2007 Accomplishments:

Initiated development of several new technologies that support highly mobile network architectures in a tactical environment, including:

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(1)development of a simulation environment to model many network nodes without having to physically deploy large networks, as well as enhancements to these protocols to continue to improve system performance;
(2) development of a new form-factor for the current network processor that is compatible with a production Explosive Ordnance Disposal (EOD) robot to support evaluation for fielding; and
(3) development of a small form-factor video codec capable of real-time video coding and decoding.

FY 2008 Plans:

Continue development of a portable implementation of a system capable of performing both OBX and MSA. Perform limited testing of a prototype system, including baseboard waveform processor, power and frequency-adjusting adjunct devices, and high-mobility networking radio. These new approaches will allow the Explosive Ordinance Disposal community, and other warfighters, the capability to operate networks with substantially improved performance and system throughput. These new approaches are expected to allow for the operation of many robots in the same operating theater, where the current system can only support a limited number of simultaneously active robots.

	FY 2007	FY 2008
NAVY SCIENCE & TECHNOLOGY OUTREACH	0	795

FY 2008 Plans:

This effort is a collaborative K-12 technology-oriented mentoring program established between the Department of the Navy and the State of Virginia. The program seeks to generate and sustain the interest and excitement of adolescents in careers in science, technology, engineering and mathematics disciplines using a proactive mentoring environment incorporating school teachers, Navy R&D Center scientists and engineers working with Virginia middle school students. The goal of the program is to increase the number of students earning university degrees in science, mathematics, engineering, and technology and to foster the development of the next generation of technologists for our Naval Research and Development Centers. In addition to their teachers, mentors from Navy science and engineering staff work with school children in their classrooms. This program exposes participants to the excitement and challenge of careers in science, technology or engineering while providing school teachers with important interactions with the naval community. The program has provided students with important interactions with career role models from among the Navy and academic communities. These interactions are strengthening peer, family, school and community support for technical collaborations and better ensure long term inclusiveness of women and minorities in science and technology

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programs. As a result of this program we expect to see an increase in the number of students taking college-prep mathematics and science courses as well as an increase in the number of students receiving degrees in engineering, mathematics and the physical sciences.

	FY 2007	FY 2008
NAVY USE OF UNOLS SHIPS	4,383	0

FY 2007 Accomplishments:

Completed tasks to provide additional vessel infrastructure and mission equipment upgrades and augmentations to benefit the overall capabilities of the vessels. This will enable such activities as overhaul of Z drive propulsion motors; replacement of over-the-side handling equipment with new, motion-compensated systems to improve safety of operations in rough seas; and further improvements in ship habitability. In addition, a portion of the funding was used to augment selected scientific cruises to maximize the return on initial base funding investments for at-sea experiments and research projects data collection.

	FY 2007	FY 2008
ONAMI NANOELECTRONICS AND NANOMETROLOGY INITIATIVE	2,491	1,987

FY 2007 Accomplishments:

This effort explored novel measurement techniques to characterize nanostructures and devices, new nanometrology tools to image and measure the structure and composition of nanoscale objects and interfaces, and techniques for evaluation of nanoscale devices for logic and biosensing. The work is detailed in a report that was submitted to ONR in November, 2007.

FY 2008 Plans:

This effort will focus on nanometrology research through collaborations with NIST and nanoelectronics research that is coordinated with the semiconductor industry through the Nanoelectronics Research Initiative (NRI).

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	FY 2007	FY 2008
ROTATIONAL MOLDED DOUBLE WALL FOR UN-MANNED PATROL BOAT	0	2,981

FY 2008 Plans:

Initiate research into developing manufacturing processes for unmanned patrol boats using a rotational molded double wall processes. These craft are integral to our transformational efforts to become more reliant on unmanned and autonomous vehicles, especially in the littorals.

	FY 2007	FY 2008
STANDOFF BIO-CHEMICAL AGENT DETECTION	971	795

FY 2007 Accomplishments:

This effort initiated research to continue on the recent successes of Texas A&M University (TAMU) researchers in the detection of anthrax and trace amounts of chemicals in the air. These breakthroughs are very relevant to national defense and homeland security.

FY 2008 Plans:

This effort supports standoff bio-chemical agent detection.

	FY 2007	FY 2008
TEXAS MICROFACTORY	0	3,478

FY 2008 Plans:

Initiate the development of a cost effective automated assembly and packaging system for microsystems in small lots by augmenting current equipment to include laser, electrical discharge machining and mechanical micromachining tools and top down nanomanufacturing tools. Demonstrate manufacturability techniques for steerable projectiles using 2D actuator arrays and microrobotic swarms to enhance the situational awareness of

BUDGET ACTIVITY: 01
PROGRAM ELEMENT: 0601153N PROGRAM ELEMENT TITLE: DEFENSE RESEARCH SCIENCES
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the Warfighter. Novel micromanufacturing platforms based on modular and multiscale architectures will enable the prototyping of new processes and products.

	FY 2007	FY 2008
TOTAL FORCE EDUCATION INITIATIVES	1,000	0

FY 2007 Accomplishments:

Completed effort with the Naval Post Graduate School (NPGS) for tuition assistance ships, PhD student support and student research.

C. OTHER PROGRAM FUNDING SUMMARY - NAVY RELATED RDT&E:
PE 0601103N University Research Initiatives
PE 0601152N In-House Laboratory Independent Research

OTHER PROGRAM FUNDING SUMMARY - NON-NAVY RELATED RDT&E:
PE 0601102A Defense Research Sciences
PE 0601101E Defense Research Sciences
PE 0601102F Defense Research Sciences

D. ACQUISITION STRATEGY:

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

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

COST: (Dollars in Thousands)

Project Number & Title	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
POWER PROJECTION APPLIED RESEARCH	112,088	106,667	79,913	79,343	110,523	154,034	173,054

A. MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: The efforts described in this Program Element (PE) are based on investment directions as defined in the Naval S&T Strategic Plan approved by the S&T Corporate Board (Jan 2007). This strategy is based on needs and capabilities from Navy and Marine Corps guidance and input from the Naval Research Enterprise (NRE) stakeholders (including the Naval enterprises, the combatant commands, the Chief of Naval Operations (CNO), and Headquarters Marine Corps). It provides the vision and key objectives for the essential science and technology efforts that will enable the continued supremacy of U.S. Naval forces in the 21st century. The Strategy focuses and aligns Naval S&T with Naval missions and future capability needs that address the complex challenges presented by both rising peer competitors and irregular/asymmetric warfare.

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, 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.

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

B. PROGRAM CHANGE SUMMARY:

	FY 2007	FY 2008	FY 2009
FY 2008/FY 2009 President's Budget Submission	114,071	83,419	82,781
Congressional Action	0	24,600	0
Congressional Undistributed Reductions/Rescissions	0	-713	0
Execution Adjustments	126	0	0
Federal Technology Transfer	-20	0	0
Program Adjustments	0	0	-2,486
Rate Adjustments	0	0	-382
SBIR Assessment	-2,089	-639	0
FY 2009 President's Budget Submission	112,088	106,667	79,913

PROGRAM CHANGE SUMMARY EXPLANATION:
Technical: Not applicable.

Schedule: Not applicable.

C. OTHER PROGRAM FUNDING SUMMARY:
Not applicable.

D. ACQUISITION STRATEGY:
Not applicable.

E. PERFORMANCE METRICS:
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.

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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.

FY 2009 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2008
Exhibit R-2a

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

COST: (Dollars in Thousands)

Project Number & Title	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
POWER PROJECTION APPLIED RESEARCH	112,088	106,667	79,913	79,343	110,523	154,034	173,054

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 2007	FY 2008	FY 2009
WMD DETECTION	0	6,694	8,094

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 WMD Detection Program. FY 2009 increase represents the ramping up of the program as continuing technological efforts evolve.

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 to support the active interrogation of special nuclear materials.

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- 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. This effort will involve formation of a team comprised of DoD, interagency, and international partners to support the demonstration.
- Continue investigations into using FEL accelerator and optical beams for WMD and chembio agent detection.
- Continue investigation of using particle beams for standoff detection of special nuclear materials.
- Continue neutron and gamma ray detection technology development.
- Continue investigation of hand held and portable detector technology for maritime interdiction.
- Continue underwater detection technology development of smuggled nuclear weapons and materials.

	FY 2007	FY 2008	FY 2009
STRATEGIC SUSTAINMENT	13,380	6,661	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.

The reduction from FY 2007 through FY 2009 is due to the completion of Technology for the Sustainment of Strategic System (TSSS) in FY 2007 and Strategic System Infrastructure (SSI) in FY 2008.

FY 2007 Accomplishments:

- TSSS: Completed phase II.
- SSI: Continued Missile propulsion efforts by conducting larger scale non-eroding throat tests, chamber bottle tests, insulator tests, component compatibility tests and propellant hazard assessment. Continued Advanced Post Boost Control System (PBCS) Valve Technology and Materials program efforts. Goal is heavy wall testing simulating a very limited full scale Post Boost control system test. Continued Ordnance Initiation Technologies program. Completed the Missile Electronics Technologies program code development with final

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Validation and Verification of the models with experimental radiation hard data and aging data. Completed Navigation sonar task with Laboratory and tank testing of the new technology transducer and hydrophones. Prototype hardware 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 2007	FY 2008	FY 2009
HIGH SPEED PROPULSION AND ADVANCED WEAPON TECHNOLOGIES	13,905	7,890	7,741

The high speed weapons work in this activity is focused on demonstrating propulsion and vehicle technologies for Mach3+ to Mach8 capable weapons. The solid rocket motor Integrated High Performance Rocket Propulsion Technology (IHPRPT) technology development activities will provide improved rocket based weapon performance. The rocket technologies apply to both air dominance and strike weapons and will provide both improved range and speed.

This work includes technologies associated with high acceleration capable projectile structures, high temperature and high strength materials to enable projectiles to survive high speed launch environment, improved thermal prediction methodologies and test techniques, wide dynamic pressure adaptable projectile controls and non-explosively launched lethal mechanisms. The high speed projectile technologies are intended to support long range Naval Fire Support weapons.

The decrease from FY 2007 to FY 2008 is due to the completion of the 6.2 portion of the National Aerospace Initiative (NAI) RATTLRS Hypersonic Turbine program.

FY 2007 Accomplishments:

- IHPRPT: Completed propellant formulation. Initiated demonstration of air-to-air system that uses new

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energetic ingredient compositions to meet Phase III IHPRPT performance goals. Continued development of surface launch component technologies.
- NAI High Supersonic Turbine Vehicle (HSTV): Completed development of component/sub-system technologies for high supersonic turbine powered weapon systems. Conducted validation, ground testing and demonstrations.
- Asymmetric Threat Defense: Continued development of propulsion and high temperature materials technologies to enable high speed weapons. Continued demonstrating dual mode warhead effectiveness in both above and below water detonations.

FY 2008 Plans:

- IHPRPT: Continue FY 2007 efforts, less those noted as completed.
- Asymmetric Threat & Laser Control Technologies: Continue development of propulsion and high temperature materials technologies to enable high speed weapons. Continue demonstrating dual mode warhead effectiveness in both above and below water detonations.

FY 2009 Plans:

- IHPRPT: Complete program through demonstration of Solid Rocket Motor Phase III goals at the subsystem level.
- Asymmetric Threat & Laser Control Technologies: Initiate high speed projectile technology development. Initiate High Power Microwave (HPM) technology development.

	FY 2007	FY 2008	FY 2009
NAVIGATION, ELECTRO OPTIC/INFRARED (EO/IR), AND SENSOR TECHNOLOGIES	12,165	10,922	5,403

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

Change 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. Reduction in funding from FY 2008 to FY 2009 is a result of realigning efforts more appropriately budgeted under the Strike and Littoral Combat Activity in this PE.

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FY 2007 Accomplishments:

- Navigation Technologies: Continued Rb Clock development and testing, Fiber Optic Ring Gyroscope development, Magnetic Passive reset for Inertial Navigation System (INS), and Advanced Global Positioning System (GPS)/INS systems for strike weapons. Initiated self-locked Intra-Cavity Alkali Vapor Laser (ICAL) opto-atomic clock project and Repeat spoofer detection and location project. Completed Network Centric Navigation (Link-16 Time Transfer), Distributed Time Standards, and Tightly Coupled GPS/INS/Loran efforts.
- EO/IR: Completed development of low cost piezoelectric motion and jitter compensation for high resolution visible and infrared sensors. Continued Millimeter Wave (MMW) and TeraHertz (THz) Imaging project. Completed development of ultra low noise uncooled nanotechnology infrared sensors and continued development nanoatomic sensor nonvolatile memories. Completed development of electronic liquid crystal based directional field of view and zoom imagers. Completed multi-sensor (visible, infrared, millimeter wavelength, terahertz and laser imagers) fusion for objection recognition effort.
- Electronics: Completed demonstration of high laser power through IR transmitting Hollow Core Photonic Band Gap (HC-PBG) fiber. Completed performance optimization and scaling law development for the Radiation Balanced Laser. (NRL)
- Electronic Warfare: Completed 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: Continued covert high bandwidth communications effort. Continued development of free space laser communications systems with the development of a hybrid infrared system with dramatically lower power requirements at the sensor/transmitter. Continued small hyperspectral sensor development. (NRL)
- Completed long-term demonstration of multiple sensor-equipped vehicles, covering autonomous sensing operation and multiple replenishment/relocation cycles under autonomous or semi-autonomous control. (NRL)
- Completed development of small autonomous mobile expendable Electronic Warfare (EW) vehicles that can replenish their energy supply. Selected multi-mode locomotion method and energy harvesting technique and constructed and demonstrated vehicles. (NRL)
- Continued development of Micro Air Vehicle (MAV). (NRL)
- Autonomous Systems: Continued development of near optimal trajectory planners to enhance the capabilities of Unmanned Aerial Vehicles (UAVs) and other distributed autonomous systems. (NRL)

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PROGRAM ELEMENT: 0602114N PROGRAM ELEMENT TITLE: POWER PROJECTION APPLIED RESEARCH
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FY 2008 Plans:

- Navigation Technologies: Program funded in PE 0602271N under the RF Navigation Technology activity.
- EO/IR: Continue MMW and THz Imaging effort, development of ultra low noise 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 gyrator 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).
- Initiate the development of a novel beam steering method in phased array radar using optical fiber based slow light techniques. (NRL)
- Initiate the development of machine-vision algorithms and guidance strategies to enable the precision autonomous recovery of small sensor platforms on moving naval vessels. (NRL)
- Initiate the development of an autonomous soaring capability and intelligent path planning for extracting energy from the environment thereby conserving onboard fuel stores of autonomous air vehicles. (NRL)
- Initiate development of high power fiber lasers in mid-IR (2-5 μm) based upon highly nonlinear IR transmitting chalcogenide photonic crystal fibers. (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 THz Imaging project through transition to 6.3 development. 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. 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).
- Autonomous Systems: Complete development of near optimal trajectory planners to enhance the capabilities of

BUDGET ACTIVITY: 02
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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 gyrator that combines a swashplateless rotor system and active stability augmentation for autonomous systems (NRL).
- Continue the development of a novel beam steering method in phased array radar using optical fiber based slow light techniques. (NRL)
- Continue the development of machine-vision algorithms and guidance strategies to enable the precision autonomous recovery of small sensor platforms on moving naval vessels. (NRL)
- Continue the development of an autonomous soaring capability and intelligent path planning for extracting energy from the environment thereby conserving onboard fuel stores of autonomous air vehicles. (NRL)
- Continue development of high power fiber lasers in mid-IR (2-5 µm) based upon highly nonlinear IR transmitting chalcogenide photonic crystal fibers. (NRL)

	FY 2007	FY 2008	FY 2009
DIRECTED ENERGY AND EM GUNS (FORMERLY ELECTRIC WEAPONS)	30,414	42,006	48,227

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 defensive weapon against advanced cruise missiles and asymmetric threats. The other major component is the Electro Magnetic (EM) gun program that is focused on developing the technology to launch a long range projectile from Navy ships. This activity also includes NRL investment/performance in these research areas.

The increase from FY 2007 through 2009 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.

FY 2007 Accomplishments:

- DE: Completed gun performance tests. Completed 750 MHz Cryounit integration and low power characterization. FEL development task, completed cryomodule design. Continued cryomodule construction. Continued 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. Continued 1 micron filamentation, halo limitation, and short Rayleigh range studies. Continued lethality testing and optical propagation studies. Continued testing of Radio Frequency (RF) gun High Voltage Power

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Supply (HVPS) components which are required for the 100 kW high current injector.
- EM Gun: Completed preliminary designs of 32MJ muzzle energy electromagnetic demonstration launchers and began detailed design with industry partners in preparation for fabrication (FY08/09) and demonstration (FY10). Continued 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. Finalized projectile conceptual designs from two industry vendors and began projectile preliminary design. Initiated conceptual design of rotating machine pulsed power. Continued Integrated Product Team (IPT) collaborations between industry, Navy and the Army Electromagnetic Launch program to ensure consistent, non-duplicative technology maturity activities.
- Continued investigation of surface treatments such as advanced coatings or "MAX-phase" materials to harden the rails in electromagnetic railguns. (NRL)
- Continued 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, 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.
- Complete investigation of surface treatments such as advanced coatings or "MAX-phase" materials to harden the rails in electromagnetic railguns. (NRL)
- Complete development of designs for viable novel electric weapon architectures that enhance performance and maintainability. (NRL)

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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.
- 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, IPT and Bore Life Consortium collaborations. Initiate development of modeling and simulation capability to support bore life development and testing.

	FY 2007	FY 2008	FY 2009
STRIKE AND LITTORAL COMBAT TECHNOLOGIES	8,253	8,051	10,448

The focus of this activity 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.

The net increase in funding between FY 2008 and FY 2009 is due to the realignment of efforts from the Navigation EO/IR activity and the planned reduction of funding for FNC efforts in this activity.

FY 2007 Accomplishments:

- Marine and UxV Tactical ISR (MUTI): Initiated and completed effort to develop improved radar that provided real-time tactical targeting and improved sensor processing which provided improved access to available ISR products. Specific tasks included: 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): Initiated effort to develop the capability to improve the processing of dynamic targets from 100 to 400 targets per day. It improved UAV performance in the areas of increased endurance and support for more autonomous operations. Specific tasks included 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): Completed effort to develop technologies for hostile fire detection and active response capabilities that increased individual Marine and tactical level unit

survivability and mobility. Specific efforts included: 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): Completed 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 included: 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)
- Completed W-band decoy development with a demonstration of active Electronic Counter-Measures (ECM) techniques. (NRL)
- Completed the development of improved processing algorithms by incorporating algorithmic tools into existing Synthetic Aperture Radar (SAR) system for testing. (NRL)
- Continued Image-While-Scan (IWS) technology development. (NRL)
- Continued genetic algorithm selection process for communication jamming. (NRL)
- Initiated development of passive interferometric imaging system to detect millimeter wave 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)
- Initiate the development of signal processing techniques to improve situational awareness and autonomous

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detection of hostile fire events in a dynamic urban clutter environment. (NRL)
- Initiate the development of techniques to combine current IR/EO technology and recent findings on the characteristics of the eye to classify and identify optical devices and individuals in real time at militarily significant ranges. (NRL)
- Initiate the development of a process to detect hostile camouflaged or hidden targets in shadows and diverse backgrounds of militarily challenging environments. (NRL)

FY 2009 Plans:

- Discriminate and Provide Terminal Guidance for Weapons Targeted at Moving Targets: Continue development of Weapons Data Link terminal toward weapon scalability and modularity.
- Dynamic Target Engagement: Complete development of Decision Support System for dynamic target engagement.
- Increased Capability Against Moving and Stationary Targets: Complete the mmW component design for the DASH multi-sensor weapon seeker and begin the mmW sensor fabrication and testing. In conjunction with building the sensor suite of the Multi-mode Sensor/Seeker, continue development of advanced signal processing techniques, which will classify and identify moving targets using ATR.
- Enhanced Weapons Technologies: Initiate three new products to expand current Counter Air / Counter Air Defense capabilities by providing improved range and end-game maneuverability while decreasing Time-of-Flight. Specific tasks to begin design and development phase are: Counter Air Advanced Medium-Range Air-to-Air Missile (AMRAAM) Improvements / Counter Air Defense Improvement / High Speed Components.
- 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.
- Continue development of passive interferometric imaging system to detect millimeter wave RF anomalies within the background environment by using exotic signal processing techniques. (NRL)
- Continue the development of signal processing techniques to improve situational awareness and autonomous detection of hostile fire events in a dynamic urban clutter environment.
- Continue the development of techniques to combine current IR/EO technology and recent findings on the characteristics of the eye to classify and identify optical devices and individuals in real time at militarily significant ranges. (NRL)
- Continue the development of a process to detect hostile camouflaged or hidden targets in shadows and diverse backgrounds of militarily challenging environments. (NRL)

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CONGRESSIONAL PLUS-UPS:

	FY 2007	FY 2008
ADVANCED PROPULSION FOR GUN LAUNCHED PROJECTILES AND MISSILES	0	796

This effort will develop advanced propulsion technologies to be used to improve the performance of gun launched projectiles and missiles.

	FY 2007	FY 2008
AGING EVALUATION OF ADVANCED MATERIALS USED FOR MILITARY AIRCRAFT	0	1,192

This effort will develop aging evaluation technologies for analysis of the advanced materials which are used in military aircraft.

	FY 2007	FY 2008
CLUSTERED MILLIMETER WAVE IMAGING SENSORS & MANUFACTURING	0	1,589

This effort will develop clustered millimeter wave imaging sensors and the manufacturing technologies required to produce those sensors.

	FY 2007	FY 2008
COMBUSTION LIGHT GAS GUN PROJECTILE	3,985	3,179

FY 2007: This effort facilitated continued development of the 155 mm Combustion Light Gas Gun. Initiated test firings of the 155 mm system with a cryogenic feed system. Performed active analysis of the aeroballistics of the projectile.

FY 2008: This effort will support combustion light gas gun projectile research.

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	FY 2007	FY 2008
COMPUTATIONAL DESIGN TOOLS FOR HIGH POWER SOURCES FOR DIRECTED ENERGY APPLICATIONS	996	0

This effort supported 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 2007	FY 2008
DEVELOPMENT PROCESSES FOR FULL SCALE PRODUCTION OF SILICON CARBIDE WAFERS	1,445	0

This effort developed processes for competitive commercial production of Silicon Carbide semiconductor substrates for use in high power electronics device applications such as DOD's electric vehicles, electromagnetic (EM) rail gun and EM aircraft launch systems.

	FY 2007	FY 2008
DEVICE INTEGRATION OF WIDE BAND GAP SEMICONDUCTORS AND MULTIFUNCTIONAL OXIDES	2,192	0

This effort supported the monolithic integration of multi-functional oxide devices with wide band gap semiconductor high power amplifiers in defense radar-microwave devices.

	FY 2007	FY 2008
ELECTRONIC MOTION ACTUATION SYSTEMS	2,192	0

This effort supported electronic motion actuation systems research by extending knowledge from work previously performed on 20,000 in-lb, three position ball valve actuators and 20,000 in-lb two position ball valve actuators for submarine applications. An additional focus was the development of a full scale controller to be used with a full scale control surface actuator.

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

	FY 2007	FY 2008
H-264 VIDEO COMPRESSION	996	0

This effort supported the application of H.264 video compression for high speed data compression.

	FY 2007	FY 2008
HALOH ENGINE	1,296	0

This effort designed, developed and experimentally validated virtual testing modeling and simulation software for the analysis of hybrid solid/liquid rocket engines.

	FY 2007	FY 2008
HIGH ENERGY CONVENTIONAL ENERGETICS (PHASE ONE)	0	4,969

This effort will develop high energy conventional energetics for use in advanced Naval weapons.

	FY 2007	FY 2008
HIGH ENERGY DENSITY CAPACITORS FOR MILITARY APPLICATIONS	2,491	0

This effort supported high energy density capacitors for military applications.

	FY 2007	FY 2008
HIGH ENERGY SUPERIOR BATTERY TECHNOLOGY FOR DEFENSE APPLICATIONS	996	0

This effort developed high energy battery technology for Navy aircraft applications.

	FY 2007	FY 2008
HIGH PERFORMANCE ALLOY MATERIALS, STEEL CASTINGS	0	1,987

This effort will develop high performance alloy materials and steel castings for use in Naval applications.

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

	FY 2007	FY 2008
HIGH PERFORMANCE FREQUENCY MODULATED (FM) FIBEROPTIC LINK	1,096	0

This effort designed and characterized a wideband optical RF down conversion using mach-zender optical modulator and optical phased locked loop.

	FY 2007	FY 2008
HIGH POWER FREE ELECTRON LASER (FEL) DEVELOPMENT FOR NAVAL APPLICATIONS	0	1,987

This effort will develop advanced high power components that will be used to improve the operation and performance of FEL when used in Naval applications.

	FY 2007	FY 2008
MARINE MAMMAL HEARING AND ECHOLOCATION RESEARCH	1,494	0

This effort supported research for the hearing of marine mammals, including special hearing and acoustic signal processing adaptations for biological sonar (echolocation).

	FY 2007	FY 2008
MARINE MAMMALS - EFFECTS OF SOUND	0	796

This effort will study the effect of various sounds on multiple types of Marine mammals.

	FY 2007	FY 2008
MILLIMETER TERAHERTZ IMAGING ARRAYS	1,245	0

This effort developed enhanced capabilities for optically based millimeter-wave distributed aperture imaging.

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

	FY 2007	FY 2008
MODULAR PAYLOAD SYSTEMS	0	1,987

This effort will develop modular payload systems for use in Naval applications.

	FY 2007	FY 2008
MULTI-SENSOR HYPERSPECTRAL SYSTEM FOR DAY/NIGHT RECONAISSANCE	3,587	0

This effort continued development and delivery of compact hyperspectral sensor hardware for day and night operation, light-weight hyperspectral processing hardware, and real-time hyperspectral data processing software. This program supported the Intelligence, Surveillance, and Reconnaissance mission.

	FY 2007	FY 2008
MULTIFUNCTIONAL OXIDE MATERIALS APPLICATIONS AND DEVICES	996	0

This effort investigated deposition and improved the crystal quality of thin crystalline films of complex oxides for application in defense radar-microwave devices.

	FY 2007	FY 2008
MULTIFUNCTIONAL OXIDE MATERIALS APPLICATIONS AND DEVICES (MFMA)	996	1,987

FY 2007: This effort investigated deposition and improved the crystal quality of thin crystalline films.

FY 2008: This effort will continue development of complex oxides for application in defense radar-microwave devices.

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

	FY 2007	FY 2008
RETROREFLECTING OPTICAL COMMUNICATIONS FOR SPECIAL OPERATIONS	2,989	0

This effort developed and built a set of compact lasercomm terminals capable of direct and retro-reflecting mode optical links. The control software for these terminals was enhanced to allow more autonomous operation which will enable net centric warfare by providing high bandwidth (Mbps-Gbps) LPI/LPD/AJ links between platforms.

	FY 2007	FY 2008
STRIKE WEAPON PROPULSION (SWEAP)	0	1,987

This effort will develop advanced propulsion technologies for use in precision strike weapons.

	FY 2007	FY 2008
THERMAL MANAGEMENT SYSTEMS FOR HIGH DENSITY ELECTRONICS	4,979	0

This effort supported thermal management systems for high density electronics.

	FY 2007	FY 2008
UNMANNED AERIAL VEHICLE FUEL CELL POWER SOURCE	0	1,987

This effort will develop unique fuel cell power sources for use in Unmanned Aerial Vehicles.

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)
PE 0603790N NATO Research and Development

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

OTHER PROGRAM FUNDING SUMMARY - 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.

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

BUDGET ACTIVITY: 02
PROGRAM ELEMENT: 0602123N
PROGRAM ELEMENT TITLE: FORCE PROTECTION APPLIED RESEARCH

COST: (Dollars in Thousands)

Project Number & Title	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
FORCE PROTECTION APPLIED RESEARCH	154,217	194,477	131,310	103,940	120,510	135,150	146,206

A. MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: The efforts described in this program element (PE) are based on investment directions as defined in the Naval S&T Strategic Plan approved by the S&T Corporate Board (Jan 2007). This strategy is based on needs and capabilities from Navy and Marine Corps guidance and input from the Naval Research Enterprise (NRE) stakeholders (including the Naval enterprises, the combatant commands, the Chief of Naval Operations (CNO), and Headquarters Marine Corps). It provides the vision and key objectives for the essential science and technology efforts that will enable the continued supremacy of U.S. Naval forces in the 21st century. The Strategy focuses and aligns Naval S&T with Naval missions and future capability needs that address the complex challenges presented by both rising peer competitors and irregular/asymmetric warfare.

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

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

BUDGET ACTIVITY: 02
PROGRAM ELEMENT: 0602123N
PROGRAM ELEMENT TITLE: FORCE PROTECTION APPLIED RESEARCH

B. PROGRAM CHANGE SUMMARY:

	FY 2007	FY 2008	FY 2009
FY 2008/FY 2009 President's Budget Submission	160,168	155,936	133,846
Congressional Action	0	41,300	0
Congressional Undistributed Reductions/Rescissions	0	-1,254	0
Execution Adjustments	-3,014	0	0
Program Adjustments	0	0	-2,176
Rate Adjustments	0	0	-360
SBIR Assessment	-2,937	-1,505	0
FY 2009 President's Budget Submission	154,217	194,477	131,310

PROGRAM CHANGE SUMMARY EXPLANATION:
Technical: Not applicable.

Schedule: Not applicable.

C. OTHER PROGRAM FUNDING SUMMARY:
Not applicable.

D. ACQUISITION STRATEGY:
Not applicable.

E. PERFORMANCE METRICS:
This PE supports the development of technologies associated with all naval platforms (surface, subsurface, terrestrial and air) and the protection of those platforms. Each PE Activity has unique goals and metrics, some of which include classified quantitative measurements. Overall metric goals are focused on achieving sufficient improvement in component or system capability such that the 6.2 applied research projects meet the need of or produce a demand for inclusion in advanced technology that may lead to incorporation into acquisition programs or industry products available to acquisition programs.

BUDGET ACTIVITY: 02
PROGRAM ELEMENT: 0602123N
PROGRAM ELEMENT TITLE: FORCE PROTECTION APPLIED RESEARCH

Specific examples of metrics under this PE include:
- Reduce the weight of current structural protection systems by 30% maintaining current energy absorption capabilities by FY 2007.
- Provide improvements in electrical component and device technology as to allow a 50% reduction in motor propulsion and motor controllers weight and volume by FY 2009.
- Increase the hydrodynamic efficiency of current hull designs by 5% by FY 2010.
- Reduce electromagnetic vulnerability of ship hulls by 50% by FY 2011.
- Torpedo defense thresholds will be validated by modeling and simulation to satisfy the overall system performance specification of a Probability of Survival (PS) of the US Navy platform as specified in the draft Capabilities Development Document (CDD) for Surface Ship Torpedo Defense.
- Additional metrics are included within the Missile Defense Activity description.

FY 2009 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2008
Exhibit R-2a

BUDGET ACTIVITY: 02
PROGRAM ELEMENT: 0602123N PROGRAM ELEMENT TITLE: FORCE PROTECTION APPLIED RESEARCH
PROJECT TITLE: FORCE PROTECTION APPLIED RESEARCH

COST: (Dollars in Thousands)

Project Number & Title	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
FORCE PROTECTION APPLIED RESEARCH	154,217	194,477	131,310	103,940	120,510	135,150	146,206

A. MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: This project addresses applied research associated with providing the capability of Platform and Force Protection for the U.S. Navy. It supports the development of technologies associated with all naval platforms (surface, subsurface, terrestrial, and air) and the protection of those platforms. The goal is to provide the ability to win or avoid engagements with other platforms or weapons and, in the event of engagement, to resist and control damage while preserving operational capability. Within the Naval Transformational Roadmap, this investment directly supports the Theater Air and Missile Defense transformational capability required by Sea Shield and the Ship to Objective Maneuver key transformational capability by virtue of improvements in platform offensive performance, stealth, and self defense. This effort supports the FNC in the areas of Sea Shield, Cross Pillar Enablers, and Enterprise and Platform Enablers (EPE).

The funding profile reflects the FY 2007 reorganization of FNC Program investments into Enabling Capabilities (ECs). As a result of this reorganization, funding for each EC has been aligned to a Budget Activity 2 and Budget Activity 3 PE as appropriate. This project reflects the alignment of investments for the following ECs: Fortified Position Security, Over-the-Horizon Missile Defense, Anti-Ship Missile Defense Technologies, Two-Torpedo Salvo Defense, Defense of Harbor and Near-Shore Naval Infrastructure Against Asymmetric Threats, Sea Based Missile Defense of Ships & Littoral Installations, Aircraft Integrated Self-Protection Suites, Advanced Threat Aircraft Countermeasures, Helicopter Low-Level Operation, Four Torpedo Salvo Defense, Shipboard Force Protection in Port and Restricted Waters - Detection and Classification, Underwater Total Ship Survivability, Compact Power Conversion Technologies, Affordable Submarine Propulsion and Control Actuation, and Advanced Electronic Sensor Systems for Missile Defense.

FY 2008 reflects the initiation of the Large Vessel Stopping Program in response to the Chief of Naval Operations' Navy Strategic Plan which specified that the Navy must combat Weapons of Mass Destruction (WMD) at sea and ashore. FY 2009 reflects the transfer of power conversion technologies for multi-function motor drives, bi-directional power conversion modules, and power management controllers from PE 0602236N/Cost

BUDGET ACTIVITY: 02
PROGRAM ELEMENT: 0602123N PROGRAM ELEMENT TITLE: FORCE PROTECTION APPLIED RESEARCH
PROJECT TITLE: FORCE PROTECTION APPLIED RESEARCH

Reduction Technologies.

B. ACCOMPLISHMENTS/PLANNED PROGRAM:

	FY 2007	FY 2008	FY 2009
STOPPAGE OF LARGE SURFACE VESSELS AT SEA	0	7,147	7,859

The Chief of Naval Operations (CNO) in the Navy Strategic Plan (NSP) has specified that the Navy must combat Weapons of Mass Destruction (WMD) at sea and ashore. To support this requirement, the Navy must be able to temporarily stop ships that are suspected of carrying WMDs or their component materials. This activity addresses the development of key technologies that will enable the Navy to use non-lethal methods for temporarily stopping and delaying non-cooperative large, greater than 20 meters or 300 gross tons, vessels at sea that will not comply with voice commands or warning devices. The technologies will be deployable by ship or aircraft and should be capable of disabling the vessel at safe distances from high-valued assets and infrastructures.

Funding increase from FY 2008 to FY 2009 is due to the natural growth of the program as technology development efforts increase.

FY 2008 Plans:

- Initiate evaluation of potential propeller entanglement device materials.
- Initiate propulsion drive-train damage predictions.
- Initiate assessment of delivery options for a large linear propeller entanglement device
- Initiate a component level proof of concept demonstration for externally inhibiting seawater cooling flow to ship propulsion equipment.
- Initiate the identification and assessment of potential commercial maritime vessel electronic vulnerabilities within representative propulsion and maneuvering control systems.
- Initiate a scaled component level proof of concept demonstration for a large vessel momentum reduction concept and determine the feasibility of seaborne or airborne delivery of a prototype system.

FY 2009 Plans:

- Continue all efforts of FY 2008.

BUDGET ACTIVITY: 02
PROGRAM ELEMENT: 0602123N PROGRAM ELEMENT TITLE: FORCE PROTECTION APPLIED RESEARCH
PROJECT TITLE: FORCE PROTECTION APPLIED RESEARCH

	FY 2007	FY 2008	FY 2009
SURFACE SHIP & SUBMARINE HULL MECHANIC & ELECTRICAL (HM&E)	55,282	84,681	82,120

Efforts include: signature reduction, hull life assurance, hydromechanics, distributed control for automated survivability (includes damage control), and advanced electrical power systems. Signature reduction addresses electromagnetic, infrared, and acoustic signature tailoring, both topside and underwater. Hull life assurance addresses development of new structural system approaches for surface ships and submarines, including the management of weapons effects to control structural damage and the improvement of structural materials. Hydromechanics addresses hydrodynamic technologies, including the signature aspects of the hull-propulsor interface and maneuvering. Distributed intelligence for automated survivability addresses both the basic technology of automating damage control systems, as well as, distributed control of systems utilizing self-healing capability. Advanced electrical power systems efforts address electrical and auxiliary system and component technology to provide improvement in energy and power density, operating efficiency and recoverability from casualties. Advanced Naval Power efforts include: Compact Power Conversion Technologies that reduce the cost of high power conversion equipment required to enable more-electric and all-electric ships. This activity also supports Global War on Terror (GWOT) Counter IED – Extramural activity which supports applied research for force protection of Naval platforms. Technologies are being developed that focus on prediction, prevention, detection, neutralization, and mitigation of improvised explosive devices in the maritime/littoral environment.

Energy and Power technology efforts caused a major funding increase from FY 2007 to FY 2008. In addition, planned growth for Payload Implosion and Platform Damage Avoidance (FNC Project) and the Solid Oxide Fuel Cell efforts contributed to the FY 2008 increase. The decrease in funding from FY 2008 to FY 2009 is due to the completion of studies and demonstrations, particularly in the area of Energy and Power.

FY 2007 Accomplishments:

Survivable Platforms - Reduced Signatures
- Continued advanced numerical acoustic codes (and gridding methods for those codes) for submarines.
- Continued mmWave Signatures measurement to identify key signature characteristics.
- Continued Alternating Current (AC) propagation experiments.

BUDGET ACTIVITY: 02
PROGRAM ELEMENT: 0602123N PROGRAM ELEMENT TITLE: FORCE PROTECTION APPLIED RESEARCH
PROJECT TITLE: FORCE PROTECTION APPLIED RESEARCH

- Continued the next generation Infrared Electro-Optic Visual (IR/EO/VIS) model for surface ships by development of mitigation strategy supporting low observable infrared platforms, development of supporting physics, and prototype measurement techniques.
- Continued development of quiet control surface design tool based on control surface flow noise studies.
- Continued modeling of electric warship components and system electromagnetic signatures.
- Continued hull machinery noise measurements.
- Continued IR and radar detectability prediction capability.
- Continued investigation of distributed pump-jet propulsion (DPJP) acoustic performance.
- Continued surface ship super-conductive degaussing with laboratory demonstration loop for Electromagnetic (EM) field accuracy measurements and control methods.
- Continued testing on Advanced Electric Ship Demonstrator (AESD) to assess energy propagation and acoustic radiation mechanisms and to develop mitigation concepts for surface ships.
- Continued IR assessment of two advanced treatments.
- Continued first of a series of IR validation experiments and critical sensitivity analysis.
- Continued Improved Corrosion Related Magnetic (CRM) Field Prediction Model to design compensation systems to reduce ship’s CRM signature
- Completed development of surface ship acoustic flow noise model (joint effort with Dutch Navy).
- Completed flow noise evaluations of surface ships with the Advanced Electric Ship Demonstrator (AESD).
- Completed and delivered ship IR scene model.
- Completed and delivered assessment and predictive capability for another source of Radio Frequency (RF) and IR signatures.
- Completed AC field propagation modeling part of electric warship components and system electromagnetic signatures effort by delivering EM field propagation models.
- Completed surface ship superconductive degaussing system laboratory evaluations of single and multiple loop systems, operating parameters, mutual interference, control stability, and a second generation High-Temperature Superconductor (HTS) wire studies.
- Initiated assessment of ship bistatic Radar Cross Section (RCS).
- Initiated large-scale tests on AESD to develop signature prediction and design tools for surface ship incorporating a variety of propulsion technologies including external podded propulsion.
- Initiated experimental effort to characterize electric drive motor signature mechanisms and verify modeling and simulation approaches for signature prediction.

Survivable Platforms - Hull Life Assurance
- Continued development of global surface wave measurement capability for ship models.

BUDGET ACTIVITY: 02
PROGRAM ELEMENT: 0602123N PROGRAM ELEMENT TITLE: FORCE PROTECTION APPLIED RESEARCH
PROJECT TITLE: FORCE PROTECTION APPLIED RESEARCH

- Continued Dynamic Behavior of Composite Ship Structures (DYCOSS) (joint effort with Dutch Navy).
- Continued development of structural analysis codes describing failure mechanism of sandwich composites.
- Continued Explosion Resistant Coatings (ERC) effort, providing US input to trilateral agreement with UK and Australia.
- Continued Joint US/Japan Advanced Hull Materials & Structures Technology (AHM&ST) addressing hybrid hull concept and hybrid (steel/composite) joints in ship construction.
- Continued composite and composite-metal hull performance characterization and testing including structural loading, thermal stress and signatures.
- Initiated effort on an advanced class of polymers as a follow-on to current ERC for application against advanced threats (GWOT).

Survivable Platforms - Distributed Intelligence for Automated Survivability
- Continued development of modeling and simulation methods for robust design and virtual testing of integration of shipboard auxiliary systems including their control systems.
- Continued research into advanced HM&E system reconfiguration approaches, including agent-based control systems and algorithms, and model-based reasoning.
- Completed land-based test site (Purdue University and Naval Surface Warfare Center, Carderock Div.) that will evaluate Integrated Engineering Plant (IEP) conceptual architectures to provide improved survivability of auxiliary systems that support combat systems.

Advanced Platforms - Advanced Platform Concepts and Designs
- Continued validation of asymmetric hull forms with experimental data.
- Continued development of analytical models to further define submarine modular hull concepts.
- Continued development of reliability based design and structural analysis code development.
- Continued development design tools for integrated antenna and composite topside.
- Continued circulation control analysis for three-dimensional flow effects.
- Continued development of test vessel and technology to evaluate performance and signature associated with electrically driven waterjets (AWJ-21) and Rim-drive motor.
- Continued aperstructures microwave communication system.
- Continued concept for Ultra High Frequency (UHF)/Very High Frequency (VHF) aperstructures opportunistic array (Advanced Hull-form Inshore Demonstrator - AHFID).
- Completed and delivered navigation radar aperstructures.

Advanced Platforms - Hydromechanics

BUDGET ACTIVITY: 02
PROGRAM ELEMENT: 0602123N PROGRAM ELEMENT TITLE: FORCE PROTECTION APPLIED RESEARCH
PROJECT TITLE: FORCE PROTECTION APPLIED RESEARCH

- Continued experimental database/computational tools development for extreme submarine maneuvers (e.g., crashback).
- Continued the validation of circulation control and advanced control surfaces with experiments.
- Continued to investigate improved maneuvering simulation capability for submarines.
- Continued validation of Reynolds Average Navier-Stokes (RANS) code for advanced waterjet propulsor performance predictions.
- Continued development of two-phase flow waterjet concept, Detached Eddy Simulation (DES) method for crashback prediction and numerical prediction method(s) of waterjet cavitation.
- Continued modeling of turbulent flow interaction with propeller Leading Edge (LE) and Trailing Edge (TE) and modeling and simulation of rough-wall boundary layer noise.
- Continued prediction and validation of constrained and unconstrained capsize motions using advanced codes.
- Completed validation of computational tools for ducted propulsor design/analysis.
- Completed experiments of submarine crashback.
- Completed prediction of constrained (heave and roll) capsize motions using advanced codes.
- Initiated development of podded propulsor design/analysis tools.

Advanced Naval Power Systems - Advanced Electrical Power Systems
- Continued demonstration of dynamic stability of an advanced intelligent, reconfigurable, solid-state-based, zonal-electrical power system that reconfigures within 10 milliseconds.
- Continued designing software for the system manager for the Universal Control Architecture (UCA).
- Continued development of thermal management technology for shipboard power distribution.
- Continued investigation of potential applications of silicon-carbide in future high voltage and high power applications.
- Continued improvements in electrical component and device technology allowing a reduction in motor propulsion and motor controllers weight and volume.
- Continued development of technologies to support dynamic reconfiguration of shipboard systems under conditions of stressing scenarios and/or system degradation.
- Continued multi-year program to directly convert thermal energy to electricity. Such a capability would allow elimination of the steam cycle on an electric warship.
- Continued development of pulsed power technologies, to include pulsed alternators and capacitors.
- Continued research into high power controller and generator applications by using mixed winding, high-phase-order induction machines actuated with multi-phase and multi-level inverters and rectifiers.
- Continued studies of alternative cooling systems for future shipboard radar systems.

BUDGET ACTIVITY: 02
PROGRAM ELEMENT: 0602123N PROGRAM ELEMENT TITLE: FORCE PROTECTION APPLIED RESEARCH
PROJECT TITLE: FORCE PROTECTION APPLIED RESEARCH

• Continued studies of system design impact on the thermal performance and reliability of two-phase pumped cooling loops.
• Continued development of structural macroscopic 3-dimensional battery.
• Continued control surface actuator project focused on the technologies needed to define the design space for control surface actuators supporting submarines.
• Initiated development of automated HVAC system architectures for future Naval platforms.

Advanced Naval Power Systems - Novel Power and Energy Transfer Systems
• Continued ship service fuel cell development.

Naval Research Laboratory (NRL)
• Continued Biofilms on Scaffolds and Characterize Spatial Distribution and Chemistries. (NRL)
• Continued development of Bacterial Mixture to Optimize Charge Generating Capacity. (NRL)
• Continued High Surface Area Conducting Electrodes for use as Biofilm Scaffolds. (NRL)
• Continued technology development for alternate approaches to high voltage fast turn off switches. (NRL)
• Continued technology development for wafer bonded high voltage power switches. (NRL)
• Continued efforts to synthesize new metal sulfides as catalysts for fuel cells and evaluate their electrochemical performance. (NRL)
• Completed fuel cell evaluation of carbide based catalysts as sulfur tolerant polymer fuel cell anodes (NRL).
• Completed scale-down (10x smaller) and testing of a biofilm-enhanced micro-microbial fuel cell (NRL)
• Initiated development of heterojunction power switching devices. (NRL)

FY 2008 Plans:

Survivable Platforms - Reduced Signatures
• Continue all efforts of FY 2007, less those noted as completed above.
• Complete hull machinery noise measurements.
• Complete development of test vessel and technology to evaluate performance and signature associated with electrically driven waterjets (AWJ-21) and Rim-drive motor (RIMJET).
• Complete modeling of electric warship components and system electromagnetic signatures with electric motor source control through motor configuration, off ship EM field control through compensation and investigation of other sources of EM fields.
• Initiate development of modeling methods and noise control concepts for modular/reconfigurable submarine

architectures.
- Initiate investigation into hull treatment concepts for acoustic signature/vibration control for surface ships.
- Initiate development of advanced RF metamaterials for platform signature control.
- Initiate development of LPI technologies for surface ship emissions including communication, navigation, electronic warfare, and combat systems.

Survivable Platforms - Hull Life Assurance
- Continue all efforts of FY 2007.
- Initiate Payload Implosion and Platform Damage Avoidance efforts.

Survivable Platforms - Distributed Intelligence for Automated Survivability
- Continue all efforts of FY 2007, less those noted as completed above.

Advanced Platforms - Advanced Platform Concepts and Designs
- Continue all efforts of FY 2007, less those noted as completed above.

Advanced Platforms - Hydromechanics
- Continue all efforts of FY 2007, less those noted as completed above.
- Complete prediction and validation of unconstrained capsize using advanced codes.
- Initiate prediction and validation of damaged stability and capsize.
- Initiate non-body-of-revolution tool development for advanced submarine configurations.

Advanced Naval Power Systems - Advanced Electrical Power Systems
- Continue all efforts of FY 2007.
- Complete studies of the thermal performance and reliability of two-phase pumped cooling loops.
- Complete research into high power controller and generator applications by using mixed winding, high-phase-order induction machines actuated with multi-phase and multi-level inverters and rectifiers.
- Initiate development of shipboard waste heat driven chiller systems.

Advanced Naval Power Systems - Novel Power and Energy Transfer Systems
- Continue all efforts of FY 2007.
- Continue ship service fuel cell development.
- Initiate program to develop and demonstrate 3 - 50 kW class solid oxide fuel cell onboard mobile power

generation capabilities having compatibility with future logistics fuels to enable rapid recharge of batteries and direct power for C4ISR equipment.

Naval Research Laboratory (NRL)
- Continue all efforts of FY 2007, less those noted as completed above.

FY 2009 Plans:

Survivable Platforms - Reduced Signatures
- Continue all efforts of FY 2008, less those noted as completed above.
- Complete testing on AESD to assess energy propagation and acoustic radiation mechanisms and to develop hull treatment concepts for surface ships.
- Complete experimental effort to characterize electric drive motor signature mechanisms and verify modeling and simulation approaches for signature prediction.
- Complete CRM Field Prediction Model with final validation by measurement of full scale ship to verify CRM Field Prediction against actual Impressed Current Cathodic Protection (ICCP) system layout for measured ship and magnetic/electric fields measured at Navy Magnetic Silencing Range Facility.
- Initiate development of signature modeling approaches for electric actuation and alternate electric drive system architectures.
- Initiate development of Low probability Intercept (LPI) technologies for surface ship emissions including communication, navigation, electronic warfare, and combat systems.

Survivable Platforms - Hull Life Assurance
- Continue all efforts of FY 2008.

Survivable Platforms - Distributed Intelligence for Automated Survivability
- Continue all efforts of FY 2008.
- Initiate Second Generation distributed systems model development.
- Initiate demonstration of real-time modeling of multiple distributed systems – utilizing small scale demonstrator.
- Initiate demonstration of Genetic Algorithm(s) for determining optimal distributed system control strategy.
- Initiate development of a hardware in-the-loop small scale demonstrator for fluid/thermal/electrical distributed systems.

BUDGET ACTIVITY: 02
PROGRAM ELEMENT: 0602123N PROGRAM ELEMENT TITLE: FORCE PROTECTION APPLIED RESEARCH
PROJECT TITLE: FORCE PROTECTION APPLIED RESEARCH

- Initiate development of Survivability Analysis Algorithms Operable on a Total Ship Modeling Environment.

Advanced Platforms - Advanced Platform Concepts and Designs
- Continue all efforts of FY 2008.

Advanced Platforms - Hydromechanics
- Continue all efforts of FY 2008, less those noted as completed above.
- Complete development of two-phase flow waterjet concept.
- Complete prediction and validation of unconstrained capsize using advanced codes.

Advanced Naval Power Systems - Advanced Electrical Power Systems
- Continue all efforts of FY 2008, less those noted as completed above.
- Complete demonstrations of improvements in electrical component and device enabling technology allowing a reduction in motor propulsion and motor controllers weight and volume.
- Complete demonstration of Ship and Submarine Electric Actuator basic technology.
- Complete studies of alternative cooling systems for future shipboard radar systems.

Advanced Naval Power Systems - Novel Power and Energy Transfer Systems
- Continue all efforts of FY 2008.
- Continue analytical model and reduced scale component development of power conversion technologies for multi-function motor drives, bi-directional power conversion modules, and power management controllers focusing on closing technology gaps associated with Alternative Integrated Power System (IPS) Architectures. (Transitioned from PE 0602236N/Cost Reduction Technologies)
- Initiate research into the development of fuel chemistries, materials, and energy conversion technologies for optimal performance in Naval power systems.

Naval Research Laboratory (NRL)
- Continue all efforts of FY 2008.
- Complete development of heterojunction power switching devices. (NRL)

	FY 2007	FY 2008	FY 2009
ADVANCED ENERGETICS	11,563	18,087	2,238

Advanced Energetics efforts address technology development to provide substantial improvements in energetic

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material systems and subsystems, primarily in terms of performance, but also addressing safety, reliability, and affordability concerns. Goals include: advanced energetic materials for warheads, propellants, and reactive material based subsystems for both defensive and offensive applications. Efforts include: development of new fuels, oxidizers, explosive ingredients and formulations; and reliable simulation tools and diagnostics to develop and design superior-performance, and/or reduced-vulnerability systems tailored to specific warfighter missions.

Increased funding in FY 2008 supports maturation and transition of promising technologies in the areas of enhanced performance formulations, insensitive explosives, detonation merging techniques, and reactive materials that have been developed under the Advanced Energetics focused efforts. These technologies will be integrated and transitioned into propellant and warhead concepts within S&T munitions programs in PEs 0602114N, 0603114N, 0602747N, and 0602000D8Z. Decreased funding in FY 2009 is due to the conclusion and transition of these focused Advanced Energetics efforts. Remaining funding will be used to complete transition efforts and to develop next generation concepts as described below.

FY 2007 Accomplishments:

- Continued Advanced Energetics research in technology development for the next generation reactive material warhead concepts (formulations, material properties, target interaction, lethality models, and experiments) for highly reactive materials, high density reactive materials and novel reactive structural materials.
- Continued Advanced Energetics research in development and evaluation of advanced explosive/propellant/reactive ingredients and formulations for next generation higher performing systems.
- Continued Advanced Energetics research in development of advanced directed hydro-reactive material warhead concepts to enhance performance of undersea warheads.
- Continued proof of concept efforts to develop insensitive explosives, propellants, and munitions without compromising performance. This work involves development of high quality, small particle energetic ingredients, novel processing techniques, and advanced energy conversion concepts; and involves both theoretical and experimental efforts.
- Continued Advanced Energetics research in advanced multiphase blast concepts employing dense metalized explosives to enhance performance of air and underwater blast warheads.
- Continued Advanced Energetics research in development and diagnostics of novel energy conversion concepts to enhance performance, more efficiently exploit available energy, and more effectively couple energy to target for air, surface, and underwater warhead application.

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FY 2008 Plans:

- Continue all efforts of FY 2007.

FY 2009 Plans:

- Continue research in technology development for the next generation reactive material warhead concepts (formulations, material properties, and energy release experiments) for highly reactive materials, high density reactive materials and novel reactive structural materials. Transition application specific target interaction, lethality modeling and ordnance specific experiments and demonstrations to Electro-magnetic Rail Gun, PE 0603114N.
- Continue development of novel energy conversion concepts to enhance performance, more efficiently exploit available energy, and more effectively couple energy to target. Limit efforts to analytical and laboratory scale proof of concept experimental efforts.
- Continue development and evaluation of energetic ingredients and formulations for next generation higher performance applications. Conclude scale-up development and testing. Transition to Integrated High Payoff Rocket Propellant Program, PE 0602114N.
- Complete proof of concept efforts to develop insensitive explosives, propellants, and munitions without compromising performance. Transition to Future Naval Capabilities Program.
- Complete development of and transition directed hydro-reactive material warhead concepts to Undersea Warheads Program, PE 0602747N.
- Complete research in advanced multiphase blast concepts employing dense metalized explosives to enhance performance of air and underwater blast warheads.

	FY 2007	FY 2008	FY 2009
FLEET FORCE PROTECTION AND DEFENSE AGAINST UNDERSEA THREATS	13,888	12,963	11,937

Fleet Force Protection and Defense against Undersea Threats efforts include applied research for complementary sensor and processing technologies for platform protection and shipboard technologies to increase the survivability of surface ship and submarine platforms against torpedo threats and to develop the capability to interdict underwater asymmetric threats to ships and infrastructure in harbors. Current small platforms (both surface and airborne) have little to no situational awareness (SA) or self-protection against air, surface,

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and asymmetric threats. (Asymmetric threat efforts are co-funded by PE 0602131M.) A goal of this activity is to provide these platforms with effective self-protection. The technology areas specific to platform protection will develop individual, multispectral (EO, IR, RF, EM, visual, and acoustic), or chemical sensors/biosensors and associated processing. To defend platforms from current and advanced threats in at-sea littoral environments and in port, these technologies must improve multispectral detection and distribution of specific threat information.

Another goal of this activity is to develop a torpedo defense capability to fill Sea Shield Warfighting Capability Gap/Enabling Capability: Platform Defense against Undersea Threats, including Four Torpedo Salvo Defense. This provides a capability to prevent any of the torpedoes, in up to four-torpedo salvos fired at high value units, from hitting those units. Specific technology includes two efforts. The first is Next Generation Countermeasure (NGCM), a mobile adaptive acoustic countermeasure with acoustic communication links among countermeasures. The second is Anti-Torpedo Torpedo (ATT)/Tripwire Demonstration, of an ATT to engage the detected threat torpedoes.

This activity supports the Fleet and Force Protection FNC and includes support to Sea Shield and Sea Strike Pillars and FNC Enabling Capabilities for: Aircraft Integrated Self-protection Suite; Fortified Position Security; Advanced Electronic Sensor Systems for Missile Defense; and Shipboard Force Protection in Port and Restricted Waters - Detection and Classification. Budget Activity 2 sensor efforts are co-funded by PEs 0602235N and 0602271N.

FY 2007 Accomplishments:

Sensors & Associated Processing
- Continued the Shipboard EO/IR Closed Loop Self-Protection System effort by initial laboratory testing of the Mid-wave Infrared and Visible Laser System (MIRVLS) generating 15W in the 3-5um region.
- Continued the End User Terminal (EUT) effort by developing a prototype 2-way amplifier for the Secure Net (SECNET) 11 card that will increase by a factor of 9 the secure transmit/receive range between Dismounted-Data Automated Communications Terminals (D-DACT) in an urban environment.
- Continued development of compact sensor systems in support of responsive Intelligence, Surveillance, and Reconnaissance (ISR). (NRL)
- Continued efforts on Antibodies for biowarfare agents to be synthetically modified with enzymes and studied via surface plasmon resonance to gain a better understanding of the impact tagging these recognition sites have on molecular recognition (kinetics and selectivity) for sensor applications. (NRL)

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- Continued efforts in biomimetic sonar systems for operation in air and aquatic environments based on bat echolocation neurophysiology and information processing algorithms.
- Continued design and fabrication of microfluidic nucleic acid extraction and enrichment methods and obtained funding for technology transfer. (NRL)
- Continued design and development of large (1.5m dia.) telescopes with associated adaptive optics for the Naval Prototype Optical Interferometer (NPOI). (NRL)
- Continued the design and development of integrated laser ground based, aircraft protection design to protect large aircraft from Infrared Surface to Air Missiles (SAMs) upon ingress and egress to an airport. (NRL)
- Continued development of solid projectile coilgun design, consumable casing material and improved railgun efficiency and developed method of reducing muzzle flash and surface wear of the rails. (NRL)
- Continued efforts in biomimetic signal processing: panoramic periscope for submarines and temporal pattern recognition for Systems for Security Breaching Noise Detection.
- Continued efforts in bioinspired quiet, efficient and maneuverable self-propelled line array using high-lift propulsors based on insect biomechanics.
- Continued the Integrated EO/IR Self-protection Suite for Rotary Wing Aircraft effort by performing a platform integration analysis and design review.
- Continued investigation of improved jam codes and closed-loop countermeasure techniques to integrate with the Shipboard Integrated Electro-Optic Defense Systems (SHIELDS) hardware for Shipboard EO/IR Closed Loop Self-protection.
- Continued the development of low-cost, lightweight radar absorbing material (RAM) based on metallized cellulose in the form of fibers, fabric and paper. (NRL)
- Continued design and testing of on-chip nucleic acid amplification and transfer technology. (NRL)
- Continued studies to develop catalytic activity profile of bioactive coatings against chemical agents. Designed and initiated fabrication of coatings to degrade both, chemical and biological agents. (NRL)
- Continued development of a portable detection system for defense against small arms fire and rocket propelled grenades (RPG) using Field Programmable Gate Arrays (FPGAs), infrared focal plane arrays (IRFPA), and filtering algorithms. (NRL)
- Continued advanced concept development to integrate object recognition and tracking algorithms, machine vision, multiple networked video streams into different classes of EO/IR sensors within the Intelligent Video Surveillance FNC product (transferred from PE 0602131M).
- Continued developing technologies to support the Intelligent Video Surveillance project which includes integration of object recognition and tracking algorithms, machine vision, and multiple networked video streams into different classes of EO/IR sensors.(Transferred into this PE from PE 0602131M.)

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- Completed first demonstration of high resolution imaging of faint sources using the combined adaptive optics and optical interferometry at NPOI. (NRL)
- Completed development of reagentless sensors for weapons of mass destruction/explosives, using engineered protein based components for detection of explosives (e.g., TNT, RDX) and other analytes in seawater.
- Completed synthesis and acquisition of all the components needed for the fabrication of durable multifunctional coatings. (NRL)
- Initiated integration of DNA and antibody array analysis and demonstrated capability for rapid screening and pathogen species confirmation. (NRL)
- Initiated design and fabrication of self-reporting coatings for system failure detection. (NRL)
- Transferred the Shipboard EO/IR Closed Loop Self-Protection effort to PE 0602271N.

Underwater Platform Self-Defense
- Continued advanced concept development of a scalable low frequency continuous wave acoustic weapon for use against underwater asymmetric threats (transferred from PE 0602131M).
- Completed ATT and NGCM efforts.

FY 2008 Plans:

Sensors & Associated Processing
- Continue all efforts of FY 2007, less those noted as completed above.
- Complete the Integrated EO/IR Self Protect Suite for Rotary Wing Aircraft by conducting a laboratory demonstration of the integrated Missile Warning Sensor (MWS) and multi-band fiber coupled laser jammer.
- Complete development of solid projectile coilgun design, consumable casing material and improved railgun efficiency and developed method of reducing muzzle flash and surface wear of the rails. (NRL)
- Complete the design and development of integrated laser ground based, aircraft protection design to protect large aircraft from Infrared SAMs upon ingress and egress to an airport. (NRL)
- Complete the Intelligent Video Surveillance project including integration of object recognition and tracking algorithms, machine vision, and multiple networked video streams into different classes of EO/IR sensors.
- Transfer biomimetic signal processing efforts, including panoramic periscope and temporal pattern recognition for security breaching noise detection to PE 0602236N.
- Transfer efforts in bioinspired quiet, and maneuverable self-propelled line array using high-lift propulsors based on insect biomechanics to PE 0602236N.

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- Transfer efforts in biomimetic sonar systems for operation in air and aquatic environments based on bat echolocation neurophysiology and information processing algorithms to PE 0602236N.
- Initiate new FNC EC Shipboard Force Protection in Port and Restricted Waters - Detection and Classification. This project will develop mission specific electro-optic/infrared sensors to detect, classify, and determine the intent of potential terrorist and special operations force threats to ships and craft inport and transiting restricted waters.

Underwater Platform Self-Defense
- Continue all efforts of FY 2007, less those noted as completed above.
- Complete the scalable low frequency continuous wave acoustic weapon for use against underwater asymmetric threats.
- Initiate development of low-cost, light weight swimmer detection and localization technologies.
- Initiate development of optimized microfluidic components suitable for explosive, chemical, and biological sensing applications, and initiate the development of models required to apply existing automated design tools to components with more complex physics and more general geometries. (NRL)

FY 2009 Plans:

Sensors & Associated Processing
- Continue all efforts of FY 2008, less those noted as completed above.
- Complete the development of low-cost, lightweight RAM based on metallized cellulose in the form of fibers, fabric and paper. (NRL)
- Initiate the Countermeasures for Advanced Imaging Infrared (IIR) Guided Missiles FNC effort by initiating IIR threat model development.
- Initiate the Countermeasures for Millimeter Wave Guided Missiles FNC effort by initiating requirements analysis.
- Initiate the Multifunction Capabilities for Missile Warning Sensors FNC effort by commencing data collection and analysis.

Underwater Platform Self-Defense
- Continue all efforts of FY 2008, less those noted as completed above.
- Continue development of low-cost, light weight swimmer detection and localization technologies.
- Initiate development of software encoded algorithms for the Anti-Torpedo Torpedo (ATT) sensor and controller that will enable ATT’s to successfully engage torpedo salvoes of up to four attacking units.

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	FY 2007	FY 2008	FY 2009
AIRCRAFT TECHNOLOGY	13,777	16,208	15,934

The Aircraft Technology activity develops high impact, scaleable naval air vehicle technologies, such as structures and flight controls for future and legacy air vehicles, integrated avionics, advanced electrical power systems, and aerodynamics, which significantly increase the naval warfighter's capabilities, effectiveness, readiness, and safety, while reducing life cycle cost. This activity directly supports the Naval Aviation Enterprise Science and Technology Strategic Plan, providing a robust and credible forward presence through flexible response and dominant power projection from the sea.

The funding increase from FY 2007 to FY 2008 is due to additional efforts in survivability/reduced observables technology (classified).

FY 2007 Accomplishments:

- Continued development of survivability/reduced observables technology (classified).
- Continued demonstration of system integration of a shaped memory alloy into a Reconfigurable Rotor Blade system for improved range and lifting capacity in a tilt rotor aircraft.
- Continued development of flight control, intelligent autonomy, command & control, and multi-vehicle cooperation technologies for UAV.
- Continued development of a Computational Fluid Dynamics (CFD) based integration system to maximize operational capability of autonomous aircraft by choosing optimal flight pattern for any environmental condition including low speed operations and brownout.
- Continued development effort to control flow and thermal dynamics in particle coating process and densification dynamics of large windows. (NRL)
- Completed design concepts and initiate technology development of an experimental vertical lift Unmanned Air vehicles (UAV).

FY 2008 Plans:

- Continue all efforts of FY 2007, less those noted as completed above.
- Continue vertical lift technology investments.
- Complete demonstration of system integration of a shaped memory alloy into a Reconfigurable Rotor Blade

system for improved range and lifting capacity in a tilt rotor aircraft.
- Complete development effort to control flow and thermal dynamics in particle coating process and densification dynamics of large windows. (NRL)

FY 2009 Plans:

- Continue all efforts of FY 2008, less those noted as completed above.
- Initiate research in fixed wing aircraft/vertical lift/rotorcraft technology areas such as aeromechanics, propulsion, active rotor control for enhanced ship board operations, structural concepts compatible with shipboard operations, autonomous operations in the shipboard and austere environment, and innovative vehicle concepts for naval application.

	FY 2007	FY 2008	FY 2009
MISSILE DEFENSE (MD)	4,847	14,353	11,222

This activity describes Missile Defense S&T projects of the Sea Shield FNC program, and non-FNC-related NRL research.
- Advanced Area Defense Interceptor (AADI) S&T planning effort for Navy - Marine Corps Air Directed Surface to Air Missile (ADSAM) live firing demonstration at White Sands Missile Range in FY 2008. To be completed in FY 2009 with funding in PE 0603123N, the metric for AADI is execution of an ADSAM demonstration by the Navy and Marine Corps that establishes the basis for further development of an operational Naval Integrated Fire Control/Counter-Air (NIFC-CA) capability.
- Distributed Weapons Coordination (DWC) open architecture combat system algorithms for automated battle management aids (ABMA), including common threat evaluation (CTE) and preferred shooter recommendation (PSR) functions that will enable fleet units to defend against air and missile attacks with increased effectiveness and efficiency. Metrics for DWC include (a) increased effectiveness of combat resources through a theater-wide threat evaluation process; (b) increased efficiency of weapons resources through weapon assignment and preferred shooter recommendations considering Theater Ballistic Missile Defense (TBMD) and Area/Ship Defense capability operating simultaneously; and (c) reduced "free riders" (threats not fired at) due to ineffective use of resources (unengaged targets) by 50% (threshold) 80% (objective).
- Distributed Sensor Coordination (DSC) algorithms for airborne sensor management in ADSAM and multi-threat air defense engagements. The metric for DSC is effective coordination of airborne sensor resources to support NIFC-CA capability, evaluated using laboratory Monte Carlo simulations within simulated stressing air defense environments.

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- Naval Interceptor Improvements (NII) technology upgrades for STANDARD Missile (SM) future fleet air defense missile. Metrics will be to achieve SM performance requirements in specified tactical rain environments and achieve SM performance requirements in all specified electronic countermeasures environments.
- Extended Distributed Weapons Coordination (EDWC) algorithms to extend DWC ABMA functionality to include coordination of passive defense measures (emission control, use of decoys, maneuvering). Metric will be improved probability of negation (Pneg) against advanced ballistic & cruise missile anti-ship threats that may be susceptible to decoys & jamming.
- Positive Control of Naval Weapons (PCNW) equipment and computer programs for an advanced multi-band weapon system / interceptor link to enable forward pass engagements and enhance link security in hostile environments. Metrics will be capabilities to receive in-flight update from TAMD systems including AEGIS combatants, airborne & land-based units, and ability to transmit status and target data to controlling unit and/or other interceptor missiles.
- Emerging technologies that support delivery of Technology Oversight Group (TOG)-approved FNC enabling capabilities (EC) structured to close operational capability gaps in missile defense.
- Non-FNC-related investigation of effects of charged particle layers on UHF to S-Band radars used to track space vehicles. (NRL)

The funding increase from FY 2007 to FY 2008 is for starting EDWC and PCNW projects as scheduled, as well as funding for culminating events in AADI ADSAM demonstration. The FY 2008-2009 decrease is due to diminished 6.2 activity in EDWC, PCNW, and NII and increased 6.3 activity funded for same projects in PE 0603123N.

FY 2007 Accomplishments:

- Continued program to investigate effects of charged particle layers on UHF to S-Band radars used to track space vehicles. (NRL)
- Performed additional AADI S&T planning and coordination for the FY 2008 Navy ADSAM live-fire demonstration taking place under PE 0603123N.
- Completed development and documentation of DWC and DSC algorithms.
- Initiated NII project.

FY 2008 Plans:

- Continue all efforts of FY 2007, less those noted as completed above.
- Initiate EDWC and PCNW efforts.

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FY 2009 Plans:

- Continue all FNC-related efforts of FY 2008.
- Complete non-FNC-related NRL program.

CONGRESSIONAL PLUS-UPS:

	FY 2007	FY 2008
ADPICAS	1,600	0

FY 2007 Accomplishments: Initiated development of intelligent composite active structures and systems to provide precision position control and vibration suppression for military and space structures to enhance their structural performance and reduce their fuel consumption. Applications include fighter jets, helicopters, smart rockets, satellites, and space stations. Phase IV effort in FY07 develops a laser long-distance satellite communication system. The laser long-distance satellite communication system will enhance the transit and receive capabilities.

	FY 2007	FY 2008
ADVANCED RECEIVE-WHILE-TRANSMIT SONAR FOR UUVS	2,192	0

FY 2007 Accomplishments: Initiated development of Advanced-Receive-While-Transmit Sonar for UUVs (Classified Effort).

	FY 2007	FY 2008
ADVANCED SIMULATION TOOLS FOR AIRCRAFT STRUCTURES MADE OF COMPOSITE MATERIALS	1,943	1,987

FY 2007 Accomplishments: Developed and tested object-based software analysis tools, for increased computational efficiency of the analytical code through the application of an advanced material strength criteria. The benefit of this tool is the support it lends toward the creation of an aircraft composite structural certification process.

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FY 2008 Plans: Continue the development and validation of tools and guidelines for the simulation of the structural and strength responses of airframe components made of fiber-reinforced composites, an area where the use of advanced computer-aided engineering technology is particularly important. This work will involve projects in which experimental validation of simulation models will be performed. An important aspect of the project is demonstration in an actual production setting the value of validated and verified simulation tools through the development of metrics in terms of improved quality and reduced life cycle costs. This project will demonstrate reduced life cycle costs of existing and new naval aircraft, reduce airframe concept to deployment time and increase the reliability of structural systems made of composite materials.

	FY 2007	FY 2008
ALTERNATIVE ENERGY RESEARCH	0	15,899

FY 2008 Plans: This effort supports Alternative Energy Research.

	FY 2007	FY 2008
APERSTRUCTURES	21,176	0

FY 2007 Accomplishments: Initiated efforts to demonstrate low observable integrated antenna technologies (aperstructures) using a series of structural (composite) and RF test articles. Addressed principal risk areas for future integrated ship-borne missile defense radars including structural integrity/shock, metrology and dynamic calibration, and deckhouse integration/signatures.

	FY 2007	FY 2008
BLAST RESISTANT ANECHOIC SPRAYABLE ELECTROMERIC COATING FOR SHIPS	1,000	0

FY 2007 Accomplishments: Developed blast resistant coating systems with improved mechanical and fire resistant properties, exceeding those that are currently commercially available. The new coatings can be applied to metal ship bulkheads and armored vehicles providing blast protection to the occupants. Previous efforts resulted in development of a coating systems with good blast resistant properties, but it included an intumescent coating to insulate the Polyurea from fire and thus can be applied to metal structures and provide blast protection.

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	FY 2007	FY 2008
CRITICAL COMPOSITE TECHNOLOGIES FOR ENABLING SPECIAL OPERATIONS FORCES (SOF) MEDIUM RANGE ENDURANCE CRAFT	4,981	994

FY 2007 Accomplishments: Completed construction and initiated operational evaluation of prototype composite craft to existing MK-V Patrol Boat.

FY 2008 Plans: Continue support to the Critical Composite Technologies for Enabling Special Operations Forces (SOF) Medium Range Endurance Craft program by advancing the technical approach for composite material design and hydrodynamic shock mitigation.

	FY 2007	FY 2008
DIRECT MOTOR DRIVEN WATERJETS	996	0

FY 2007 Accomplishments: Initiated technology development and demonstration of a direct electric motor driven waterjet propulsor for naval applications. This effort will develop a more efficient and power dense integrated rim-driven waterjet and mated power electronics that eliminates shafts and seals, decreases the system footprint and weight, and enhances propulsion system arrangement flexibility.

	FY 2007	FY 2008
FACIAL RECOGNITION TECHNOLOGY	996	0

FY 2007 Accomplishments: Continued development of technologies for facial (biometrics) recognition algorithms for heightened accuracy and speed for identification applications. Improved face recognition for outdoor non-cooperative subjects. Developed super-resolution for imagery from video. Developed new low-resolution matcher for long-range face imagery. Developed face forensics workstation.

	FY 2007	FY 2008
FORCE PROTECTION APPLIED RESEARCH	0	1,987

FY 2008 Plans: This effort supports Force Protection Applied Research.

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	FY 2007	FY 2008
HIGH FREQUENCY ACOUSTIC SIGNAL PROCESSOR SYSTEM	2,622	0

FY 2007 Accomplishments: Continued development of a real time, high frequency, acoustic signal processor to aid in Harbor Surveillance (Swimmer Detection), and Terrestrial Surveillance for Perimeter Security and Force Protection Applications both in CONUS and at forward deployed sites.

	FY 2007	FY 2008
HIGH TEMPERATURE SUPER CONDUCTING MAGNETIC ENERGY STORAGE	0	397

FY 2008 Plans: This effort supports development of a High Temperature Super Conducting Magnetic Energy Storage system.

	FY 2007	FY 2008
HIGH TOUGHNESS ALUMINUM STRUCTURES	0	1,193

FY 2008 Plans: This effort supports the High Toughness Aluminum Structures program.

	FY 2007	FY 2008
LARGE UNMANNED UNDERWATER VEHICLE TECHNOLOGIES	996	0

FY 2007 Accomplishments: Initiated development of technologies to allow the Navy to develop long range and high endurance large Unmanned Underwater Vehicles (UUVs) with short duration high speed capability to meet future operational surface and undersea requirements. Technologies developed by this effort include greater energy density storage and advanced propulsion and control systems that provide improved remote system operation and resource management.

	FY 2007	FY 2008
LITHIUM-ION CELL DEVELOPMENT	2,290	2,980

FY 2007 Accomplishments: Initiated development and evaluation of: (1) advanced slurry preparation methods;

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(2) nano scale material electrodes; (3) metal based anode materials; (4) safer chemistry alternatives to the traditional cobalt oxide; and (5) applied research into the requirements and the approach for generating domestic supply of critical cell electrode materials.

FY 2008 Plans: Continue Lithium-Ion Cell program development.

	FY 2007	FY 2008
MAGNETIC REFRIGERATION TECHNOLOGY FOR NAVAL APPLICATIONS	1,644	3,180

FY 2007 Accomplishments: Continued development of advanced magnetocaloric materials and active magnetic regenerators towards demonstration of a high temperature span magnetic refrigerator. A breadboard system based on Navy requirements will be constructed. A repeatable hydriding process will be developed to obtain materials with large magnetic entropy change and controllable Curie temperatures.

FY 2008 Plans: Continue Naval Magnetic Refrigeration Technology program development.

	FY 2007	FY 2008
NANO-MAGNETIC MATERIALS FOR FUTURE MILITARY PROPULSION/ENERGY SYSTEMS	996	0

FY 2007 Accomplishments: Continued development of soft magnetic materials capable of meeting the demanding performance requirements of high power density electric machines and power electronics. This effort continues to focus on developing nanoengineered alloys that optimize the magnetic properties such as increased saturation magnetic flux levels and minimization of the magnetostrictive losses and electromagnetic noise levels, while retaining or improving the mechanical strength and temperature performance of the magnetic materials. A novel nanostructured magnetic alloy with significantly improved glass formability and an associated scale up pilot scale production process will be developed, with guidance from a system design study for 100kW core for a high frequency transformer. A prototype core component for a high frequency transformer will be fabricated and fully characterized.

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	FY 2007	FY 2008
NANOSTRUCTURED COMPOSITE MARINE COATINGS	1,993	0

FY 2007 Accomplishments: Initiated development of greatly improved coating systems designed to protect ships from marine environment, utilizing several recent technological breakthroughs. This effort focused on anticorrosion research at the University of New Hampshire's, Nanostructured Polymers Research Center which conducts applied research in the following areas including: New coatings to address corrosion; working with nanostructured composite marine coatings; and coatings with multiple microscopic additives that enhance their durability and performance, such as "Self-Healing Coating" in application of areas that are sensitive to stress. The purpose is to further refine the above technologies to develop novel coating additives for improved steel-coating adhesion, to develop coatings with sequential multistage curing for easier shipyard application and to enhance capabilities to improve micro and nano imaging characterization of steel-epoxy coatings to support and accelerate structured coating development.

	FY 2007	FY 2008
NAVAL AVIATION TECHNOLOGY EXPLORATION INITIATIVE	0	796

FY 2008 Plans: Initiate feasibility study to incorporate an early stage transformational technology development model into the Naval Aviation Enterprise (NAE) Science and Technology strategic plan. The strategic plan provides a roadmap for insertion of new technologies critical to meeting the current and future objectives of the Navy.

	FY 2007	FY 2008
OPTICAL RECOGNITION PROTOCOL FOR BIOLOGICS DETECTION	0	795

FY 2008 Plans: This effort supports the Optical Recognition Protocol for Biologics Detection program.

	FY 2007	FY 2008
PLANAR SOLID OXIDE FUEL CELL SYSTEM DEMONSTRATION AT UTC SIMCENTER	1,644	3,478

FY 2007 Accomplishments: Initiated design and test simulation capability necessary to conduct applied research on a solid oxide fuel cells capable of being used in national military applications.

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FY 2008 Plans: Continue Planar Solid Oxide Fuel Cell System Demonstrations at the University of Tennessee Chattanooga (UTC) SimCenter: National Center for Computational Engineering.

	FY 2007	FY 2008
PMRF FORCE PROTECTION LAB	3,109	1,987

FY 2007 Accomplishments: Continued force protection and security technologies by integrating, evaluating and demonstrating enabling technologies, tools, and processes. Approaches included integration of advanced sensor systems, novel sensor and data fusion processes, behavior modeling and analysis, and data mining and knowledge extraction techniques.

FY 2008 Plans: Continue PMRF Force Protection Lab development efforts.

	FY 2007	FY 2008
SHIPBOARD PRODUCTION OF SYNTHETIC LOGISTICS AND AVIATION FUEL	996	1,590

FY 2007 Accomplishments: Initiated the design, development and fabrication of the basic components for a synthetic shipboard logistic and aviation fuel generation capability.

FY 2008 Plans: Continue Shipboard Production of Synthetic Logistics and Aviation Fuel development efforts.

	FY 2007	FY 2008
SMALL WATERCRAFT PROPULSION DEMONSTRATOR	2,690	0

FY 2007 Accomplishments: Continued previous efforts to develop an advanced internal combustion engine to be used as part of a power-dense electric drive system for a small watercraft. Developed and tested a full-scale, laboratory tested prototype energy-dense power generation system.

BUDGET ACTIVITY: 02
PROGRAM ELEMENT: 0602123N PROGRAM ELEMENT TITLE: FORCE PROTECTION APPLIED RESEARCH
PROJECT TITLE: FORCE PROTECTION APPLIED RESEARCH

	FY 2007	FY 2008
STABLIZED LASER DESIGNATION CAPABILITY	0	993

FY 2008 Plans (continuation of FY 2007 program in PE 0603123N): Continue development of system design requirements and target tracking algorithms for an enhanced, medium altitude laser designation capability for medium altitude aircraft operations that can address moving targets, as well as targets in a Global Positioning System (GPS)-jammed environment.

	FY 2007	FY 2008
UNDERSEA PERIMETER SECURITY INTEGRATED DEFENSE ENVIRONMENT	996	2,782

FY 2007 Accomplishments: Continued research on undersea perimeter security integrated defense environment. This is a networked pilot beta test site on the RI/CT waterfronts which incorporates surface and undersea sensor/visual technologies from partnering companies to create an automated underwater perimeter detection and response system for system users. The pilot project provides direct test bed information enhancing existing facility security procedures, 24x7.

FY 2008 Plans: Continue Undersea Perimeter Security Integrated Defense Environment development efforts.

C. OTHER PROGRAM FUNDING SUMMARY - NAVY RELATED RDT&E:
PE 0204152N E-2 Squadrons
PE 0205601N HARM Improvement
PE 0601153N Defense Research Sciences
PE 0602114N Power Projection Applied Research
PE 0602131M Marine Corps Landing Force Technology
PE 0602235N Common Picture Applied Research
PE 0602271N RF Systems Applied Research
PE 0602747N Undersea Warfare Applied Research
PE 0603114N Power Projection Advanced Technology
PE 0603123N Force Protection Advanced Technology
PE 0603235N Common Picture Advanced Technology
PE 0603271N RF Systems Advanced Technology

BUDGET ACTIVITY: 02
PROGRAM ELEMENT: 0602123N PROGRAM ELEMENT TITLE: FORCE PROTECTION APPLIED RESEARCH
PROJECT TITLE: FORCE PROTECTION APPLIED RESEARCH

PE 0603502N Surface and Shallow Water Mine Countermeasures
PE 0603513N Shipboard System Component Development
PE 0603553N Surface ASW
PE 0603561N Advanced Submarine System Development
PE 0603609N Conventional Munitions
PE 0603640M USMC Advanced Technology Demonstration (ATD)
PE 0604307N Surface Combatant Combat System Engineering
PE 0604518N Combat Information Center Conversion
PE 0604558N New Design SSN
PE 0604561N SSN-21 Developments

OTHER PROGRAM FUNDING SUMMARY - NON-NAVY RELATED RDT&E:
PE 0602270A Electronic Warfare Technology
PE 0602000D8Z Joint Munitions Technology
PE 0602204F Aerospace Sensors

D. ACQUISITION STRATEGY:
Not applicable.

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

BUDGET ACTIVITY: 02
PROGRAM ELEMENT: 0602131M
PROGRAM ELEMENT TITLE: MARINE CORPS LANDING FORCE TECHNOLOGY

COST: (Dollars in Thousands)

Project Number & Title	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
MARINE CORPS LANDING FORCE TECHNOLOGY	40,822	31,813	36,480	39,858	44,568	45,848	47,155

A. MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: The efforts described in this Program Element (PE) are based on investment directions as defined in the Naval Science and Technology (S&T) Strategic Plan approved by the S&T Corporate Board (Jan 2007). This strategy is based on needs and capabilities from Navy and Marine Corps guidance and input from the Naval Research Enterprise (NRE) stakeholders (including the Naval enterprises, the combatant commands, the Chief of Naval Operations (CNO), and Headquarters Marine Corps). It provides the vision and key objectives for the essential science and technology efforts that will enable the continued supremacy of U.S. Naval forces in the 21st century. The Strategy focuses and aligns Naval S&T with Naval missions and future capability needs that address the complex challenges presented by both rising peer competitors and irregular/asymmetric warfare.

This PE is organized into seven expeditionary warfighting capability areas. These are: Command, Control, Communications, Computers (C4); Intelligence, Surveillance and Reconnaissance (ISR); Maneuver; Force Protection; Logistics; Human Performance, Training and Education; and, Firepower. The primary objective of this PE is to develop and demonstrate the technologies needed to meet the Marine Corps' unique responsibility of training and equipping the Marine Air/Ground Task Force (MAGTF) for Expeditionary Maneuver Warfare. This PE provides the knowledge base to support Advanced Technology Development (6.3) and is the technology base for future expeditionary warfare capabilities. This PE supports the Expeditionary Force Development System of the Marine Corps Combat Development Command and responds directly to the Marine Corps Science and Technology (S&T) process as well as supporting related Littoral and Expeditionary Maneuver Warfare capabilities developed by the Navy's Mission Capability Program. The Future Naval Capabilities (FNC) process is supported and funds are programmed accordingly. The FNC program explores and demonstrates technologies that enable Sea Strike, Sea Shield, Sea Basing and FORCEnet pillars. The core 6.2 program also supports Discovery and Invention (D&I) and Innovation and Transformation (I&T). Within the Naval Transformation Roadmap, this investment will achieve key transformational capabilities required by the Sea Power 21 Pillars, as well as enable Ship to Objective Maneuver (STOM), Persistent Intelligence, Surveillance and Reconnaissance and the Global War on Terrorism

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(GWOT).

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

BUDGET ACTIVITY: 02
PROGRAM ELEMENT: 0602131M
PROGRAM ELEMENT TITLE: MARINE CORPS LANDING FORCE TECHNOLOGY

B. PROGRAM CHANGE SUMMARY:

	FY 2007	FY 2008	FY 2009
FY 2008/FY 2009 President's Budget Submission	42,031	26,785	26,902
Congressional Action	0	5,500	0
Congressional Undistributed Reductions/Rescissions	0	-205	0
Execution Adjustments	-190	0	0
Program Adjustments	-238	0	9,648
Rate Adjustments	0	0	-70
SBIR Assessment	-781	-267	0
FY 2009 President's Budget Submission	40,822	31,813	36,480

PROGRAM CHANGE SUMMARY EXPLANATION:
Technical: FY 2009 reflects funding for a DoD directed integrated capability demonstration supporting the Protection of Ground Forces and Systems. DoD directed this initiative in response to the determination that its S&T investment is likely too small to meet the imposing security threats that challenge our Nation, and it may not be adequately postured to take advantage of key scientific and technological opportunities that offer breakthrough advantages to our warfighters. This broad, multi-year (through the FYDP) initiative will expand existing technology integration and increase/spur the application of more fundamental technologies to force and platform protection. The goal is multiple broad phased force protection applications and technologies, with off-ramps for fielding successes, therefore, funding associated with this DoD initiative is reflected throughout the PE.

Schedule: Not applicable.

C. OTHER PROGRAM FUNDING SUMMARY:
Not applicable.

D. ACQUISITION STRATEGY:
Not applicable.

BUDGET ACTIVITY: 02
PROGRAM ELEMENT: 0602131M
PROGRAM ELEMENT TITLE: MARINE CORPS LANDING FORCE TECHNOLOGY

E. PERFORMANCE METRICS:

The primary objective of this PE is the development of technologies to meet unique Marine Corps needs in conducting Expeditionary Maneuver Warfare and Combating Terrorism. The program consists of a collection of projects categorized by critical warfighting function. Individual project metrics reflect the technical goals of each specific project. Typical metrics include the advancement of related Technology Readiness Levels, the degree to which project investments are leveraged with other performers, reduction in life cycle cost upon application of the technology, and the identification of opportunities to transition technology to higher categories of development.

BUDGET ACTIVITY: 02
PROGRAM ELEMENT: 0602131M PROGRAM ELEMENT TITLE: MARINE CORPS LANDING FORCE TECHNOLOGY
PROJECT TITLE: MARINE CORPS LANDING FORCE TECHNOLOGY

COST: (Dollars in Thousands)

Project Number & Title	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
MARINE CORPS LANDING FORCE TECHNOLOGY	40,822	31,813	36,480	39,858	44,568	45,848	47,155

A. MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: This project is organized into nine activities which are represented as seven Expeditionary Warfighting Capability Areas, as well as Future Concepts; Technology Assessment and Roadmapping; and the Littoral Combat/Power Projection (LC/PP) FNC. The seven Expeditionary Warfighting Areas support the Discovery and Invention (D&I) and the Innovation and Transformation (I&T) investment. The LC/PP FNC supports the Exploitation and Deployment (E&D) investment.

B. ACCOMPLISHMENTS/PLANNED PROGRAM:

	FY 2007	FY 2008	FY 2009
LITTORAL COMBAT/POWER PROJECTION	21,064	9,589	9,657

This activity is aligned with the Sea Strike, Sea Shield, Sea Basing and FORCEnet pillars and provides the capability for the demonstration and transition of technologies developed through the related Marine Corps S&T programs directly to an acquisition program of record.

Through 2005, the focus of the FNC efforts was on satisfying technology gaps related to Power Projection and Littoral Combat as the products of those efforts are transitioned to acquisition programs of record. The funding profile for FY 2007 reflects the reorganization of the FNC program investments into Enabling Capabilities (ECs). As a result of this reorganization, the funding for each EC has been realigned to a Budget Activity as appropriate. The focus of the FNC within this PE is on technology related to Urban, Asymmetric, Littoral and Expeditionary Maneuver Warfare Operations. The related S&T development is of the highest importance to Marine Corps operations in Iraq, Afghanistan and the Global War on Terrorism (GWOT). These Warfighter Capability Gaps are among those highest ranked by the Office of the Chief of Naval Operations and the Marine Corps Combat Development Command based on urgency and need. The technologies associated with these gaps are being pursued as part of an overall effort that addresses Sea Strike, Sea Shield, Sea Basing

and FORCEnet Capability Gaps. Warfighter Capability Gaps are made up of ECs and supporting products.

The decrease from FY 2007 to FY 2008 is due to the transition of a significant number of efforts to other PEs as described in the FY 2007 accomplishments, as well as zero-sum realignments within the Future Naval Capability program of record to fund Technology Oversight Group approved Enabling Capabilities.

FY 2007 Accomplishments:

- Continued Expeditionary Fighting Vehicle (EFV) obstacle avoidance subsystem design, integrated subsystems and prepared for demonstration.
- Continued efforts to provide urban direction finding of Radio Frequency (RF) emitters from moving platforms. (Concurrent funding in PE 0603640M. Realigns to PE 0603640M in FY 2007.)
- Continued effort in Distributed Common Ground/Surface System (DCGS) that involves the migration of tactical intelligence systems (sensor networks) to a net-ready architecture and the development of enterprise services that translate this data. (Realigns to PEs 0602235N and 0603235N in FY 2007.)
- Continued development of target acquisition architecture, information exchange, connectivity and interoperability of target hand-off, fire control, and coordination systems. (Previous and concurrent funding in PE 0603640M. Realigns to PEs 0602114N and 0603114N in FY 2007.)
- Continued design and test of hostile fire detection and counter-fire system (GUNSLINGER). (Realigns to PEs 0602114N and 0603114N in FY 2007.)
- Continued development of integrated vehicle self-defense system technologies to defeat incoming Rocket Propelled Grenades (RPGs). (Concurrent funding in PE 0602782N.)
- Continued development and integration of network monitoring and management tools technology and transition to acquisition. (Concurrent funding in PE 0603782N. Realigns to PE 0603235N in FY 2007.)
- Continued integration and demonstration of innovative relays Beyond Line Of Sight (BLOS) in the areas of wideband communications and advanced modular systems. (Concurrent funding in PE 0603782N. Realigns to PE 0603235N in FY 2007.)
- Continued development of algorithms and initiated modifications of hardware and software for use in discriminating between individual single channel RF emitters on the battlefield and determining their locations; provide algorithms to MARCORSYSCOM Program Manager (PM) INTEL. (Concurrent funding in PE 0603782N. Realigns to PE 0603640M in FY 2007.)
- Continued development and began transitioning EFV obstacle detection capability to EFV Direct Reporting Program Manager. (Realigns to PE 0603640M in FY 2007.)
- Continued development of land mine countermeasure insensitive munitions technology.

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- Continued development of integrated vehicle self-defense system to defeat incoming RPGs.
- Continued the development of tactical ISR data structures and pattern recognition algorithms. (Realigns to PE 0602114N in FY 2007.)
- Continued advanced concept development to alert approaching targets with an unambiguous warning that, if ignored, will clearly demonstrate hostile intent of the approaching target. (Realigned from PE 0602123N.)
- Completed development of a fires coordination architecture to network existing expeditionary fires systems to enable MAGTF/Joint Fires; transition multiple software injectors to MARCORSYSCOM PM GC2. (Transitions to PE 0602114N.)
- Completed investigation of ammunition packing techniques to lower weight and have the packaging provide additional use on the battlefield; provide prototype packaging to MARCORSYSCOM PM AMMO. (Transitions to PE 0602114N.)
- Completed development and transition of advanced weapons materials for use in artillery and mortar systems to reduce weight while maintaining strength, and increasing operational life and capability to acquisition; provide prototype mortar tube, bipod and baseplate to MARCOSYSCOM PM Expeditionary Fire Support System (EFSS). (Transitions to PE 0602114N.)
- Completed integration and testing of secure mobile network/secure wireless LAN technologies, including advanced protocols, frequency conversions and power amplification; provide advanced networking protocols and antennas to MARCORSYSCOM PM COMM. (Previous effort funded in PEs 0602236N and 0603236N.)
- Completed development, integration and transition of airborne ISR (tactical littoral sensing) capability to MARCORSYSCOM PM INTEL.
- Completed transition of expeditionary maneuver planning and decision-making tools for Marine ground forces to Navy and Marine Corps acquisition; Expeditionary Decision Support System (EDSS) transitions to MARCORSYSCOM and PMS 490. (Transitions to PE 0602114N.)
- Completed development of the Asymmetric Threat Weapon. (Effort partially realigned from PE 0602123N, currently being funded by both PEs.)
- Initiated transparent urban structure ‘see thru the wall’,image and mapping technologies development.
- Initiated modular scalable effects weapons technologies development.
- Initiated development of an integrated company level Urban Sensor Suite. (Automated Control of Large Sensor Networks) (Transitions to PE 0602235N.)
- Initiated detect and ID facilities technology development. (Transparent Urban Structures)
- Initiated decision aids technology development. (Transparent Urban Structures)
- Initiated indirect prototype technology development. (Modular Scalable Effects Weapon)

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FY 2008 Plans:

- Continue all efforts of FY 2007, less those noted as completed above.
- Initiate development of Modular Scalable Effects weapons technologies. (Concurrent funding in PE 0603640M.)
- Initiate development of counter Improvised Explosive Device (IED) technologies. (Concurrent funding in PE 0603640M.)
- Initiate development of tactical urban breaching technologies. (Concurrent funding in PE 0603640M.)

FY 2009 Plans:

- Continue all efforts of FY 2008, less those noted as completed above.
- Initiate development of individual Warfighter protection technologies. (Concurrent funding in PE 0603640M; funding will also be provided by PE 0603236N in FY 2009).
- Initiate development of advanced survivability and mobility technologies for Marine Corps tactical and combat vehicles. (Concurrent funding in PE 0603640M).

	FY 2007	FY 2008	FY 2009
MANEUVER	5,820	6,080	5,790

The Maneuver thrust area focuses on the development, demonstration, and transition of technologies that will increase the warfighting capabilities and effectiveness of the MAGTF. This thrust aims at capturing emerging and "leap ahead" technologies in the areas of mobility, materials, propulsion, survivability, durability, signature reduction, modularity, and unmanned systems. Special emphasis on survivability technologies for the defeat of small arms, IEDs, mine blast, and RPGs continue to be incorporated into this thrust area. A concentrated effort has also been made in the development of modeling and simulation tools that integrate many different physics based modeling systems with rigorous operational analysis simulations to accurately define a system's performance characteristics. These tools will aid in defining the trade space for emerging technologies and assist in providing the program manager insight and guidance into pursuing future technologies. Finally, this technology thrust area also seeks to develop technologies to enhance combat vehicle crewman effectiveness and situational awareness through the incorporation of advanced autonomous vehicle functions triggered directly by the cognitive state of the operator. Presently, Mine Countermeasures (MCM) supports and enhances the maneuver and force protection Marine landing forces with the development of technologies to enable detection, neutralization, breaching, and clearing of mines, IEDs, and Unexploded Ordnance (UXO) from the beach exit to inland objectives. MAGTF MCM is a functional component of Naval

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Expeditionary Maneuver Warfare and includes Ship to Objective Maneuver (STOM), Expeditionary Operations from a Sea Base, sustained Operations Ashore, Urban and Asymmetric Operations, and Operations other than War.

The decrease in funding from FY 2008 to FY 2009 reflects funds being realigned to the new activity "Force Protection" within this PE.

FY 2007 Accomplishments:

- Continued lightweight Expeditionary Systems Materials (ESM) efforts to determine feasibility of scaling and producing candidate structural armor.
- Continued Cognitive Assessment and Task Management technologies for combat vehicle crewmen (formerly Augmented Cognition effort).
- Continued development of Advanced Electromagnetic Armor (E-NERA).
- Continued the development of scalable explosive neutralization technologies for MCM.
- Continued S&T programs to address MAGTF Land MCM Master Plan capability gaps.
- Continued technologies for stand-off detection and neutralization of mines, IEDs, and Unexploded Ordnance (UXO). (Transitions to Force Protection activity in FY 2009)
- Continued technologies to defeat side/top attack and advanced fuse mines through signature reduction and advanced signature duplication. (Transitions to Force Protection activity in FY 2009)
- Continued development of modeling tools to accurately determine loading and fragmentation effects on targets from mine explosions. (Transitions to Force Protection activity in FY 2009)
- Continued development of technologies to defeat advanced mine fuzes (seismic, acoustic, and infrared). (Transitions to Force Protection activity in FY 2009)
- Continued development of computational models to scale the effects of small-scale explosives tests to full-scale landmine explosions in order to study mine blast effects on advanced vehicle geometry. (Transitions to Force Protection activity in FY 2009)
- Completed development of Variable Load & Ride Height Suspension System.
- Completed Whole Vehicle Fuel Efficiency Improvement effort.
- Completed USMC participation in Explosion Resistant Coating Advanced Concept and Technology Demonstration (ERC ACTD).
- Initiated development of countermeasures for smart mine sensors.
- Initiated mobility enhancement development effort for current and future light and medium weight Marine Corps vehicle programs.
- Initiated and completed development of materials to promote Combat Science and Technology Vehicle (CSTV)

survivability.
- Initiated development of advanced electromagnetic armor for ground vehicle survivability.
- Initiated development of cognitive assessment and task management concept for CSTV.

FY 2008 Plans:

- Continue all efforts of FY 2007, less those noted as completed above.
- Complete development of scalable explosive neutralization methods.
- Initiate integration of CSTV capabilities.
- Initiate development of fuel efficiency and battlefield power technologies for the CSTV and ground vehicles.
- Initiate studies into mine signature classification. (Transitions to Force Protection activity in FY 2009)
- Initiate technology development programs to address force protection capability gaps. (Transitions to Force Protection activity in FY 2009)
- Initiate spectral signature classification efforts for MCM applications. (Transitions to Force Protection activity in FY 2009)

FY 2009 Plans:

- Continue all efforts of FY 2008, less those noted as completed above.
- Initiate efforts addressing survivability and technologies to mitigate acceleration and traumatic brain injuries to vehicle occupants to enhance tactical mobility in support of Distributed Operations.
- Initiate efforts addressing advanced suspension systems with ride height adjustment capabilities, adjustable ride quality capabilities, rollover prevention, and load equalizing systems to enhance tactical mobility and survivability in support of Distributed Operations.
- Initiate efforts addressing improvements in vehicle fuel efficiency by improvements in drive train efficiencies, engine efficiencies and alternative fuels capabilities to enhance tactical mobility in support of Distributed Operations.
- Initiate technology development programs to address maneuver capability gaps in Survivability such as an Advanced Seat Technology effort to improve/increase occupant protection within the platform by reducing injury due to the effects of dynamic blast events and accidental vehicle rollover.
- Initiate technology development programs to address maneuver capability gaps in Mobility such as a Vehicle Stability effort to improve/increase vehicle performance characteristics such as reducing vehicle rollover tendencies.

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	FY 2007	FY 2008	FY 2009
FORCE PROTECTION	0	0	3,864

This activity supports the Force Protection Thrust's applied research program. Technologies are being developed that focus on the following: Landmine avoidance, detection, and breaching / neutralization; Counter Improvised Explosive Devices; Counter Rocket, Artillery, Mortars, and Snipers; Technologies for improved protection for individuals including Marine Personnel Protective Equipment against blast and ballistic threats and in chemical, radiological, and biological environments; and Physical installation and checkpoint security.

FY 2009 reflects additional funding for a DoD directed integrated capability demonstration supporting the Protection of Ground Forces and Systems. This capability demonstration has been directed to be wide ranging and encompass technologies for:
- Pre-detonation of IEDs,
- Personal protection materials,
- Personal power generation,
- Micro power sources, and
- Augmented reality

The integrated demonstration will be a broad, multi-year thrust to both investigate technology integration as well as spur application of more fundamental technologies to force and platform protection. The goal is multiple broad phased force protection applications and technologies, with off-ramps for fielding successes. Technologies being developed by the Force Protection activity are central to the integrated demonstration program.

FY 2009 Plans:

The following efforts transitioned from the Maneuver activity:
- Continue development of technologies for stand-off detection and neutralization of mines, IEDs, and UXO.
- Continue development of technologies to defeat side/top attack and advanced mine fuzes (seismic, acoustic, and infrared) through advance signature reduction, duplication, and projection.
- Continue spectral signature classification efforts for MCM applications.
- Continue development of computational models to scale the effects of small-scale explosives tests to full-scale landmine explosions in order to study mine blast effects on advanced vehicle geometry.

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- Continue studies into mine signature classification.
- Continue technology development programs to address force protection capability gaps.
- Complete development of studies into mine signature classification.
- Complete development of modeling tools to accurately determine loading and fragmentation effects on targets from mine explosions.
- Complete evaluation of low passive inter-modulation narrowband antennas and wideband antennas for potential use in detection methodologies.
- Initiate studies of sensor fields to identify and classify mine threats.
- Initiate evaluation of active wideband double notch filters for a wide spur-free dynamic range in specific frequencies of interest to cover a variety of threats.
- Initiate an Explosive Hazard Defeat for IED Neutralization effort focused on applying passive infrared phenomenology understanding to a capability enabling defeat of PIR devices from significant stand-off distances.
- Initiate Counter Rocket, Artillery, Mortar, and Sniper efforts addressing indications and warnings for pre-shot sniper detection and enabling detection of sniper observation and targeting in advance of a ballistic event.

	FY 2007	FY 2008	FY 2009
HUMAN PERFORMANCE, TRAINING AND EDUCATION	1,927	2,202	3,495

This activity develops advanced training technology and technologies that enhance neural and cognitive aspects of human performance including cognitive task analysis, tactical decision-making, modeling, simulation, range instrumentation, and synthetic environment generation. This activity name has changed in FY 2008 to "Human Performance, Training and Survivability" to better describe its program/projects. Some projects will migrate from the Firepower activity during FY 2008.

The increase from FY 2008 to FY 2009 funding addresses USMC priorities in cognitive and physical enhancement, modeling and simulation, and virtual reality squad level training in support of Distributed Operations.
FY 2009 reflects additional funding for USMC priorities in cognitive and physical enhancement; modeling and simulation; virtual reality squad level training in support of Distributed Operations; and a DoD directed integrated capability demonstration supporting the Protection of Ground Forces and Systems. This capability demonstration has been directed to be wide ranging and encompass technologies for:
- Pre-detonation of IEDs,

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- Personal protection materials,
- Personal power generation,
- Micro power sources, and
- Augmented reality

The integrated demonstration will be a broad, multi-year thrust to both investigate technology integration as well as spur application of more fundamental technologies to force and platform protection. The goal is multiple broad phased force protection applications and technologies, with off-ramps for fielding successes. Technologies being developed by the Human Performance, Training and Education activity are central to the integrated demonstration program.

FY 2007 Accomplishments:

- Continued evaluation and development of tools to support real-time cognitive and behavioral assessment (augmented cognition) and improvement of individuals and teams during operations and training.
- Continued research in the area of team training task analyses and training effectiveness evaluation techniques to develop more effective training systems for Military Operations in Urban Terrain (MOUT).
- Continued and completed research to develop metrics for improving an individual's operational performance in stressful urban environments including use for selection and recruiting to that mission specialty.
- Continued research to evaluate the feasibility of integrating augmented reality technologies into current and emerging training systems.
- Completed development of a performance fidelity architecture, applying the model to develop guidelines and specifications for a to-be-built training system.
- Completed development of tools to rapidly generate synthetic environments (3D databases, database correlation techniques) within an urban landscape (MOUT), and apply to existing training programs (i.e., Virtual Technologies and Environments—(VIRTE) Demo III).
- Initiated research on combat situation awareness and its effect on combat performance.
- Initiated research on combat feeding and hydration.
- Initiated research on physiological correlates for strategic corporal assessment.
- Initiated development into a Marine performance optimization model.
- Initiated the development of training effectiveness measures and techniques as applied to disparate, multi-platform, multi-mission team training.

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FY 2008 Plans:

- Continue all efforts of FY 2007, less those noted as completed above.
- Complete research on combat situation awareness and its effect on combat performance.
- Initiate research into distributed operations peak neural and cognitive performance.
- Initiate research into next generation survivability enhancement technologies.

FY 2009 Plans:

- Continue all efforts of FY 2008, less those noted as completed above.
- Continue studies into next generation physical performance enhancement methodologies and technologies (continues in 0603640M).
- Complete evaluation of tools to support real-time cognitive and behavioral assessment (augmented cognition) and improvement of individuals and teams during training.
- Complete research in the area of team training task analyses and training effectiveness evaluation techniques to develop more effective training systems for MOUT.
- Initiate the development of foundational learning theories extended to complex tasks for a range of expertise levels, training mitigation strategies triggered by neurophysiological markers of learning, cognition and expertise, and principles of expertise development on a continuum of novice to expert.
- Initiate development of training mitigation strategies triggered by behavioral and neurophysiological markers of learning, cognition and expertise.
- Initiate additional Human Performance and Training efforts (Cognitive and physical enhancement, modeling and simulation, and virtual reality squad level training in support of Distributed Operations).
- Initiate Distributed Operations training system investigations to perceptual skills enhancement that lead to enhanced cognition and decision making.
- Initiate additional efforts to incorporate effects of nutrition and functional fitness into models and simulations in the Distributed Operations Virtual Toolkit.
- Initiate Advanced Mobile Assessment and Field Readiness Technologies to improve the capability to assess situational awareness in the field and predict physical performance by developing mobile, rugged tools, algorithms, and models.
- Initiate a Mind-Body Integration Systems effort to improve team training by developing and validating Electroencephalogram (EEG) (and other physiological and performance measures) for use in assessing team performance, coordination, and cohesion in training environments.

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	FY 2007	FY 2008	FY 2009
COMMAND, CONTROL, COMMUNICATIONS, COMPUTERS, INTELLIGENCE, SURVEILLANCE AND RECONNAISSANCE (C4ISR)	3,012	3,128	0

This activity provides technologies for secure, robust, self-forming, mobile communications networks (FORCEnet); distributed computing to support information dissemination to all echelons; and sensors, software and data processing to support formation of appropriate common picture. Emphasis for Marine Corps efforts includes power management, low detect ability, size and weight constraints, and interoperability within the joint environment.

The FY 2009 funding profile reflects both C4 and ISR efforts now being placed into new and separate activities within this PE.

FY 2007 Accomplishments:

- Continued development of conformal, broadband, Ultra High Frequency-Very High Frequency (UHF-VHF) antennas.
- Continued development of non-line-of-sight communications technologies.
- Continued development of technology to provide position location in Global-Positioning System (GPS) restricted environments.
- Continued development of information fusion technologies to allow automated construction of a common tactical picture from various sources of sensor data. (Transitions to ISR activity in FY 2009)
- Continued development of low power consumption urban sensing technologies.(Transitions to ISR activity in FY 2009)
- Completed development of low-probability of detection random noise communications waveforms.
- Completed development of communications technologies for high attenuation and multi-path environments. Efforts will continue to mature this technology within PE 0603640M.
- Completed development of network management capabilities for the low-bandwidth, heterogeneous communication environment.
- Completed development of urban navigation technologies.
- Initiated development of tagging, tracking and locating technologies to monitor adversary movement. (Transitions to ISR activity in FY 2009)
- Initiated development of information on demand technologies to provide warfighter with the right information at the right time. (Transitions to ISR activity in FY 2009)

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- Initiated development of urban sensing technologies to detect weapons at distance. (Transitions to ISR activity in FY 2009)
- Initiated development of adaptable enemy course of action engine to manipulate adversary decisions. (Transitions to ISR activity in FY 2009)

FY 2008 Plans:

- Continue all efforts of FY 2007, less those noted as completed above.
- Complete development of conformal, broadband, UHF-VHF antennas.
- Complete development of technology to provide position location in GPS restricted environments.
- Complete development of non-line-of-sight communications technologies.
- Initiate development of advanced tactical sensor technologies to improve unit awareness. (Transitions to ISR activity in FY 2009)

	FY 2007	FY 2008	FY 2009
COMMAND, CONTROL, COMMUNICATIONS, AND COMPUTERS (C4)	0	0	2,994

This activity supports S&T investment in Command and Control and is focused in three main areas: (1) Implementing the FORCEnet concept. FORCEnet is the operational construct and architectural framework for naval warfare in the information age that integrates warriors, networks, command and control, and weapons into a networked, distributed, combat force that is scalable across all levels of conflict from the seabed to space and sea to land. The Marine Corps instantiation of FORCEnet is Marine Air Ground Task Force Command and Control (MAGTF C2), with technologies to exchange data and information with and among distributed tactical forces. (2) Developing decision support systems that enable warfighters to take advantage of the FORCEnet and MAGTF C2 and tactically extend Net-Enabled Command and Control (NECC) for shared situational awareness, and (3) providing effective combat identification of enemy combatants, friendly forces, and non-combatants. Activities in this R2 activity provide technologies for secure, robust, self-forming, mobile communications networks distributed computing to support information dissemination to all echelons; and sensors, software and data processing to support formation of appropriate common picture. Marine Corps specific efforts includes power management, low detect ability, size and weight constraints, and interoperability within the joint environment.

In FY 2007 and FY 2008, this effort was funded in the C4ISR activity within this PE. The increase in funding from FY 2008 to FY 2009 is due to this being the first year that C4 has been reported as a separate activity.

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FY 2009 Plans:

- Initiate development of C3 for the Distributed Operations Marine technologies. This includes development of technologies to allow small units to share Position and Location Information (PLI) in GPS-denied or restricted environments thereby enhancing current blue force situational awareness.
- Initiate development of urban/restricted environment communications technologies.
- Initiate new efforts in Over-the-Horizon Communications which include the development of an airborne software-defined communications, networking, Electronic Signals Intelligence (ELINT) and Electronic Warfare (EW) capability.

	FY 2007	FY 2008	FY 2009
INTELLIGENCE, SURVEILLANCE, AND RECONNAISSANCE (ISR)	0	0	1,995

This activity develops ISR technologies for applications in future intelligence, surveillance, and reconnaissance. Technologies being pursued enhance situational awareness, persistent surveillance, and tactical decision making through automated analysis of data and rapid integration of information and acquired knowledge. Specific technologies in this activity effectively present actionable information to decision-makers, especially those at the lower command levels. This includes complete future automation of options and persistent surveillance in support of distributed operations.

In FY 2007 and FY 2008, this effort was funded in the C4ISR activity within this PE. The increase in funding from FY 2008 to FY 2009 is due to this being the first year that ISR has been reported as a separate activity.

FY 2009 Plans:

The following efforts transitioned from the C4ISR activity:
- Continue development of information fusion technologies to allow automated construction of a common tactical picture from various sources of sensor data.
- Continue development of low power consumption urban sensing technologies.
- Continue development of tagging, tracking and locating technologies to monitor adversary movement.
- Continue development of information on demand technologies to provide warfighter with the right information at the right time.
- Continued development of urban sensing technologies to detect weapons at distance.

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- Continue development of adaptable enemy course of action engine to manipulate adversary decisions.
- Continue development of advanced tactical sensor technologies to improve unit awareness.
- Initiate and continue development of distributed information architecture technologies.
- Initiate and continue the decision prediction, manipulation, stimulation and learning detection capability to add tools that enable the warfighter to operate inside the OODA loop of an irregular actor. The Observe, Orient, Decide, Act (OODA) Loop provides a standard description of decision making cycles that is widely understood and accepted throughout the U.S. military.
- Initiate and continue development of a single integrated battlespace picture with tactical and strategic injects that begins to close the gap between ISR and C2.
- Initiate and continue Actionable Intelligence for Expeditionary and Irregular Warfare effort which includes real-time methods for Identifying Human Networks.
- Initiate tagging, tracking, and locating technologies development to address development of multi-INT track continuity.
- Initiate development of advanced tactical nets to include additional phenomenologies and the netting of C2, Sensors and Analysis nodes
- Initiate efforts addressing “battlespace awareness” of human networks, improving the accuracy of classification decisions and enabling a human network predictive capability. Once a human network tensor can be defined and dynamically observed in a common feature space, predictive capabilities are realized. If one network is observed to be moving towards at risk behavior, a generalized force warning may be enabled addressing the threat associated with all networks with similar human network tensors. When combined, research into human network awareness, network classification and network prediction, will be a powerful tool for warfare against the irregular actor.

	FY 2007	FY 2008	FY 2009
FIREPOWER	2,555	2,729	4,271

This activity develops technology for application on current and future expeditionary weapons and elements of the kill chain. It includes, but is not limited to, the following technologies: Fuze, fire control, launch/propulsion, lethality, and accuracy.

The increase in funding from FY 2008 to FY 2009 addresses expanded efforts in lightweight weapons and ammunition, as well as exploration of infantry applications in support of emerging USMC requirements in lightening the load of the individual Marine. FY 2009 reflects additional funding for expanded efforts in

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lightweight weapons and ammunition; exploration of infantry applications associated with emerging USMC requirements in lightening the load of the individual Marine; and a DoD directed integrated capability demonstration supporting the Protection of Ground Forces and Systems. This capability demonstration has been directed to be wide ranging and encompass technologies for:
- Pre-detonation of IEDs,
- Personal protection materials,
- Personal power generation,
- Micro power sources, and
- Augmented reality

The integrated demonstration will be a broad, multi-year thrust to both investigate technology integration as well as spur application of more fundamental technologies to force and platform protection. The goal is multiple broad phased force protection applications and technologies, with off-ramps for fielding successes. Technologies being developed by the Firepower activity are central to the integrated demonstration program.

FY 2007 Accomplishments:

- Continued development of a concept for an insensitive munition propulsion system to enable firing a shoulder launched rocket from an enclosed space.
- Initiated development of enhanced mortar munitions for more effective fire support.
- Initiated an investigation of the scalability of variable effects conventional munitions technology for improving firepower effectiveness while increasing affordability and decreasing logistical burden in support of expeditionary warfare.
- Initiated development of collaborative fires coordination technologies.
- Initiated development of precision fires engagement technologies.

FY 2008 Plans:

- Continue all efforts of FY 2007.

FY 2009 Plans:

- Continue all efforts of FY 2008.
- Initiate and continue development of Distributed Operations Precision Engagement collaborative fires coordination technologies.

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- Initiate expanded efforts in lightweight weapons and ammunition (mortars, crew served weapons, ammunition and packaging).
- Initiate Targeting & Engagement and Precision Target Location efforts that include Integrated Day/Night Sight Technology.
- Initiate design and development of lightweight technologies that provide individual Marines enhanced capabilities to detect and identify man-size targets at least out to the maximum effective range of their personal weapons during all conditions (daylight, limited visibility, & darkness) by integrating multiple capabilities into a single system.

	FY 2007	FY 2008	FY 2009
LOGISTICS	1,691	1,985	3,410

This activity supports Marine Corps Expeditionary Logistics which is the practical discipline and real world application of the deployment, sustainment, reconstitution, and re-deployment of forces engaged in expeditionary operations. Expeditionary Logistics replaces mass with assured knowledge and speed, is equally capable ashore or afloat in austere environments, and is fully scalable to meet uncertain requirements. Expeditionary Logistics logically divides into five pillars: deployment support, force closure, sustainment, reconstitution/redeployment, and command and control. These pillars are thoroughly integrated and perpetually related in execution.

The increase from FY 2008 to FY 2009 is due to the initiation of additional efforts in lightweight portable battlefield power sources supporting USMC priorities in lightening the load of the individual Marine and enhancing the Marine Corps rifle squad’s overall capabilities.
FY 2009 reflects additional funding for additional efforts in lightweight portable battlefield power sources supporting USMC priorities in lightening the load of the individual Marine and enhancing the Marine Corps rifle squad’s overall capabilities; and a DoD directed integrated capability demonstration supporting the Protection of Ground Forces and Systems. This capability demonstration has been directed to be wide ranging and encompass technologies for:
- Pre-detonation of IEDs,
- Personal protection materials,
- Personal power generation,
- Micro power sources, and
- Augmented reality

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The integrated demonstration will be a broad, multi-year thrust to both investigate technology integration as well as spur application of more fundamental technologies to force and platform protection. The goal is multiple broad phased force protection applications and technologies, with off-ramps for fielding successes. Technologies being developed by the Logistics activity are central to the integrated demonstration program.

FY 2007 Accomplishments:

- Continued developing and assessing concepts that permit precision delivery of logistics assets while also reducing the logistics footprint ashore.
- Continued development of an alternate power source to reduce logistics footprint and increase sustainability of Marine expeditionary forces.
- Completed research into using polymer gel electrolytes and novel air electrodes in next generation metal air batteries to demonstrate the feasibility of performance improvement.
- Initiated assessment of 20W Stirling Engine for increased efficiency during distributed operations.
- Initiated assessment of portable, alternative water purification systems.
- Initiated analysis of Personal Power Network / Centralized Distributed Operations Power Generation System.

FY 2008 Plans:

- Continue all efforts of FY 2007, less those noted as completed above.
- Initiate development of wireless vehicle health diagnosis and reporting.
- Initiate development of advanced logistics distribution system. The increase in funds supports Distributed Operations.

FY 2009 Plans:

- Continue all efforts from FY 2008.
- Complete analysis of Personal Power Network for transition to “Lighten the Load” FNC EC beginning in FY 2010.
- Initiate advancement of a solid oxide fuel cell capable of directly oxidizing liquid logistic fuels such as JP-8, thus eliminating the necessity for both reforming and sulfur removal pre-processing of the fuel.
- Initiate advancement of high specific energy electrochemical capacitors to function as peak electric load-leveling buffers in advanced lightweight portable power applications.
- Initiate applications of advanced material surface treatments and coatings for reducing required maintenance

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and enhancing operational readiness of expeditionary warfare vehicles, machinery, and electrical systems.

	FY 2007	FY 2008	FY 2009
FUTURE CONCEPTS, TECHNOLOGY ASSESSMENT, AND ROADMAPPING	430	635	1,004

This activity supports the planning and integration of technology development efforts across the entire PE. In conjunction with the Concepts Based Capabilities System and the Marine Corps Warfighting Laboratory, unique and novel concepts for advanced warfighting are developed and validated. Effectiveness analyses are conducted to identify the synergistic effects that can be achieved through the integration of emerging technology with innovative tactics, doctrine, and techniques. Technology assessments are conducted to determine the supporting technologies that have the highest impact across the warfare areas, and warrant further investment within this PE. Technology Roadmapping is conducted to help identify opportunities to leverage technology development within the Department of the Navy and the Department of Defense, as well as, with the commercial sector and university communities. The resultant technology investment strategy is developed and used to guide out-year technology development efforts.

FY 2009 reflects additional funding for new assessments in Asymmetric/Irregular Warfare and Distributed Operations; and a DoD directed integrated capability demonstration supporting the Protection of Ground Forces and Systems. DoD directed this initiative in response to the determination that its S&T investment is likely too small to meet the imposing security threats that challenge our Nation, and it may not be adequately postured to take advantage of key scientific and technological opportunities that offer breakthrough advantages to our warfighters. This capability demonstration has been directed to be wide ranging and encompass technologies for:

- Pre-detonation of IEDs,
- Personal protection materials,
- Personal power generation,
- Micro power sources, and
- Augmented reality

The integrated demonstration will be a broad, multi-year thrust to both investigate technology integration as well as spur application of more fundamental technologies to force and platform protection. The goal is multiple broad phased force protection applications and technologies, with off-ramps for fielding successes. The Logistics activity funds the assessments which will determine the right USMC S&T investment to meet the imposing security threats.

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FY 2007 Accomplishments:

- Continued Technology Assessments associated with the Urban Asymmetric and Expeditionary Warfare Capability Gap.
- Continued the integrated planning of concepts and technology development.
- Continued development of the Expeditionary Maneuver Warfare Investment Strategy.
- Continued Technology Assessments and Roadmapping within Command, Control, Communication, Computers, Intelligence, Surveillance, and Reconnaissance (C4ISR); and Firepower Thrust Areas of the PE.
- Completed Technology Assessment and Roadmapping of the Maneuver, Human Performance, and Training and Survivability Thrust Areas.
- Completed development of the Expeditionary Maneuver Warfare Investment Plan.
- Initiated implementation of an S&T Management Information System.
- Initiated Technology Assessment of the Combating Terrorism portfolio.

FY 2008 Plans:

- Continue all efforts from FY 2007, less those noted as completed above.
- Complete implementation of S&T Management Information System.
- Initiate assessment of the technical requirements of the Marine Corps Special Operations Command (MARSOC).

FY 2009 Plans:

- Continue all efforts from FY 2008, less those noted as completed above.
- Continue assessment of the technical requirements of the MARSOC.
- Initiate and continue assessments in Lightening the Marine’s Load and Enhancing the Capabilities of the Marine Corps Rifle Squad.
- Initiate assessments in Asymmetric / Irregular Warfare and Distributed Operations.
- Initiate assessments of all new and emerging Counter Sniper Technologies.
- Initiate new planning and integration of technology development efforts to meet imposing security threats that challenge our Nation.

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CONGRESSIONAL PLUS-UPS:

	FY 2007	FY 2008
HIGH POWER LIGHTWEIGHT ZINC-AIR BATTERY	1,603	994

FY 2007: This effort addressed the potential application of highpower lightweight zinc-air batteries in addressing the battlefield needs of the Marine Corps.

FY 2008: The Marine Corps has multiple Science and Technology Objectives (STOs) stating a need for the Warfighters to carry fewer batteries that are lighter, more powerful and longer lasting and has a power source capable of supporting all ground communications systems with increased mission run time per battery. The FY 2008 Congressional Add is directly relevant to those STOs and will continue the efforts initiated in FY 2007 that address those needs, such as developing an air electrode that provides 60% higher power capability over commercially available air electrodes.

	FY 2007	FY 2008
INTEGRATED ASYMMETRIC URBAN WARFARE	971	0

This effort addressed the asymmetric warfighting challenges of the urban battlefield: specifically, the need for greater speed of information, enhanced urban visualization/speed of tactical level decisions, enhanced close quarter combat capabilities and infantry equipment, and greater speed of action and sustainment as well as related priority work in weapon accuracy and lethality and enhanced individual survivability. The product will be a quantitative modeling and simulation approach offering an opportunity to develop specific performance criteria for asymmetric warfare technologies under development and thus is of great value for integrating these technologies.

	FY 2007	FY 2008
SURVIVABILITY PROGRAM	0	1,491

This effort will produce a system of systems that are expeditionary and lightweight, which provide increased protection from a myriad of enemy attacks throughout the spectrum of warfare.

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	FY 2007	FY 2008
WARFIGHTER RAPID AWARENESS PROCESSING TECHNOLOGY FOR DISTRIBUTED OPERATIONS	1,749	2,980

FY 2007: This effort supported Distributed Operations. This was a new USMC concept which described an operating approach that created an advantage over an adversary through the deliberate use of separation and coordinated, interdependent, tactical actions enabled by increased access to functional support, as well as by enhanced combat capabilities at the small-unit level.

FY 2008: The current focus of this investment is on small-unit leader decision making and control of fires. The FY 2008 increase will focus on the exploration of all aspects of individual cognition and decision-making, physiology and ergonomics, and the technologies needed to integrate these aspects in order to support the development of a Marine who is optimized to perform within an asynchronous/distributed operational setting.

C. OTHER PROGRAM FUNDING SUMMARY - NAVY RELATED RDT&E:
PE 0204163N Fleet Telecommunications (Tactical)
PE 0206313M Marine Corps Communications Systems
PE 0206623M Marine Corps Ground Combat/Supporting Arms Systems
PE 0601152N In-House Laboratory Independent Research
PE 0601153N Defense Research Sciences
PE 0602235N Common Picture Applied Research
PE 0602782N Mine and Expeditionary Warfare Applied Research
PE 0603235N Common Picture Advanced Technology
PE 0603236N Warfighter Sustainment Advanced Technology
PE 0603612M USMC Mine Countermeasures Systems - Adv Dev
PE 0603635M Marine Corps Ground Combat/Support System
PE 0603640M USMC Advanced Technology Demonstration (ATD)
PE 0603782N Mine and Expeditionary Warfare Advanced Technology

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OTHER PROGRAM FUNDING SUMMARY - NON-NAVY RELATED RDT&E:
PE 0603004A Weapons and Munitions Advanced Technology
PE 0603005A Combat Vehicle and Automotive Advanced Technology
PE 0603606A Landmine Warfare and Barrier Advanced Technology

D. ACQUISITION STRATEGY:
Not applicable.

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

BUDGET ACTIVITY: 02
PROGRAM ELEMENT: 0602234N
PROGRAM ELEMENT TITLE: MATERIALS, ELECTRONICS AND COMPUTER TECHNOLOGY

COST: (Dollars in Thousands)

Project Number & Title	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
MATERIALS, ELECTRONICS AND COMPUTER TECHNOLOGY	971	1,987	0	0	0	0	0

A. MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: This Program Element is funded in its entirety by two Congressional Adds.

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PROGRAM ELEMENT: 0602234N
PROGRAM ELEMENT TITLE: MATERIALS, ELECTRONICS AND COMPUTER TECHNOLOGY

B. PROGRAM CHANGE SUMMARY:

	FY 2007	FY 2008	FY 2009
FY 2008/FY 2009 President's Budget Submission	996	0	0
Congressional Action	0	2,000	0
Congressional Undistributed Reductions/Rescissions	0	-13	0
SBIR Assessment	-25	0	0
FY 2009 President's Budget Submission	971	1,987	0

PROGRAM CHANGE SUMMARY EXPLANATION:
Technical: Not applicable.

Schedule: Not applicable.

C. OTHER PROGRAM FUNDING SUMMARY:
Not applicable.

D. ACQUISITION STRATEGY:
Not applicable.

E. PERFORMANCE METRICS:
Not applicable.

BUDGET ACTIVITY: 02
PROGRAM ELEMENT: 0602234N
PROGRAM ELEMENT TITLE: MATERIALS, ELECTRONICS AND COMPUTER TECHNOLOGY

CONGRESSIONAL PLUS-UPS:

	FY 2007	FY 2008
CENTER FOR MICROWAVE FERRITIES AND MULTIFUNCTIONAL INTEGRATED CIRCUITS	971	0

This effort supported the Center for Microwave Ferrities and Multifunctional Integrated Circuits. Hexa-ferrite barium iron oxide (Ba FeO3) films were grown on molecular beam epitaxially (MBE) prepared seed layers by liquid phase epitaxy, characterized at microwave frequency for compatibility with wide electronic bandgap RF semiconductor circuits. Thin metal film passive RF IC component devices were also studied.

	FY 2007	FY 2008
INFRARED MATERIALS LABORATORIES	0	1,987

This effort will improve the technology for long wavelength mercury cadmium telluride based infra-red focal plane arrays (FPAs).

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

BUDGET ACTIVITY: 02
PROGRAM ELEMENT: 0602235N
PROGRAM ELEMENT TITLE: COMMON PICTURE APPLIED RESEARCH

COST: (Dollars in Thousands)

Project Number & Title	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
COMMON PICTURE APPLIED RESEARCH	86,853	103,751	77,054	83,719	65,279	69,613	68,718

A. MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: The efforts described in this Program Element (PE) are based on investment directions as defined in the Naval Science and Technology (S&T) Strategic Plan approved by the S&T Corporate Board (Jan 2007). This strategy is based on needs and capabilities from Navy and Marine Corps guidance and input from the Naval Research Enterprise (NRE) stakeholders (including the Naval enterprises, the combatant commands, the Chief of Naval Operations (CNO), and Headquarters Marine Corps). It provides the vision and key objectives for the essential science and technology efforts that will enable the continued supremacy of U.S. Naval forces in the 21st century. The Strategy focuses and aligns Naval S&T with Naval missions and future capability needs that address the complex challenges presented by both rising peer competitors and irregular/asymmetric warfare.

Activities and efforts in this program examine concepts and technologies that enable the transformation to network centric warfare. Network centric capabilities rely on information to connect assets and provide timely and accurate understanding of the environment. The mission area requirements for rapid, accurate decision-making; dynamic, efficient, mission-focused communications and networks; and pervasive and persistent sensing drive network centric S&T investments. The program focus is on S&T enabling technologies that provide decision making and mission execution to achieve battlespace superiority. Program activities seek to develop hardware and software technologies that (1) identify and integrate informational content from multi-media sources including images, and intelligence sources; (2) integrate massive amounts of information; and (3) provide automatic correlation, fusion, and insight to support user-cognitive processes. Particular programmatic emphasis will be placed on automating the association of objects and events in the battlespace and automatically transforming this information into actionable knowledge (e.g., indications and warnings of intent). In current and future operational environments such as Global War on Terrorism (GWOT) and Maritime Domain Awareness (MDA), warfighters require technologies evolved to support information needs regardless of location and that are consistent with the user’s level of command or responsibility within varying operational situations. Net-centric operations include communications and information assurance capabilities to enable

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PROGRAM ELEMENT TITLE: COMMON PICTURE APPLIED RESEARCH

all-source data access, multi-source processing, and tailored dissemination of information to Command and Control (C2) and Intelligence, Surveillance and Reconnaissance (ISR) users across the network. The operational benefits sought are increased speed of response, accuracy and precision of command; distributed self-synchronization; flexibility and adaptability to an operational situation; and decision superiority. Technologies emphasized provide warfighters with a robust, secure, mission responsive network; integrated information leading automated courses of action; and presentation of knowledge to speed understanding. The payoff is access to tailored information in near real time with corresponding increases in speed of command, improved decision-making, and reduction in manpower.

This program explores and demonstrates technologies that enable options for the Navy's FORCEnet, Sea Shield, and Sea Strike pillars and contains investments in the following Enabling Capabilities (ECs): Hostile Fire Detection and Response, Next Generation Command, Control and Decision Support, Combat Identification (ID) Information Management of Coordinated Electronic Surveillance, Combat ID in the Maritime Domain to Reveal Contact Intent, Automated Control of Large Sensor Networks, and Real-Time Long Range Air Defense Combat ID in Support of Early Engagement. In the context of the Naval Transformation Roadmap construct, this investment will achieve capabilities required by FORCEnet (Persistent Intelligence, Surveillance, and Reconnaissance; Time Sensitive Strike; and Sea Based Information Operations), Sea Strike (Ship-to-Objective Maneuver), and Sea Shield (Theater Air and Missile Defense).

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

BUDGET ACTIVITY: 02
PROGRAM ELEMENT: 0602235N
PROGRAM ELEMENT TITLE: COMMON PICTURE APPLIED RESEARCH

B. PROGRAM CHANGE SUMMARY:

	FY 2007	FY 2008	FY 2009
FY 2008/FY 2009 President's Budget Submission	88,929	93,376	54,443
Congressional Action	0	12,000	0
Congressional Undistributed Reductions/Rescissions	0	-701	0
Execution Adjustments	-275	0	0
Program Adjustments	-508	0	23,024
Rate Adjustments	0	0	-413
SBIR Assessment	-1,293	-924	0
FY 2009 President's Budget Submission	86,853	103,751	77,054

PROGRAM CHANGE SUMMARY EXPLANATION:
Technical: Not applicable

Schedule: Not applicable

C. OTHER PROGRAM FUNDING SUMMARY:
Not applicable.

D. ACQUISITION STRATEGY:
Not applicable.

E. PERFORMANCE METRICS:
Performance metrics are discussed within the R2a.

BUDGET ACTIVITY: 02
PROGRAM ELEMENT: 0602235N PROGRAM ELEMENT TITLE: COMMON PICTURE APPLIED RESEARCH
PROJECT TITLE: COMMON PICTURE APPLIED RESEARCH

COST: (Dollars in Thousands)

Project Number & Title	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
COMMON PICTURE APPLIED RESEARCH	86,853	103,751	77,054	83,719	65,279	69,613	68,718

A. MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: Activities and efforts in this program examine concepts and technologies that enable the transformation to network centric warfare. Network centric capabilities rely on information to connect assets and provide timely and accurate understanding of the environment. The mission area requirements for rapid, accurate decision-making; dynamic, efficient, mission-focused communications and networks; and pervasive and persistent sensing drive network centric S&T investments. The program focus is on S&T enabling technologies that provide decision making and mission execution to achieve battlespace superiority. Program activities seek to develop hardware and software technologies that (1) identify and integrate informational content from multi-media sources including images, and intelligence sources; (2) integrate massive amounts of information; and (3) provide automatic correlation, fusion, and insight to support user-cognitive processes. Particular programmatic emphasis will be placed on automating the association of objects and events in the battlespace and automatically transforming this information into actionable knowledge (e.g., indications and warnings of intent). In current and future operational environments such as GWOT and MDA, warfighters require technologies evolved to support information needs regardless of location and that are consistent with the user’s level of command or responsibility within varying operational situations. Net-centric operations include communications and information assurance capabilities to enable all-source data access, multi-source processing, and tailored dissemination of information to C2 and ISR users across the network. The operational benefits sought are increased speed of response, accuracy and precision of command; distributed self-synchronization; flexibility and adaptability to an operational situation; and decision superiority. Technologies emphasized provide warfighters with a robust, secure, mission responsive network; integrated information leading automated courses of action; and presentation of knowledge to speed understanding. The payoff is access to tailored information in near real time with corresponding increases in speed of command, improved decision-making, and reduction in manpower.

This program explores and demonstrates technologies that enable options for the Navy's FORCEnet, Sea Shield, and Sea Strike pillars and contains investments in the following ECs: Hostile Fire Detection and Response,

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PROJECT TITLE: COMMON PICTURE APPLIED RESEARCH

Next Generation Command, Control and Decision Support, Combat ID Information Management of Coordinated Electronic Surveillance, Combat ID in the Maritime Domain to Reveal Contact Intent, Automated Control of Large Sensor Networks, and Real-Time Long Range Air Defense Combat ID in Support of Early Engagement. In the context of the Naval Transformation Roadmap construct, this investment will achieve capabilities required by FORCEnet (Persistent Intelligence, Surveillance, and Reconnaissance; Time Sensitive Strike; and Sea Based Information Operations), Sea Strike (Ship-to-Objective Maneuver), and Sea Shield (Theater Air and Missile Defense).

B. ACCOMPLISHMENTS/PLANNED PROGRAM:

	FY 2007	FY 2008	FY 2009
NETWORK COMMAND, CONTROL AND COMBAT SYSTEMS	10,716	26,544	24,272

This Activity explores development of advanced technologies that contribute to integrated decision-making and mission execution to achieve battlespace superiority. In current and future operational environments, such as the GWOT and MDA, warfighters require technologies evolved to support information needs regardless of location and consistent with the user's level of command or operational situation. To achieve this, it must be possible to automate understanding of the battlespace by identifying objects, determining relationships among the objects, assessing intent, and automatically generating courses of action with associated risks and uncertainty. This initiative focuses on information integration, examining the critical S&T needs of automatic association and merger of information for unified presentation; automated recognition and cueing for significant patterns of information, computer-aided reasoning for task-oriented information dissemination; timely, accurate information and sensor fusion from heterogeneous sources, as well as supporting technologies to provide the understanding and relationship of different entities shown in the battlespace and their collective intent. This initiative will focus on advanced or novel approaches for processing and fusing information from disparate sources (e.g., images, intelligence sources); optimal decision aids incorporating rigorous decision theory and automated inference and reasoning; and assuring information integrity and availability according to mission objectives.

This Activity is focused on and has absorbed projects dealing with information fusion efforts — a critical element of network centric warfare and the emerging technologies that enable more automated support to warfighters. While completing earlier projects, this Activity is also initiating a number of efforts that focus on two very critical efforts: Automated Image Understanding (developing the capability to automatically understand image/scenes and assess threats which help the battlefield commander in making efficient and

BUDGET ACTIVITY: 02
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accurate decisions) and Automated Information Integration (leverage emerging technologies to manage and exploit sensors and other sources of data or information to develop approaches and tools for (semi)-automated data integration and reasoning about information from diverse sources in ways that support decision makers with timely, actionable information at operational and tactical levels of command).

In FY 2008, many of the investments will be approaching demonstration and experimentation phases. The increase from FY 2007 through FY 2008 reflects the cost of field demonstrations, limited objective experiments and sea trials which will be used to validate the utility of the concepts developed along with initiating the development of software and algorithms for integrating the functions of target acquisitions, tracking, data computation, and engagement control across multiple platforms for engaging multiple threats.

In FY 2009, a number of efforts will be completing experimentation demonstration phases and entering final analysis and reporting activities requiring less investment.

FY 2007 Accomplishments:

- Continued the development of algorithms and demonstration of data reduction through joint classification and feature optimization, realizing transfer of data to information, realizing automation and integration vis-a-vis Analog/Digital data (reduced bandwidth requirements and reduced burden on analysts and warfighters).
- Continued the development of a feature extraction module that segments the video based on video mosaicing.
- Continued the development of algorithms with Naval/Joint imagery systems to handle video metadata, which includes Global Positioning System, time, and sensor information.
- Continued the development of recommendations for standardizing the storage and linking of feature descriptions within a common database framework.
- Continued the development and characterization of new target detection and recognition algorithms to exploit higher dimensional data (spatial, temporal, and spectral) within the Network Centric Warfare framework. Approach uses advanced correlation approaches to provide improved target detection and recognition performance by integrating multiple sensor measurements.
- Continued the development of a suitable ontology for exercising large-scale distributed situational threat awareness in Naval battlespace environments.
- Continued the development of a Case-Based Reasoning simulation/model for implementing situation, threat awareness fusion solutions and a Bayesian Network inference engine for manipulating uncertainty and learning from data.
- Continued the development of an initial prototype for an information sharing infrastructure that maintains

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data integrity and confidentiality for enclaves of networked workstations running Commercial Off the Shelf (COTS) operating systems and applications.

- Continued the demonstration and conducted image registration error analysis for the multi-resolution and multi-scale image processing effort.
- Continued the augmentation of the real world information with computer-generated information in the Battlefield Augmented Reality System effort. The activity designed a modular framework to support the system design and enables the insertion of custom scheduling and replication solutions. Other efforts focused on the middleware layer to support emerging network centric sensor-to shooter systems.
- Continued development of automated methods for identifying significant changes between temporally separated images (not video) to extend work on automatic target recognition and pattern recognition into change detection algorithms.
- Continued demonstration of a FORCEnet limited objective experiment involving the application of new techniques of discrete optimization, statistical discrimination, and artificial intelligence for the resource allocation of weapons. Compared initial results with high fidelity physics based models for threat and anti-threat weapon systems for continued development of Anti-Air Warfare optimization algorithms.
- Continued research and demonstrations of modulated near-infrared (IR) optical retroreflector data to develop spacecraft to spacecraft data exchange techniques. (NRL)
- Continued development of "through-the-sensor" exploitation techniques to obtain environmental information from shipboard radars, and use of that information in nowcasting. (NRL)
- Continued development of technology to improve reliability of systems to survive Information Warfare attacks.
- Continued development of technology for improved steganography and watermarking. (NRL)
- Continued development of technology for improving voice data interpretation and presentation to cope with audio information overload in Navy Systems. (NRL)
- Continued development of technology to improve collaborative operational planning for tactical users using Head-Up Displays. (NRL)
- Continued development of sensor management algorithms that reduce the amount of labeled training data required, employing semi-supervised classifier and active learning techniques motivated by asymmetric threat, which limited training data anticipated.
- Continued demonstration of predictive surface platform threat behavior algorithms and software employing techniques using pattern recognition on geospatial and attribute data. Also developed autonomous monitoring and reporting of high interest and anomalous maritime vessels.
- Continued demonstration of a trusted data store which maintains data pedigree and detects anomalies in a limited objective experiment.

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- Continued efforts in ontology-based information fusion for enhanced situational awareness and classification-based knowledge discovery.
- Continued efforts in Joint Director of Laboratory's Data Fusion Model Level 1/2/3 data fusion using abductive reasoning, Bayesian networks, agent-based techniques, statistical-based methods, and other approaches.
- Continued efforts in automated image understanding that use active computations and visual pattern recognition for networked target recognition systems in maritime domain awareness.
- Continued efforts in the automated integration of disparate sources of information that involve data mining methods and game theory.
- Completed development of improvements in face recognition technology via enhanced image registration software. (NRL)
- Completed the implementation of a real-time anti-ship missile state assessment capability against modern threats by conducting an empirical performance evaluation and analyze system implications. (NRL)
- Initiated demonstration of anomaly detection, feature-based target tracking, track-to-pattern association and scoring, track-to-group clustering, pattern discovery and learning, pattern templates/descriptions and predictive modeling tools in a limited objective experiment.
- Initiated development of an interface between the Level 1 and Level 2/3 data fusion processes across federated service oriented architectures.
- Initiated development of new data schemas and methods to allow more efficient assembly of a common operational picture (COP) integrating informational content from images, track data, intelligence and incomplete track data.
- Initiated development of semi-supervised detection algorithms for multi-sensor imagery, video and human intelligence that will enable self-deploying sensor networks.
- Initiated Level 1 fusion algorithm and architecture design with associated ontology to manage information from automated sensors to provide a more dynamic and accurate battlespace picture through improved object refinement.
- Initiated development of a scalable system design for coordinated Unmanned Aerial Vehicle (UAV) formation control that integrates onboard and offboard sensor data. (NRL)

FY 2008 Plans:

- Continue all efforts from FY 2007 less those noted as completed above.
- Complete the development of algorithms and demonstration of data reduction through joint classification and feature optimization, realizing transfer of data to information, realizing A/I vis-a-vis Analog/Digital data

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(reduced bandwidth requirements and reduced burden on analysts and warfighters).
- Complete the development of a feature extraction module that segments the video based on video mosaicing.
- Complete the development of algorithms with Naval/Joint imagery systems to handle video metadata, which includes Global Positioning System, time, and sensor information.
- Complete the development of recommendations for standardizing the storage and linking of feature descriptions within a common database framework.
- Complete the development and characterization of new target detection and recognition algorithms to exploit higher dimensional data (spatial, temporal, and spectral) within the Network Centric Warfare framework. Approach uses advanced correlation approaches to provide improved target detection and recognition performance by integrating multiple sensor measurements.
- Complete the development of a suitable ontology for exercising large-scale distributed situational threat awareness in Naval battlespace environments.
- Complete the augmentation of the real world information with computer-generated information in the Battlefield Augmented Reality System effort. The activity designed a modular framework to support the system design and enables the insertion of custom scheduling and replication solutions. Other efforts focused on the middleware layer to support emerging network centric sensor-to shooter systems.
- Complete demonstration of a FORCEnet limited objective experiment involving the application of new techniques of discrete optimization, statistical discrimination, and artificial intelligence for the resource allocation of weapons. Compare initial results with high fidelity physics based models for threat and anti-threat weapon systems for continued development of Anti-Air Warfare optimization algorithms.
- Complete development of technology to improve collaborative operational planning for tactical users using Head-Up Displays. (NRL)
- Initiate the development of software and algorithms for integrating the functions of target acquisition, tracking, data computation, and engagement control across multiple platforms for engaging multiple threats.
- Initiate the investigation of service oriented methods to automatically retrieve relevant information for a community of interest. (NRL)
- Initiate the development of a new radar signature analysis technique based on nonlinear dynamics. (NRL)
- Initiate the development of a novel particle filter-based elevation angle tracking algorithm to improve the capability to track low-angle targets over the sea surface under multipath conditions using passive sensors. (NRL)
- Initiate the development of the theory and technology for near-field electromagnetic (EM) phenomenology relevant to high resolution, through-the-wall imaging at close ranges in urban operations. (NRL)

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FY 2009 Plans:

- Continue all efforts from FY 2008 less those noted as completed above.
- Complete the development of a Case-Based Reasoning simulation/model for implementing situation, threat awareness fusion solutions and a Bayesian Network inference engine for manipulating uncertainty and learning from data.
- Complete the development of a prototype for an information sharing infrastructure that maintains data integrity and confidentiality for enclaves of networked workstations running Commercial Off the Shelf (COTS) operating systems and applications.
- Complete development of automated methods for identifying significant changes between temporally separated images (not video) to extend work on automatic target recognition and pattern recognition into change detection algorithms.
- Complete sensor management algorithms that reduce the amount of labeled training data.
- Complete ontology-based information fusion for enhanced situational awareness and classification-based knowledge discovery.
- Complete efforts in Joint Director of Laboratory's Data Fusion Model Level 1/2/3 data fusion using abductive reasoning, Bayesian networks, agent-based techniques, statistical-based methods, and other approaches.
- Complete efforts in automated image understanding that use active computations and visual pattern recognition for networked target recognition systems in maritime domain awareness.
- Complete efforts in the automated integration of disparate sources of information that involve data mining methods and game theory.
- Complete development of technology for improving voice data interpretation and presentation to cope with audio information overload in Navy Systems. (NRL)
- Complete development of technology for improved steganography and watermarking. (NRL)
- Complete development of a scalable system design for coordinated Unmanned Aerial Vehicle (UAV) formation control that integrates onboard and offboard sensor data. (NRL)
- Initiate approaches and tools for (semi)-automated data integration and reasoning about information from diverse sources in ways that support decision makers with timely, actionable information at operational and tactical levels of command, with an emphasis on missions that are related to GWOT and force protection.

	FY 2007	FY 2008	FY 2009
KNOWLEDGE SUPERIORITY AND ASSURANCE	6,951	24,291	18,485

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This Activity explores fundamental technologies that enhance the Navy's capability to exploit, manage and integrate complex, heterogeneous, multi-source information for the next generation common picture. S&T work in information processing, discovery, integration and presentation; expeditionary ISR; and networked sensors is being focused on Navy and Marine Corps Warfighter Capability Gaps identified through analysis of operational and exercise lessons learned, as well as campaign analysis of capabilities required in the 2010-2024 time frame.

The significant increase from FY 2007 through FY 2008 is the result of two ECs, Combat ID Information Management of Coordinated Electronic Surveillance and Automated Control of Large Sensor Networks, that were initiated in FY 2007. These ECs have a substantial increase in total investment in FY 2008 to support technology development, limited objective experiments, and sea trials to validate metrics and utility in FY 2008.

The decrease from FY 2008 to FY 2009 is due to completion of FNC efforts to develop object-level data fusion algorithms to improve maritime common operational picture development in a service oriented architecture environment, and the development of technologies for smart tactical sensors, platforms, and algorithms in an urban/cluttered environment. The balance of the reduction reflects a reduced level of investment in ongoing efforts to fund higher priority requirements.

FY 2007 Accomplishments:

- Continued the Electronic Warfare Integrated System for Small Platforms (EWISSP) effort by exploration and refinement of the subsystem interface software that will operate via Versa Module Eurocard (VME)-64 and Recommend Standard (RS)-422 buses.
- Continued the exploration of rapid course of action development using synthetic semi-automated forces for fast, large-scale, and high-fidelity simulations; including models of human cognition and visualization techniques for assessing outcomes and uncertainties.
- Continued Actionable Information from Multiple Intel Sources in a Global Information Grid Enterprise Services (GIG-ES) Environment (previously reported in PE 0603235N). Result in: automated integration of multi-INT surveillance & reconnaissance of red, white, and blue force locations for Combat ID by providing software integrated into Navy and Marine Corps Command Control & Combat Systems; order of magnitude less false recognition; and identification of significant military entities consistent with sensor capabilities.
- Continued effort for Improved Maritime Common Operational Tactical Picture in a GIG-ES Environment (previously reported in PE 0603235N). This effort provides software to perform level one fusion of

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intelligence sources and tactical organic sensors to provide knowledge about battlespace objects including location, track, and Combat Identification.
- Continued design of tools enabling mission-specific tactical sensor fields for at least two separate mission areas (previously reported in PE 0603235N).
- Continued design of tactical distributed data analysis and automated indications and warnings for 50% of tactical data (previously reported in PE 0603235N).
- Continued design of automated tactical platform and sensor planning and management sufficient for one operator to control multiple sensors (previously reported in PE 0603235N).
- Continued developing and testing airborne and shipboard battle manager platforms for UAVs operating from Littoral Combat Ships. Continued developing and began testing an open architecture airborne control station that can be used onboard a P-3 type aircraft for the control of multiple UAVs (Previously reported in PE 0602114N).
- Completed development of multi-vehicle cooperation technologies.
- Completed medium-fidelity simulation of multi-vehicle cooperation technologies for multiple classes of Naval unmanned vehicles in littoral ISR (Previously reported in PE 0602114N).
- Initiated development of object-level data fusion algorithms to improve maritime common operational picture development in a service oriented architecture environment.
- Initiated Joint Director of Laboratories Data Fusion Model Level 2/3 data fusion research exploring techniques using Bayesian networks, Dempster-Schafer Evidential Reasoning and other techniques for analyzing operational data in establishing routine behaviors & dependencies based on multi-intelligence fusion and anomaly recognition that indicates hostile intent in the maritime/littoral domain.
- Initiated investigation of smart tactical sensors, platforms, and algorithms in an urban/cluttered environment for at least 2 sensing modalities.
- Initiated investigation of human to tactical sensor field interface to enable the user to locate relevant knowledge within 3 minutes.
- Initiated investigation of local tactical net and Distributed Common Ground Station information interfaces to achieve Level 1 integration.
- Initiated the all-source track and identity fusion effort integrating a broad range of intelligence product information including: Kinematic Radar Reports, Organic and UAV imagery, electronic and communications emissions and human spot reports for tactical and organic sensors to be augmented with national sensors.

FY 2008 Plans:

- Continue all efforts of FY 2007 less those noted as completed above.

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- Complete development of object-level data fusion algorithms to improve maritime common operational picture development in a service oriented architecture environment.
- Complete investigation of smart tactical sensors, platforms, and algorithms in an urban/cluttered environment for at least 2 sensing modalities.

FY 2009 Plans:

- Continue all efforts of FY 2008 less those noted as completed above.
- Initiate effort to develop and apply emerging technologies that support delivery of Technology Oversight Group approved FNC enabling capabilities structured to close operational capability gaps that involve the common picture.
- Initiate packaging of emerging common picture technologies into deliverable FNC products and ECs that can be integrated into acquisition programs within a five year period.
- Initiate efforts for the mature common picture technologies that support naval requirements identified within the FORCEnet naval capability pillar.
- Initiate effort to develop new, and leverage emerging, technologies that support dynamic and response management and control of net-centric enterprise theater and tactical ASW operations. This includes automation support for synchronized planning of resources and multi-mission execution, and access and shared awareness of data activities and status among Maritime Operation Centers and tactical forces through in a tactical, netted service-oriented architecture (SOA) environment.
- Initiate effort to develop and apply emerging technologies that support self organizing networking and assured communications exchange in tactical communications networks.

	FY 2007	FY 2008	FY 2009
COMMUNICATION AND NETWORKS	11,688	9,272	9,417

This Activity develops wireless communications network technologies critical to the performance and robustness of naval communications for air, ship, submarine, and land platforms. Developments include bandwidth efficient communication techniques; advanced networking techniques for robust, highly dynamic environments; interoperable wireless networks for secure communications and protocols; and bandwidth and network management techniques that can effectively manage and allocate bandwidth across tactical and theater levels in support of wireless network centric operations. The exploration payoffs include increased network data rates, improved coalition interoperability, dynamic bandwidth management, greater mobile network connectivity, and efficient waveforms to improve information processing and communications with land forces.

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The decrease from FY 2007 to FY 2008 reflects a reduced level of investment to fund higher priority requirements.

FY 2007 Accomplishments:

- Continued efforts to mature the superconducting cross-correlator to technology readiness level 4 to enable the development of a multi-function multi-net digital-Radio Frequency dehopping receiver for Link-16. This involves the integration of High Temperature Superconductors analog and Low Temperature Superconductors digital circuits in a COTS two-stage cryocooler.
- Continued project to architect multi-Mega bits per second (Mbps) naval laser communication system for ships. Designed rate-adaptable optical receiver using avalanche photo-diodes and array-detection techniques for improved performance in poor weather conditions.
- Continued construction and characterization of spectrally clean, out-phased high-power transmitter using X-band monolithic microwave integrated circuit (MMIC) technology, developing Continuous Wave (CW) radar receiver technology implementing wideband 500-MHz linear chirp at the X-band transmitter, and Ballistic Missile Defense (BMD) discrimination by performing experiments to study micro-Doppler signatures from BMD targets that undergo micro-motions. (NRL)
- Continued development of a concept for recovering Global Positioning Systems (GPS) signals in a "friendly" jamming environment thus allowing GPS to be used while denying that capability to an adversary. (NRL)
- Continued research and demonstrations of modulated near-infrared (IR) optical retroreflector data to develop spacecraft to spacecraft data exchange techniques. (NRL)
- Continued development of high data rate (HDR) communications (> 1 Gbps data links) for small tactical Unmanned Aerial Vehicles (UAV) in ISR applications, meeting the size, weight and power requirements.
- Continued development of Robust Airborne Networking Extensions (RANGE) for joint battlespace networking, networking UAVs, and hybrid mobile ad hoc networking (MANET)/satellite operation. Implemented MANET protocols for cross-layer optimized routing, including disruption tolerant networking to sensors and platforms.
- Continued development of an ultra-wide band (UWB) groundwave communication transceiver for a distributed sensor network and gateway buoys.
- Continued Broadband Electronically-steerable Array for Mission Security (BEAMS), a low cost analog beam forming and steering technique for UAV to UAV and UAV to ground station communications.
- Continued development of protocols and algorithms for mobility and security in emerging IPv6 next generation MANET.
- Continued development of technology to improve tactical network Satellite Communication linkage and multi-

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user detection. (NRL)
- Continued development of an adaptive rate terminal to maintain laser communications in poor weather conditions.
- Continued the development of free space hybrid Infrared laser communications links with greater than 10X bandwidth of digital link for same power. (NRL)
- Completed cryogenic packaging, test, and demonstrate direct digital dehopping of multiple Link-16 waveforms. Establish transition path to Joint Tactical Radio System (JTRS) -compliant communications.
- Completed research and development in Multiple-in-Multiple-out (MIMO) antenna technology and OFDM signaling to improve data throughput (500 Mbps) in strong multipath environments. Finish prototyping of lab models. Finish demo in urban environment. Explore possible transition to United States Marine Corps and/or JTRS.
- Completed the development of an adaptive rate terminal to maintain laser communications in poor weather conditions. Test the system at NRL's 32 km maritime Chesapeake Bay test bed. Establish transition path to fleet deployment.
- Completed BEAMS prototyping and demonstrating Rotman lens beamformer on small UAVs for additional range and mission security.
- Completed development of technology to improve mobile, ad hoc networks via multi-agent programs. (NRL)
- Completed communications Specific Emitter Identification (SEI) by transitioning best approaches into operational Navy electronic support and electronic attack systems. (NRL)
- Completed the design, fabrication and testing of the phased array RF elements for autonomous systems with the fabrication of a prototype unmanned system. (NRL)
- Completed development of technologies in support of responsive micro-satellites including high speed W-band communications, compact deployable structures, and small, xenon electric propulsion systems. (NRL)
- Initiated development of digital beam forming and steering for small UAVs in upper Ka band (38 GHz), including Risley prism conformal antennas and lightweight switched beam antennas made of composite materials.
- Initiated development of small foot-print, low-power fly-by optical communications underwater between unmanned underwater vehicles (UUV)/unmanned surface vehicles (USV) and bottomed sensor field, utilizing blue-green directly modulated semiconductor lasers.
- Initiated development of submarine to UUV/USV/sensor Comms using underwater Modulating Retroreflector technology.
- Initiated development of advanced topology and medium access control (MAC) for extremely low power consuming sensor networks.
- Initiated techniques for UWB range extension by time reversal and other methods, including receiver prototyping.
- Initiated development of low-cost integrated stub antenna and ferroelectric phased array technology for

directional communications.
• Initiated expanded study of "friendly" GPS jamming techniques to include those designed specifically to minimize fratricide while maintaining effectiveness of jamming against threat GPS receivers. (NRL)
• Initiated the development of pattern recognition algorithms to allow detection and identification of intruders into remote or urban areas. (NRL)
• Initiated the development of technical characteristics of a Communications Electronic Attack (EA) system that consists of a master EA platform that operates in concert with a network of simple subordinate platforms. (NRL)
• Initiated investigation of the feasibility of performing emissive hyperspectral imaging for detection and recognition of targets at night with high search rates and high resolution ground samples. (NRL)

FY 2008 Plans:

• Continue all efforts of FY 2007 less those noted as completed above.
• Complete prototyping of the HDR communications (> 1 Gbps data links) for small tactical UAVs in ISR applications, meeting the size, weight and power requirements.
• Complete development of RANGE protocols and software kit for dynamic inter-UAV networking.
• Complete development of an UWB groundwave communication transceiver and high frequency (HF) antenna for a distributed sensor network and gateway buoys.
• Complete development of protocols and algorithms for mobility and security in emerging IPv6 next generation MANETs.
• Complete development of a concept for recovering GPS signals in a "friendly" jamming environment thus allowing GPS to be used while denying that capability to an adversary. (NRL)
• Initiate development of underwater Extremely Low Frequency (ELF) antenna and RF technology for submarine comms at speed and depth.
• Initiate development of metamaterial structures and periodic L-C loading for submarine HF-IP buoy-cable antennas (BCA).
• Initiate development of service oriented networking protocols and middleware for the tactical warfighter and platforms.
• Initiate the development of wireless-ready, reliable data transport technologies suitable for tactical-edge and afloat networks. (NRL)

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FY 2009 Plans:

- Continue all efforts of FY 2008 less those noted as completed above.
- Complete prototyping of the conformal array for digital beam forming and steering on small UAVs in upper Ka band (38 GHz).
- Complete development of small foot-print, low-power fly-by optical communications underwater between UUVs/USVs and bottomed sensor field, utilizing direct modulated semiconductor lasers or modulating retro-reflectors (MRR)in the blue-green band.
- Complete development of advanced topology and MAC for extremely low power consuming sensor networks.
- Complete prototyping of receivers that demonstrate UWB range extension by time reversal methods.
- Complete the development of free space hybrid Infrared laser communications links with greater than 10X bandwidth of digital link for same power. (NRL)
- Complete the development of pattern recognition algorithms to allow detection and identification of intruders into remote or urban areas. (NRL)
- Initiate development of Line of Sight (LOS) high data rate UAV-sensor communications for expeditionary forces.
- Initiate development of advanced signal processing, coding and switching amplifier techniques for high power amplification.
- Initiate metamaterials based dish antennas development for Ka-Ku band satellite communications (SATCOM).
- Initiate development of low intercept and low probability of Detection (LPD), jam resistant communications/networks for distributed nodes.
- Initiate blue-green fiber laser technology development for space-based submarine communications.
- Initiate development of network coding and cognitive radio networking technologies with heterogeneous links.

	FY 2007	FY 2008	FY 2009
MULTI-SOURCE INTEGRATION AND COMBAT IDENTIFICATION	8,563	1,940	3,183

This activity addresses theater air and missile defense (TAMD) needs for rapid, high confidence Combat Identification (CID) of air and missile threats at long range using real time and non-real time threat attributes and intelligence information. This activity supports the Sea Shield Pillar Enabling Capability of Real Time Long Range Air Defense CID in Support of Early Engagements and related CID Science & Technology to be worked under the FORCEnet FNC.

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The funding decrease from FY 2007 to FY 2008 is due to completion of the technology/algorithm development for Multi-Source Integration (MSI), Composite Combat Identification (CCID), and Advance Sensor Netting Technology (ASNT) in FY 2007.

The increase between FY 2008 and FY 2009 is to support completion of research for networked sensors.

FY 2007 Accomplishments:

- Continued development of a robust test environment to elucidate the design principles of human and sensor network interactions. (NRL)
- Completed ASNT, CCID, and MSI development. MSI, ASNT, and CCID transitioned to the E-2C/D Program Management Office (PMA-231), Intelligence, Surveillance, Reconnaissance, and Information Operations Program Office (PMW-180), and Program Executive Office-Integrated Warfare Systems (PEO-IWS).
- Initiated effort to improve the resolution of the High Frequency Relocatable Over-the-Horizon Radar (HF-ROTHR) more than two orders of magnitude using time-reversal methods. (NRL)

FY 2008 Plans:

- Continue all efforts of FY 2007 less those noted as completed above.

FY 2009 Plans:

- Continue all efforts of FY 2008.
- Complete development of a robust test environment to elucidate the design principles of human and sensor network interactions. (NRL)

	FY 2007	FY 2008	FY 2009
HUMAN FACTORS AND ORGANIZATIONAL DESIGN	5,519	6,708	4,978

This activity (formerly Human Computer Interface) focuses on improving platform, task force, and battle group operations by developing decision support technology for incorporation into operational systems. The goals are to enhance human performance effectiveness; improve decision support and decision-making collaboration; improve human-centered design; and accelerate insertion of advanced human factors engineering technology into existing and new weapons systems. The payoff is the creation of decision-action cycles that are faster than

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an enemy's, and reduced workload and staffing requirements. Specific objectives include achieving improved situational awareness and speed of command through a deeper understanding of human capabilities and limitations, as well as accomplishing quality performance in complex, dynamic, high-tempo, and uncertain threat environments. These objectives are being pursued in three focus areas: Decision Support and Organizational Design, Collaboration and Knowledge Management, and Human-Computer Interaction/Visualization.

The increase from FY 2007 to FY 2008 is due to additional emphasis and expansion of the exploration of cognitive modeling and exploration of Human and Organizational Interfaces to large complex data sets including the GWOT.

The decrease from FY 2008 to FY 2009 reflects the completion of development of a user tool to counteract perceptual errors associated with 3D perspective-view visual displays, research on tools to assist in the management of task interruptions, and overall reduced level of investment to fund higher priority requirements.

FY 2007 Accomplishments:

- Continued evaluation of Latent Semantic Analysis (LSA) of operator communications as an effective metric of shared situational awareness in unmanned aerial vehicle control teams.
- Continued demonstration of Electronic Card Wall (EWALL) (a computational human cognitive processing system) for representation and transfer of meaning among heterogeneous and distributed team members engaged in complex problem solving.
- Continued developing jointly with the Naval Air Systems Command, a FORCEnet-based test bed to identify and evaluate the cognitive processes to be employed to optimize collaborative decision-making in a geographically distributed and time-delayed situation.
- Continued model-based simulations and experiments to investigate the effectiveness of hierarchical organizational structures in network-centric operational environments in order to evaluate the implementation of FORCEnet concepts.
- Continued development of new threat scenarios incorporating Joint Force Maritime Component Commander operations, counter-insurgency and humanitarian operations with the staff of the Naval War College. These new threat scenarios will provide the basis for Limited Objective Experiments in the Innovation Laboratory at the Naval War College.
- Continued development of Dynamic Network analysis (a terrorist network analysis tool) in operational command setting at U.S. Pacific Command.

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- Continued the improvement of terror network analysis decision tools for combatant command use and military planning, including testing of tools, development of metrics, and validation.
- Continued evaluation of the effectiveness of a change history tool to minimize the effect of interruptions.
- Continued application of cognitive architecture modeling to the design of interface analysis tools.
- Continued deployment of models for Effects-Based Operations (EBO) aboard naval vessels to support Expeditionary Group One to conduct kinetic and non-kinetic tactical operations in a measured manner.
- Continued development of a cognitive model of human performance with 3D audio displays.
- Continued jointly with the Air Force applied research on the integration of Information Operations in Air Control Centers.
- Continued applied research on command and control adaptive architectures for Expeditionary Strike Groups working with OPNAV N-75B and Expeditionary Strike Group ONE, San Diego.
- Continued development of a user tool to counteract perceptual errors associated with 3D perspective-view visual displays.
- Completed development of technology to improve voice biometrics via the development of multi-dimensional, adaptive speaker verification technology. (NRL)
- Initiated the development of advanced computational models capable of analyzing multi-dimensional networks of thousands of nodes. Current capabilities enable the analysis of networks consisting of hundred of nodes.
- Initiated the development of computational models of influence that incorporate the social structure, values and cultural processes of urban non-western communities for achieving post-conflict stabilization.
- Initiated the development of social network models to model the human element in maritime domain awareness.
- Initiated effort to improve response speed of the LSA tool to a near-interactive level and incorporate into a fleet experiment. Collect and evaluate data to validate improved speed and effectiveness of developing situational awareness.
- Initiated effort to incorporate the EWALL prototype into a simulation of the Tactical Operations Center of the Special Operations Forces and collect performance data to validate effectiveness.
- Initiated Sea Basing research on rehearsal for Expeditionary Strike Groups in the conduct of maritime interdiction missions and developing reach-back capability for computationally intense analysis for evaluating courses of action.

FY 2008 Plans:

- Continue all efforts of FY 2007 less those noted as completed above.
- Complete development of a user tool to counteract perceptual errors associated with 3D perspective-view visual displays.

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- Complete research on tools to assist in the management of task interruptions.
- Complete 3D audio experiments in the context of Common Enterprise Display System (CEDS) to evaluate cognitive models of 3D audio perception.
- Initiate research on advanced computational models to incorporate additional capabilities in the analysis of terror networks and on various types of flow in these networks (such as the flow of expertise, resources).
- Initiate effort to improve social network models to analyze merchant marine traffic.
- Initiate development of metrics to identify and measure the contribution to team performance of the cognitive processes underlying ad-hoc team decision making.
- Initiate effort to improve the model of ad-hoc team decision making by including collaborative agent-based contribution to team performance.
- Initiate research on the application of information architectures (DOD Architectures Framework), executable models (Petri Nets) and cognitive models to the systematic design of Human-Computer Integration.
- Initiate effort to develop tools for more automated, cost-efficient modeling of human system interaction.
- Initiate research on adaptive command and control architectures in support of the Navy's new Maritime Strategy.
- Initiate methods to introduce key cognitive abilities to autonomous vehicles that will enable warfighters and vehicles to work together more collaboratively. (NRL)

FY 2009 Plans:

- Continue all efforts of FY 2008 less those noted as completed above.
- Initiate development of a computational model of subjective reasoning for course of action selection activity in distributed, asynchronous teams.
- Initiate test and validation of a cognitive processes model of team collaboration in a Maritime Interdiction Operations domain.
- Initiate human cultural and social modeling to improve warfighting, civilian military operations and humanitarian operations in non-Western environments.
- Initiate research on quantitative formalisms for developing and assessing the completeness, consistency and accuracy of rules of engagement (ROEs).
- Initiate research on executable models and optimization algorithms for adaptive command structures that are congruent with mission requirements to support the design of Maritime Headquarters with Maritime Operations Centers (MHQ/MOC) organizations.
- Initiate research on models to support the design of scalable joint and coalition Maritime Operations Centers that allocate responsibilities to elements afloat and ashore.

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	FY 2007	FY 2008	FY 2009
TACTICAL SPACE EXPLOITATION	17,463	23,072	16,719

The Tactical Space Exploitation initiative explores the application of new space craft technologies on small, light-weight and low-cost satellites to enhance naval warfighting capabilities; taking advantage of the global access, revisit and connectivity provided by orbital platforms. Initial efforts will be aimed at developing integrated signals electronics packages to test new concepts for global ship tracking and two-way data exfiltration using next-generation Internet Protocol (IP) technology from an array of sea-based and land-based sensors. Advanced multispectral/hyperspectral electro-optical sensors will be developed to demonstrate new warfighting constructs and communications payload technology deployed on satellites to demonstrate augmented mobile satcom capabilities over a theater.

The significant increase in planned funding in FY 2008 represents resources required to cover costs of hardware, research, and demonstration of technology associated with all programs, with a significant portion of this funding being allocated in support of the communications satellite payload for augmented mobile satellite communications over a theater of operations.

In FY 2009, investments in this activity are curtailed in response to completion of the development of communications satellite payload to provide augmented mobile satcom over a theater from high altitude earth orbit with payload launch in late FY 2008.

FY 2007 Accomplishments:

- Continued development of communications satellite payload to provide augmented mobile satcom over a theater from high altitude earth orbit.
- Continued development of integration plans, algorithms, and satellite concept of operations to demonstrate the integrated signals payload as a secondary payload on an FY 2007 small satellite launch.
- Continued development of small multifunctional integrated signals electronics systems for ship tracking from space and two-way data exfiltration from distributed global sensors.
- Continued development of a satellite-borne electro-optical sensor system for FY 2008 launch on a small satellite to test new techniques for surveillance of environments and targets of naval interest for anti-submarine warfare and mine warfare.
- Completed preliminary environmental and flight testing of hardware components.

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- Initiated program to use chemical release from satellites launched into selected low-Earth orbits to de-populate intense trapped electrons in radiation belts following a low-altitude nuclear explosion in space. (NRL)

FY 2008 Plans:

- Continue all efforts of FY 2007 less those noted as completed above.
- Complete development and launch of communications satellite payload to provide augmented mobile satcom over a theater from high altitude earth orbit.
- Initiate the development of a highly capable self-inspection vehicle for spacecraft with large complex deployables. (NRL)
- Initiate the development of a preliminary design for electrodynamic propulsion technology demonstration spacecraft. (NRL)

FY 2009 Plans:

- Continue all efforts of FY 2008 less those noted as completed above.
- Complete and launch maritime hyperspectral payload on TacSat or Space Test Program (STP) satellite. Develop improved maritime hyperspectral payload for flight on the International Space Station through STP. Complete analysis of TacSat 3 data.

CONGRESSIONAL PLUS-UPS:

	FY 2007	FY 2008
ADVANCED PANORAMIC SENSOR SYSTEMS FOR UAVS	971	795

FY 2007 - This effort developed advanced visual imaging technologies and related sensors and associated computing technologies for UAVs.

FY 2008 - This effort supports Advanced Panoramic Sensor Systems for UAVs research.

	FY 2007	FY 2008
ALL WEATHER SENSE & AVOID FOR UAVS	0	2,384

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This project will design and integrate a system of sensors that create a direction finder interface to enable automatic collision avoidance for UAVs flying in national airspace, in crowded theaters of operations, and hazardous weather.

	FY 2007	FY 2008
M2C2	5,978	3,180

FY 2007 - This effort has developed and demonstrated innovative communications concepts and technologies, such as improved satellite communications, digital data and laser technology and improved chat capabilities, for integration into the Marine Corps Mobile Modular Communications and Command unit.

FY 2008 - This effort supports M2C2 research.

	FY 2007	FY 2008
MULTICULTURAL OPERATIONS TRAINING & TACTICS SYSTEMS (MCOTTS)	1,644	0

This project developed an agent-based software system that rapidly gathers cultural information, provides situational understanding, models, and interactively simulates cultural norms under expected operational conditions and scenarios.

	FY 2007	FY 2008
PACIFIC MISSILE RANGE FACILITY/PEARL HARBOR INTEGRATED NETWORK	2,815	0

This effort developed improved computer software/technologies to monitor and display increased volumes of data collected during tests and exercises at the range.

	FY 2007	FY 2008
PACOM AGILE COALITION ENVIRONMENT	6,775	0

The Pacific Agile Coalition Environment (ACE) effort developed crypto devices agile enough to create virtual private networks (VPNs) to support bilateral and tailored multi-lateral relationships without having to build

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or lock-down unique networks for each community-of-interest security enclave. ACE enabled CENTRIXS to converge from a set of independent networks to a single network that supports multiple security enclaves on an on-demand basis.

	FY 2007	FY 2008
RADIO SENSOR MODULE (RASM)	2,192	1,590

FY 2007 - This project developed concepts and designed radio technology with ultra-broad band, operating frequency capability to enable communication flexibility in a complex, jamming environment.

FY 2008 - This effort supports Radio Sensor Module (RASM) research.

	FY 2007	FY 2008
THEATER UNDERSEA WARFARE INITIATIVE (TUSW)	5,578	3,180

FY 2007 - This project developed Theater Undersea Warfare (TUSW) Program tools including operations rehearsal simulations and enhancements to the Asset Allocation Tool (AAT). It also evaluated TUSW tools in Undersea Warfare exercises and the studied composable FORCENet integration.

FY 2008 - Develop data fusion technology to help bring clarity to the USW picture by integrating disparate, real-time tactical and sensor data and the Navy's best oceanographic, geophysical, and hydrographic data.

	FY 2007	FY 2008
UGV MOBILITY & COORDINATION IN JOINT URBAN/LITTORAL ENVIRONMENTS	0	795

The UGV effort will develop technologies to address robotic communications (such as signature reduction techniques) and control (including mobility) in support of tactical Marine Corps units in all environments, but specifically those in urban and littoral terrains.

C. OTHER PROGRAM FUNDING SUMMARY - NAVY RELATED RDT&E:
PE 0204152N E-2 Squadrons
PE 0205601N HARM Improvement

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PE 0206313M Marine Corps Communications Systems
PE 0601153N Defense Research Sciences
PE 0602114N Power Projection Applied Research
PE 0602123N Force Protection Applied Research
PE 0602131M Marine Corps Landing Force Technology
PE 0602236N Warfighter Sustainment Applied Research
PE 0602271N RF Systems Applied Research
PE 0603114N Power Projection Advanced Technology
PE 0603123N Force Protection Advanced Technology
PE 0603235N Common Picture Advanced Technology
PE 0603236N Warfighter Sustainment Advanced Technology
PE 0603271N RF Systems Advanced Technology
PE 0603609N Conventional Munitions
PE 0603640M USMC Advanced Technology Demonstration (ATD)
PE 0603658N Cooperative Engagement
PE 0604307N Surface Combatant Combat System Engineering
PE 0604518N Combat Information Center Conversion

OTHER PROGRAM FUNDING SUMMARY - NON-NAVY RELATED RDT&E:
PE 0602782A Command, Control, Communications Technology
PE 0602204F Aerospace Sensors
PE 0602702F Command Control and Communications

D. ACQUISITION STRATEGY:
Not applicable.

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

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PROGRAM ELEMENT TITLE: WARFIGHTER SUSTAINMENT APPLIED RESEARCH

COST: (Dollars in Thousands)

Project Number & Title	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
WARFIGHTER SUSTAINMENT APPLIED RESEARCH	114,975	107,564	93,862	92,068	94,177	86,301	87,242

A. MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: The efforts described in this Program Element (PE) are based on investment directions as defined in the Naval S&T Strategic Plan approved by the S&T Corporate Board (Jan 2007). This strategy is based on needs and capabilities from Navy and Marine Corps guidance and input from the Naval Research Enterprise (NRE) stakeholders (including the Naval enterprises, the combatant commands, the Chief of Naval Operations (CNO), and Headquarters Marine Corps). It provides the vision and key objectives for the essential science and technology efforts that will enable the continued supremacy of U.S. Naval forces in the 21st century. The Strategy focuses and aligns Naval S&T with Naval missions and future capability needs that address the complex challenges presented by both rising peer competitors and irregular/asymmetric warfare.

This PE supports the Future Naval Capabilities (FNCs) of Littoral Combat/Power Projection, Capable Manpower, Force Health Protection Future Capability, and Total Ownership Cost (TOC) Reduction; and innovation-based efforts that will provide technology options for future Navy and Marine Corps capabilities. Efforts focus on manpower and personnel; naval systems training; littoral combat and power projection capabilities; advanced naval materials; medical technologies; environmental quality; biocentric technologies; high speed sealift; cost reduction technologies; and seabasing technologies. Within the Naval Transformation Roadmap, this investment supports eight transformational capabilities within the "Sea Strike", "Sea Shield", and "Sea Basing" operational concepts; the critical human system, "Sea Warrior"; and Naval business efficiencies within "Sea Enterprise." FY 2008 reflects the reinitiation of Human Systems Integration efforts to develop automation, human interface, and decision support technologies (funded in FY 2005 and prior).

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

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B. PROGRAM CHANGE SUMMARY:

	FY 2007	FY 2008	FY 2009
FY 2008/FY 2009 President's Budget Submission	119,759	88,297	93,263
Congressional Action	0	20,880	0
Congressional Undistributed Reductions/Rescissions	0	-730	0
Execution Adjustments	-2,174	0	0
Program Adjustments	0	0	765
Rate Adjustments	0	0	-166
SBIR Assessment	-2,610	-883	0
FY 2009 President's Budget Submission	114,975	107,564	93,862

PROGRAM CHANGE SUMMARY EXPLANATION:
Technical: Not applicable.

Schedule: Not applicable.

C. OTHER PROGRAM FUNDING SUMMARY:
Not applicable.

D. ACQUISITION STRATEGY:
Not applicable.

E. PERFORMANCE METRICS:
As discussed in Section A, there are a significant number of varied efforts within this PE. For the most part these efforts support the FNC program of the Office of Naval Research. As such, each is monitored at two levels. At the lowest level each is measured against both technical and financial milestones on a monthly basis. Annually each FNC and its projects are reviewed in depth for technical and transition performance by the Chief of Naval Research against goals which have been approved by the Navy's senior flag level Technical Oversight Group.

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The FNC managers conduct routine site visits to performing organizations to assess programmatic and technical progress and most projects conduct an annual or bi-annual review by an independent board of visitors who assess the level and quality of the Science and Technology (S&T) basis for the project.

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COST: (Dollars in Thousands)

Project Number & Title	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
WARFIGHTER SUSTAINMENT APPLIED RESEARCH	114,975	107,564	93,862	92,068	94,177	86,301	87,242

A. MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: This project supports the FNC's of Littoral Combat/Power Projection, Capable Manpower, Force Health Protection Future Capability, and Total Ownership Cost (TOC) Reduction; and innovation-based efforts that will provide technology options for future Navy and Marine Corps capabilities. Efforts focus on manpower and personnel; naval systems training; littoral combat and power projection capabilities; advanced naval materials; medical technologies; environmental quality; biocentric technologies; high speed sealift; cost reduction technologies; and Sea Basing technologies. Within the Naval Transformation Roadmap, this investment supports eight transformational capabilities within the "Sea Strike", "Sea Shield", and "Sea Basing" operational concepts; the critical human system, "Sea Warrior"; and Naval business efficiencies within "Sea Enterprise."

B. ACCOMPLISHMENTS/PLANNED PROGRAM:

	FY 2007	FY 2008	FY 2009
HUMAN SYSTEMS INTEGRATION	0	2,280	2,494

This activity supports the warfighter by designing affordable user-centered systems that are efficient, easy to use, and provide required mission capabilities at lowest lifecycle costs. Such systems will be optimally designed for the right number and types of personnel, requiring minimum training while providing high skills retention.

FY 2008 reflects a reinitiation of work in this field of research, so important to the reduction in complex naval systems design, acquisition, operation, and maintenance costs and improvements in the effectiveness of operations. This effort was funded from FY 2002 through FY 2005 under this PE within the Manpower and Personnel activity; budget priorities led to the gap in funding in FY 2006 and FY 2007. Congressional, DoD, and Navy policies and instructions require Navy and Marine Corps Program Managers to have a comprehensive plan

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for Human Systems Integration (HSI) in the acquisition process to optimize total system performance, minimize total ownership costs, and ensure the system is built to accommodate the characteristics of the user population that will operate, maintain, and support the systems. A strong HSI effort must be part of the Capable Manpower Program during the period FY 2008 - FY 2012.

FY 2008 Plans:

- Initiate research to develop automation and human interface technologies to support collaborative decision-making in which multiple unmanned system operators manage groups of vehicles with optimal manning.
- Initiate research to develop tactical decision making concepts to integrate spatially disparate displays and reduce the reliance of crew support to achieve superior ship commanding officer and crew decision making.
- Initiate HSI tool research, development, and application to engineering efforts to develop robust standardized set of human systems integrated specific modeling and simulation tools to assess the interaction between operators performance by system design by manning levels.

FY 2009 Plans:

- Continue all efforts of FY 2008.

	FY 2007	FY 2008	FY 2009
MANPOWER/PERSONNEL	2,422	2,435	2,540

These technologies enhance the Navy's ability to select, assign, and manage its people by responding to a variety of requirements, including: managing the force efficiently and maintaining readiness with fewer people and smaller budgets; providing warfighting capabilities optimized for low-intensity conflict and littoral warfare; and operating and maintaining increasingly sophisticated weapons systems while managing individual workload and supporting optimal manning.

This activity further supports the warfighter by providing enhanced capabilities by designing affordable user-centered systems that are efficient, easy to use, and provide required mission capabilities at lowest lifecycle costs. Such systems will be optimally designed for the right number and types of personnel, requiring minimum training while providing high skills retention.

FY 2007 Accomplishments:

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- Continued low-velocity impact and shaker table dynamic internal response mapping with new anatomical features and sensor suite GelMan thoracic surrogate. (NRL)
- Completed modeling of forecasting/trend analysis models within functions of the personnel enterprise.
- Completed applicant cultures and values program to assess the practicality and predictive validity of socialization measures for selection into the military.
- Completed modeling integration methodologies for sailor/marine members' cognitive agents and distribution and assignment system portal.

FY 2008 Plans:

- Continue all efforts of FY 2007 less those noted as completed above.
- Initiate development of a virtual, experimental-based software environment to test and evaluate the effect of various incentive structures on resource allocation decision making.
- Initiate development of artificial intelligence and optimization techniques to create simulation based decision support tools for resource allocations across units and battle groups.
- Initiate development of Unit-level tools to enable commanders to analyze the cost implications of their actions and weigh tradeoffs between readiness, cost, and risk.
- Initiate development of intelligent agents to empower total force members to make training and assignment choices that enhance their careers and meet personal goals.
- Initiate research to provide results for guiding the development on an interface allowing experts in HSI to work with subject matter experts to define and refine critical intra-domain concepts while capturing information for future use.
- Initiate a continuous engineering process evaluation and adaptation to show that the developing process is executable and effective.

FY 2009 Plans:

- Continue all efforts of FY 2008.

	FY 2007	FY 2008	FY 2009
TRAINING TECHNOLOGIES	11,130	10,999	10,812

Training technologies enhance the Navy's ability to train effectively and affordably in classroom settings, in

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simulated environments, while deployed, and to operate effectively in the complex, high-stress, information-rich and ambiguous environments of modern warfare such as asymmetric warfare. Technology development responds to a variety of requirements, including providing more affordable approaches to training and skill maintenance. Improved training efficiency and cost-effectiveness is achieved by applying operations research, modeling and simulation, and instructional, cognitive, and computer sciences to the development, delivery, evaluation, and execution of training.

FY 2007 Accomplishments:

- Continued program on intelligent agents for objective-based training.
- Continued Computer Generated Forces (CGF) task aimed at improved techniques for human cognitive and behavioral modeling.
- Continued work on effective feedback in artificially intelligent tutoring for dynamic task environments such as anti-air warfare, instrument flying and other characteristic military tasks.
- Continued a systematic program of applied research addressing unanswered questions regarding effective instructional strategies in artificially intelligent tutoring.
- Continued work on software tools to facilitate building natural language tutorial dialogs for artificially intelligent tutoring.
- Continued task to apply recently developed learning techniques that can be used in a model interacting with its application environment to extend or refine its knowledge base and behavioral competence.
- Continued task to develop multi-agent based architectures for modeling human behavior, improve techniques for human cognitive and behavioral modeling, and create highly realistic simulated teammates.
- Continued field studies and user tests evaluating new features and job aiding tools.
- Completed development of optimized strategies for performance aiding and training.
- Completed development of immersive interaction technologies for team training application.
- Completed research in CGF for improving training effectiveness in Virtual Environments.
- Completed task to develop multi-agent based architectures for modeling human behavior, improve techniques for human cognitive and behavioral modeling, and create highly realistic simulated teammates.
- Completed modeling of the integration of different military domains into a distributed Virtual Technologies and Environments Full Spectrum Combat simulation.

FY 2008 Plans:

- Continue all efforts of FY 2007 less those noted as completed above.

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- Initiate development of optimized strategies for performance aiding and training.
- Initiate development of virtual technologies for warfare training application.
- Initiate development of technologies to support human performance in networked warfighting environments.
- Initiate development of training technologies for culture, values, and language training and opponent simulation for training systems.

FY 2009 Plans:

- Continue all efforts of FY 2008.
- Initiate research to create computational models of human behavior in selected non-Western environments that reflect the dominant cultural, social, ethnic, and economic determinants of behaviors, attitudes, and beliefs of individuals, groups, and organizations operating in these environments, and exploit these models to forecast responses to our actions and those of others attempting to exert influence in these environments.

	FY 2007	FY 2008	FY 2009
LITTORAL COMBAT / POWER PROJECTION	9,327	10,673	6,000

This activity provides for technologies that enhance the ability of the Navy-Marine Corps team to assure access and sustained operations in the Littorals. The FNC Program considers all the critical functions of warfighting: command, control, communications, computers, intelligence, surveillance, and reconnaissance (C4ISR); fires; strike; maneuver; sustainment; and fleet/force protection. This activity includes technical assessments and trade studies for FNC Enabling Capabilities that transition high priority technologies to the Navy and Marine Corps in support of the Sea Strike, Sea Shield, Sea Basing, and ForceNet Naval Power 21 pillars as well as Enterprise and Platform Enabling Science and Technology requirements.

The decrease from FY 2008 to FY 2009 reflects the completion of the Battlefield Power Generation Technology FNC effort in FY 2008.

FY 2007 Accomplishments:

- Continued development of battlefield power generation technologies.
- Completed program to develop oxygen, water vapor and temperature measurement capability for safety during littoral combat (NRL).
- Completed efforts for laser safety testing of Streak Tube Imaging Light Detection and Ranging (LIDAR)

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technology being developed as part of the obstacle avoidance system for the Expeditionary Fighting Vehicle (EFV).
- Completed development of advanced weapons materials technology for use in artillery and mortar systems. (Concurrently funded by PE 0602131M).
- Completed development of improved lightweight fire control systems interface technologies.
- Completed development of landmine countermeasure insensitive munitions technology. (Concurrent effort funded by PE 0602131M).

FY 2008 Plans:

- Complete development of battlefield power generation technologies.
- Initiate efforts to conduct FNC warfighter sustainment applied research, including technology management of FNC investments supporting the naval enterprise and naval capability pillars.
- Initiate efforts to perform technology analyses to support the development and validation of FNC technology performance metrics for enabling capabilities structured to close naval capability gaps.
- Initiate efforts to assess technology options for the development of applied FNC technologies packaged into deliverable S&T products.

FY 2009 Plans:

- Continue all efforts of FY 2008 less those noted as completed above.

	FY 2007	FY 2008	FY 2009
ADVANCED NAVAL MATERIALS	6,772	8,275	13,519

Advanced Naval Materials efforts include: developing advanced, high-performance materials; processes to reduce weight and cost; and enhanced sonar transducers.

Increase from FY 2007 to FY 2008 is due to completion of acceptance testing methodologies for advanced transducer materials and welding processes for high-nickel naval steels. The increase between FY 2008 and FY 2009 reflects the initiation of new applied research in Naval Structural Health Monitoring and Corrosion Control Prevention Technologies.

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FY 2007 Accomplishments:

- Continued low cost phthalonitrile based organic resin material and hybrid composite development with improved fire resistance; and process development of fiber reinforced foam material.
- Continued development of multifunctional transducer material, high-force high-strain actuators; and evaluation of advanced transducer single crystal high strain materials.
- Continued multi-laser-processing technique development for the fabrication of ultra hard materials for wear resistance applications.
- Continued development of advanced, cost-efficient joining of titanium for >25% weight reduction of large seaborne structures.
- Continued development of advanced composites and polymers with fire resistance for ship structures.
- Continued development of nanotube reinforced composite materials for the improvement of their out-of-plane mechanical properties.
- Continued development of acceptance testing methodologies for advanced transducer single-crystal high-strain materials and definition of standardized materials properties and composition ranges.
- Continued development of compositional tuning of single-crystal, high-strain transducer materials, for specialized naval system applications.
- Continued development of cavitation resistant ship rudder coatings based on the FY 2004 shipboard coating study.
- Continued catalyst development and grew vertically aligned carbon nanotubes in existing gated silicon post structures in a Direct Current (DC) plasma Chemical Vapor Deposition (CVD) reactor, obtaining stable field emission and 1 ampere/cm2 current densities. (NRL)
- Continued marine titanium alloy design and development, exploiting anticipated cost reductions for high performance, reduced maintenance naval applications.
- Continued development of continuous single wall carbon nanotube composite materials for next generation air and naval platforms.
- Continued evaluation of corrosion performance on the family of conjugated poly (phenylenevinylene) polymers.
- Continued development of techniques and procedures to enhance hot corrosion and oxidation resistance.
- Continued development of surface preparation methods and characterization of corrosion performance for future naval ship materials.
- Continued evaluation of low temperature carburized materials for marine application.
- Continued development of coating performance and knowledge database for Naval use.
- Continued development of mechanistic model for stress corrosion cracking in Nickel Aluminum Bronze (NAB).
- Continued development of Microbiologically Influenced Corrosion (MIC) resistant passive alloys for sea

basing.
- Continued friction stir welding development for control of residual stresses and elimination of distortion in naval steels.
- Completed fabrication studies of pultruded sandwich for low cost, high performance ship structural applications.
- Completed cellular metal blast resistant materials with full section ship hull blast evaluation.
- Completed development of weld processing of stainless steel.
- Completed program to optimize a-c loss and mechanical reliability of second generation high temperature superconductors for future naval power applications. (NRL)
– Initiated development of innovative sonar transducers based on high-strain, high-coupling piezoelectric single crystals.
- Initiated development of solid-state growth methods for making high-strain, high-coupling piezoelectric single crystals.
– Initiated development of integrated structural composites with blast resistance, manufacturing technologies, and low-cost organic resins with improved fire resistance.
- Initiated development of novel processing technologies for increasing the fatigue strength and corrosion resistance of weldments for ship structures with reduced weight and maintenance requirements.
- Initiated development of friction stir joining of marine titanium alloys.

FY 2008 Plans:

- Continue all efforts of FY 2007 less those noted as completed above.
- Complete evaluation of corrosion performance on the family of conjugated poly (phenylenevinylene) polymers.
- Complete development of techniques and procedures to enhance hot corrosion and oxidation resistance.
- Complete development of MIC resistant passive alloys for sea basing.
- Complete development of acceptance testing methodologies for advanced transducer single-crystal high-strain materials.
- Complete development of welding processes and consumables for high-nickel containing naval steels.
- Complete development of phthalonitrile based organic resin material and hybrid composite development with improved fire resistance; and process development of fiber reinforced foam material.
- Complete catalyst development and grow vertically aligned carbon nanotubes in existing gated silicon post structures in a DC plasma CVD reactor, obtaining stable field emission and 1 ampere/cm2 current densities. (NRL)
- Initiate development of materials processing methods for single crystal piezoelectrics to make strong,

robust sonar transducers.
- Initiate modeling and process development of single-melt cold hearth casting of naval titanium alloys including Ti 5-1-1-1 for enhanced mechanical properties and formability.
- Initiate development of models and characterization methods for dynamic loading (water slamming and blast loading) in polymer composite materials.
- Initiate ballistic test program to assess dependence of penetration velocity on coating thickness and substrate properties. (NRL)
- Initiate effort to develop single domain antibodies for the recognition of explosives and small toxins. (NRL)

FY 2009 Plans:

- Continue all efforts of FY 2008 less those noted as completed above.
- Complete development of compositional tuning of single-crystal, high-strain transducer materials, for specialized naval system applications.
- Complete evaluation of corrosion performance on conjugated poly (phenylenevinylene) polymers.
- Complete development of techniques and procedures to enhance hot corrosion and oxidation resistance.
- Complete development of MIC resistant passive alloys for sea basing.
- Initiate development of novel growth methods to specialized single crystal transducer materials tuned to requirements of specialized naval systems.
– Initiated development of new 3D mechanical characterization technique for polymer composites based on dissipative energy density principles.
– Initiate development of continuous based monitoring techniques of new synthetic fuels and lubricants based on electromagnetic signature analysis.
– Initiate development and application of distributed fiber optic Bragg gratings for structural health monitoring of ships and aircrafts.
- Initiate grain boundary engineering to improve corrosion resistance of marine grade Al alloys.
- Initiate assessment of the degree of sensitization potential of marine grade Al alloys.
- Initiate investigation of criteria for stable pitting of stainless steel.
- Initiate acoustic damping coatings for ship tank application.
- Initiate development of surface assessment technologies to measure surface profile and chlorine.
- Initiate evaluation of advanced material coating for erosion control on helicopter main rotor blade leading edges.

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	FY 2007	FY 2008	FY 2009
MEDICAL TECHNOLOGIES	8,398	12,256	12,020

This program supports the development of field medical equipment, diagnostic capabilities and treatments; technologies to improve warfighter safety and to enhance personnel performance under adverse conditions; and systems to prevent occupational injury and disease in hazardous, deployment environments. Navy investment in these areas is essential because Navy/USMC mission needs are not adequately addressed by the civilian sector or other Federal agencies. For example, civilian emergency medicine does not address casualty stabilization during long transit times to definitive care. The National Institutes of Health (NIH) focuses on the basic science of disease processes and not applied research related to development. Programs are coordinated with other Services through the Armed Services Biomedical Research Evaluation and Management (ASBREM) Committee to prevent duplication of effort. This project funds the Force Health Protection FNC that will provide technology options for future Navy and Marine Corps capabilities and supports the "Sea Warrior" component of the Naval Transformation Roadmap, medical logistics aspects of "Sea Basing" and expeditionary force medical support associated with "Sea Strike".

The increase from FY 2007 to FY 2008 reflects realignment of funds from PE 0603729N to support the Force Health Protection Future Capability FNC program.

FY 2007 Accomplishments:

- Continued studies on decompression sickness (DCS) and arterial gas embolism (AGE), to include novel approaches to the prevention, detection and treatment of DCS/AGE, particularly by non-recompressive methods.
- Continued efforts to develop prophylactic agents preventing hyperbaric oxygen toxicity. Prolonged exposure to hyperbaric oxygen can be toxic to lungs, nervous system and eyes.
- Continued efforts to assess the impact of thermal (i.e., heat and cold) stress on operational performance. Underwater thermal extremes can affect diver performance and alter risk of incurring decompression sickness.
- Continued studies related to optimization of diver performance. Operational performance in the undersea environment can be hampered by a variety of environmental stressors.
- Continued study to evaluate endomorphin-based product to treat traumatic brain injury (TBI).
- Continued studies related to optimization of submariner health and performance. Submarine crewmembers are exposed to a variety of unique stressors including prolonged deployments, effects of altered diurnal rhythms, non-standard breathing gases, lack of sunlight, etc that can impact health and performance.

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- Continued studies related to biomedical effects of underwater sound. Military divers must operate safely and effectively in potentially complex underwater sound fields.
- Continued research to treat and prevent attrition due to combat related psychological stress and acute Post Traumatic Stress Disorder (PTSD), a significant problem for retention of personnel.
- Continued efforts for "stress inoculation" to mitigate the impact of exposure to stressful combat environments prior to deployment.
- Completed work on shipboard injury, exposure guidelines, and engineering specifications for preventing shock-related injury. Reducing neck, spine and musculoskeletal injury will increase force readiness.
- Completed work on hearing protection systems and on improved treatment for restoring Noise-Induced Hearing Loss (NIHL). Compensation for hearing loss currently costs DoN over $70M per year.
- Completed study to identify selective & specific biomarkers for mild and moderate TBI.

FY 2008 Plans:

- Continue all efforts of FY 2007 less those noted as completed above.
- Complete study to evaluate endomorphin-based product to treat TBI.
- Complete research to treat and prevent attrition due to combat related psychological stress and acute PTSD, a significant problem for retention of personnel.
- Initiate program to develop enhanced First Responder capability.
- Initiate program to develop enhanced Forward Resuscitative Surgical capability.
- Initiate program to develop enhanced En Route Care capabilities.
- Initiate efforts to mitigate the effects of environmental and other threats to health.
- Initiate efforts to reduce operational injuries.
- Initiate efforts to reverse NIHL.

FY 2009 Plans:

- Continue all efforts of FY 2008 less those noted as completed above.

	FY 2007	FY 2008	FY 2009
ENVIRONMENTAL QUALITY	3,122	3,495	3,303

Environmental Quality technologies enable sustained world-wide Navy operations in compliance with all local, state, regional, national and international laws, regulations and agreements, and support the Navy

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Transformational Roadmap in the areas of Sea Basing, Sea Strike and Sea Warrior. Compliant operations enable training evolutions and exercises that are critical for maintaining readiness.

FY 2007 Accomplishments:

- Continued development of new, advanced, environmentally benign AF/Anti-Corrosive (AC) coating systems for Navy platforms, far-term noise and air pollution emissions abatement technology for unrestricted operations, and alternative torch technologies for shipboard plasma waste treatment, and multiple aqueous metal ion sensor to incorporate copper sensor developed in the Strategic Environmental Research and Development Program (SERDP) program for planned combined transition to the Environmental Security Technology Certification Program (ESTCP).
- Continued initial development of robotic Hull Biomimetic Underwater Grooming (BUG) and associated grooming approaches.
- Completed evaluation of aqueous film forming foam (AFFF) without perfluoroctanylsulfonates (PFOS) and studies to determine copper input into harbors from Navy ship hull coatings.
- Initiated development of advanced environmentally sound technologies for shipboard waste treatment and pollution abatement systems.
- Initiated pilot scale system development of miniature gasification process for treatment of shipboard solid waste.
- Initiated and complete initial decision report on impact of synthetic lubricants on shipboard oily waste treatment systems.

FY 2008 Plans:

- Continue all efforts of FY 2007 less those noted as completed above.
- Complete alternate torch technologies for shipboard plasma waste treatment.
- Complete report on cost benefit analysis of improved hull coatings and technologies for prevention of marine fouling.
- Initiate development and modifications to shipboard oily waste treatment systems to accommodate processing of synthetic lubricants.

FY 2009 Plans:

- Continue all efforts of FY 2008 less those noted as completed above.

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- Complete pilot scale system development of miniature gasification process for treatment of shipboard solid waste.
- Complete development of the Mobile Cleaning Recovery and Recycling System (MCRRS) vehicle for cleaning of aircraft non-skid decks as a part of advanced environmentally sound tetechnologies for shipboard waste treatment and pollution abatement systems.
- Complete initial development of robotic Hull BUG and associated grooming approaches.
- Initiate field evaluation of prototype robotic Hull BUG to identify gaps needed to refine and advance the technology.

	FY 2007	FY 2008	FY 2009
BIOCENTRIC TECHNOLOGIES	995	5,168	6,443

Biocentric technologies provide novel solutions for naval needs based upon the applications of biosensors, biomaterials, and bioprocesses. Topic areas include, but are not limited to development of biologically-based signal processing for medical, surveillance and security applications; bioinspired robotics; microbial or plant engineering to produce high-value naval materials such as energetic compounds or to develop sentinel organisms, and marine mammal diagnostics to support the Navy's Fleet Marine Mammal Systems.

The increase from FY 2007 to FY 2008 is due to realignment and consolidation of existing efforts funded under PE 0602123N Activity "Fleet Force Protection and Defense Against Undersea Threats" and PE 0602435N Activity "Coastal Geosciences/Optics/Biology" into this activity. The increase from FY 2008 to FY 2009 is due to the initiation of new efforts for advanced biometric sensing for autonomous systems, chemical sensing, and micro-bio-fuel cells for autonomous vehicles.

FY 2007 Accomplishments:

- Continued engineered microbial synthesis and processing of energetic materials.
- Continued development of innovative naval biosensors, biomaterials, and bioprocess technology (i.e., engineered plants for explosives detection, study of human stress biomarkers and bioinspired panoramic imaging systems).
- Continued efforts on naval biosensor to detect brain structures and blood vessels through skull bones.
- Continued efforts on innovative marine mammal diagnostics to detect viruses, bacteria, fungi and immunomarkers.
- Completed efforts in marine mammal vaccine.

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- Initiated, develop and demonstrate methods for determining multiple microbial genetic sequences which will have profound implications for detection of environmental pathogens and marine sensory systems using microorganisms. (NRL)
- Initiated program to aid warfighter protection that will provide versatile systems for tagging and tracking using chemical tangents tailored to simultaneously satisfy operational requirements and match optical or physio-chemical detection methods. (NRL)
- Initiated a program to develop a microfabricated analytical system for trace detection of illicit materials including explosives, and other hazardous chemicals. (NRL)

FY 2008 Plans:

- Continue all efforts of FY 2007 less those noted as completed above.

The following tasks will move from PE 0602123N to Biocentric Technologies in FY 2008 due to realignment of funds and focus.
- Continue biomimetic signal processing efforts, such as temporal and temporal pattern recognition for security breaching noise detection and biomimetic sonar systems for operation in air and aquatic environments based on bat echolocation neurophysiology and information processing algorithms.
- Continue efforts in bioinspired quiet, and maneuverable self-propelled line array using high-lift propulsors based on animal wing and fin biomechanics.
- Continue efforts in naval biosensors, biomaterials and bioprocessing, (i.e., underwater explosives/chemical detectors and benthic microbial energy harvesting)

The following tasks will move from PE 0602435N to Biocentric Technologies in FY 2008 due to realignment of funds and focus.
- Continue efforts on innovative marine mammal diagnostics (detection of viruses, fungi and bacteria, and immunomarkers).
- Continue engineering development and optimization of sea-floor sediment energy harvesting system for sustainable and autonomous powering of underwater sensor networks.

FY 2009 Plans:

- Continue all efforts of FY 2008.
- Continue marine mammal immunomarker efforts, including the characterization of the dolphin fore-stomach

microbial community, identification of probiotic immunostimulating species and immunobioassays for stress and infection detection.
- Complete biomimetic temporal pattern recognition for security breaching noise detection and biomimetic sonar systems for operation in air and aquatic environments based on bat echolocation neurophysiology and information processing algorithms.
- Complete development of an initial set of molecular diagnostic tests for bacterial, fungal and viral pathogens of marine mammals.
- Initiate efforts on advanced biomimetic sensing and neural control for human-robot interaction to enable effective collaboration of warfighters and autonomous systems.
- Initiate efforts on advanced biomimetic sensing and neural-based intelligent control and neural control for human-robot interaction to enable effective collaboration of warfighters and autonomous systems.
- Initiate development of underwater chemical sensors powered by sediment fuel cell
-Initiate research for detection or mitigation of microbes or compounds of naval relevance in various settings.
- Initiate micro-bio-fuel cell efforts for implanted or micro-autonomous vehicles.
- Initiate integration of biomimetic sonar with bioinspired autonomous undersea vehicles (with high-lift propulsors) to achieve closed loop control.

	FY 2007	FY 2008	FY 2009
HIGH SPEED SEALIFT	10,663	0	0

Fast sealift continues to be a military priority. However, friction drag reduction is increasingly essential for long-range, large-payload Navy ships to travel at high speeds (50+ knots). The High Speed Sealift (HSS) effort focuses on the design of a hydrodynamic experimentation capability to resolve questions pertaining to full-scale implementation of friction drag reduction procedures.

This effort ends in FY 2007.

FY 2007 Accomplishments:

- Completed development of experimentation test plans, management procedures, and system requirements.
- Completed high-speed sealift system studies.
- Completed designs for large-scale testing of technologies, concepts, and systems.
- Initiated and completed large-scale assembly and testing of technologies, concepts, and systems.

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- Initiated and completed experiments for HSS technologies, concepts and systems.

	FY 2007	FY 2008	FY 2009
COST REDUCTION TECHNOLOGIES	8,638	9,494	9,736

Cost Reduction Technology efforts include: developing ultrareliable materials and sensors to reduce cost by enabling condition-based and zero maintenance capabilities; and airframe and ship corrosion efforts for advanced cost effective prevention and life cycle management technologies. This activity includes the Navy's share of the Versatile, Affordable, Advanced Turbine Engine (VAATE) program for materials. Investments under this activity were previously reported under Advanced Naval Materials and were broken out to provide improved clarification of the overall investment scope.

FY 2007 Accomplishments:

- Continued development of ceramic matrix composite turbine blades for gas turbine engines.
- Continued development of portable, real-time, non-destructive examination (NDE)/Non-destructive Inspection (NDI) technology for heat damage detection in composite materials.
- Continued development of cavitation resistant ship rudder coatings transitioned from FY 2005 Advanced Naval Materials.
- Continued development of fiber-optic Bragg grating demodulation system for structural health monitoring of ships and submarines. (moved from Advanced Naval Materials activity)
- Continued development of a revolutionary new thermal spray technology for repair and refurbishment of worn and/or corroded components on ships, aircraft and combat vehicles.
- Completed development of durable new materials and thermal barrier coatings for naval gas turbine hot sections; environmental barrier coatings for ceramics/composites for gas turbine engines; new thermal barrier technology; materials and processes for high temperature turbine disks; and higher temperature aluminum alloys for propulsion.
- Completed development of calcium magnesium aluminum-silicate (CMAS) resistant thermal barrier coatings.
- Completed development of nickel-aluminized thermal barrier coating which will be phase compatible with turbine blade alloys.
- Completed development of standardized road test methodology and coating test metrics for USMC vehicles.
- Completed development of single coat corrosion control coatings for collect/hold/transfer (CHT) ship tank.
- Completed development of ultrasonic imaging NDI for aircraft.
- Completed NDE/NDI technologies for damage detection in composite materials.

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- Completed advance coatings and component for Marine Corps vehicles.

FY 2008 Plans:

- Continue all efforts of FY 2007 less those noted as completed above.
- Initiate development of durable alloys and materials for shipboard and aircraft gas turbine engines and spallation-resistant thermal barrier coatings for shipboard/aircraft marine gas turbine hot sections.
- Initiate development of advanced materials and processes for high temperature marine turbine disks and combustors.
- Initiate development of oxidation and vanadium/sulfate-resistant high temperature coatings for shipboard/aircraft gas turbine engines.
- Initiate development of CMAS-resistant coatings for ceramic matrix composites.
- Initiate development of high temperature foil bearing coatings for aircraft engine weight reduction.
- Initiate development of high temperature organic matrix composites.
- Initiate development of low-platinum and platinum-free aluminide coatings that are phase compatible with turbine blade alloys and exhibit low oxidation rates.
- Initiate efforts to assess manufacturing issues and reliability of ceramic matrix composites for turbine engines.
- Initiate integrated development of durable thermal barrier coating system with various bond coats for naval aircraft gas turbine hot section.
- Initiate development of materials processing for future gas turbine molybdenum-based alloys.
- Initiate efforts to conduct warfighter sustainment applied research, including technology management of investments supporting the naval enterprise and naval capability pillars.
- Initiate efforts to perform technology analyses to support the development and validation of FNC technology performance metrics for enabling capabilities structured to close naval capability gaps.
- Initiate efforts to assess technology options for the development of applied FNC technologies packaged into deliverable science and technology products.
- Initiate applied research and development of improved coatings for (1) non-skid surfaces, (2) ship rudders, (3) high performance ship topsides, and (4) high performance airfield pavements.
- Initiate efforts for the development of technologies supporting automated shipboard assembly of air-delivered weapons. (This effort realigned to Sea Basing Technologies activity in this PE in FY 2009)
- Initiate analytical model and reduced scale component development of shipboard compact power conversion technologies for multi-function motor drives, bi-directional power conversion modules, and power management controllers, focusing on closing technology gaps associated with Alternative Integrated Power System

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Architectures. (This effort transfers to PE 0602123N in FY 2009)

FY 2009 Plans:

- Continue all efforts of FY 2008.
- Initiate applied research in determining lifting of hot section materials exposed to alternative synthetic fuels and petroleum-synthetic fuel blends.
- Initiate applied research development of Calcium Magnesium Aluminum-Silicate (CMAS)-resistant coatings for molybdenum-base alloys.
- Initiate life prediction research for modeling of hot section gas turbine materials, including blades, in mixed naval environments.
- Initiate development of an Adaptive Expert System to automatically and rapidly analyze aircrew performance (1M+ flight hours annually) to detect human factors related mishap leading indicators using a new technique with anomaly detection and corroboration.

	FY 2007	FY 2008	FY 2009
SEA BASING TECHNOLOGIES	11,523	21,742	26,995

This activity includes development and advancement of technologies to support Seabasing. Areas include: advanced hull forms, propulsion, and materials to support high speed, shallow draft, and beachable connectors; innovative connector interface and transfer technologies; advanced wave and position sensors and autonomous controls to support vessel to vessel interfaces; and autonomous conveyance systems to support automated and integrated warehousing.

The increase in funding between FY 2007 to FY 2008 is due to the initiation of the Sense and Respond Logistics (S&RL) program. The increase from FY 2008 to FY 2009 represents changes in the complexity and cost for expanded efforts under the T-Craft Innovative Naval Prototype (INP) program model design and fabrication. This change is also due to a planned increase in funding for the Sea Basing program, continuation of the S&RL program, and movement of Automated-semi-automated Weapons Breakout and Build-up System funding from Cost Reduction Technologies into this R-2 Activity where the effort is correctly identified in the FY 2008 Plans.

FY 2007 Accomplishments:

- Continued multiple Innovative Naval Prototype (INP) contracts for preliminary designs in the area of a Sea

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Base to "Over-the-Shore" Connector Prototype (T-CRAFT)and a Rapidly Deployable Seabasing Stable Transfer Platform.
- Completed the preliminary design phase of the T-CRAFT demonstrator.
- Initiated the down-selection of T-CRAFT designs for further development and model construction and testing.
- Initiated T-CRAFT model construction and testing.
- Initiated the construction of a scaled model of a Rapidly Deployable Stable Transfer Platform demonstrator.
- Initiated a second evaluation of potential Seabasing INP efforts.

FY 2008 Plans:

- Continue all efforts of FY 2007 less those noted as completed above.
- Initiate planning of T-CRAFT prototype and component development.
- Initiate S&RL research in: battlefield fuel management; decision support systems for S&RL; emergent intelligence/intelligent agents for S&RL; and advanced sensors/processes for S&RL.

FY 2009 Plans:

- Continue all efforts of FY 2008.
- Continue efforts for the development of technologies supporting automated shipboard assembly of air-delivered weapons. (Realigned from Cost Reduction Technologies activity in this PE after FY 2008.)
- Complete T-CRAFT model testing and evaluation.
- Initiate the down-selection of Transformable (T-CRAFT) designs for prototype and component development and fabrication.

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CONGRESSIONAL PLUS-UPS:

	FY 2007	FY 2008
ADVANCED FOULING AND CORROSION CONTROL COATINGS	6,974	1,989

FY 2007 Accomplishments – Using combinatorial synthesis techniques, this effort conducted applied research into new and/or advanced polymers. It also catalogued candidate coatings to be evaluated for ship hull antifouling, fouling release, or anti-corrosion applications. Classes of coatings may include: silicones; silicones with tethered biocides; and silicone modified polyurethanes.

FY 2008 Plan - Continue development of promising classes of ship hull fouling release and antifouling coatings bases on silicones, silicones with tethered biocides, silicone and fluoropolymer modified polyurethanes. This effort will continue collaborations with other ONR academia for the synthesis of new coatings and for field testing of promising coatings.

	FY 2007	FY 2008
ADVANCED REINFORCED MATERIALS AND NEW MATERIALS RESEARCH FOR AIRCRAFT TIRES	971	993

FY 2007 Accomplishments - This effort addressed applied research and development of advanced materials for the Joint Strike Fighter (JSF) tires. Specifically, this research program is investigating: will functionalized and alternate microstructure Polybutadiene (PBD) polymers for improved tread wear, high reinforcement filler and modified elastomers for reduced weight, merged tire reinforcement with increased strength and lower weight, advanced material concepts and processes for reduced liner weight, and alternate bead designs for reduced weight.

FY 2008 Plan - The objective of the program continues to be to reduce weight, improve strength, wear, air retention, and fatigue resistance for aircraft tires. The program continues to: investigate new polybutadiene rubbers for increased number of landings; investigate new fillers and modified elastomers for lighter weight and improved wear resistance; investigate new tire reinforcement and alternate bead construction for added strength.

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	FY 2007	FY 2008
AMELIORATION OF MILITARY HEARING LOSS	971	795

FY 2007 Accomplishments - This research addressed optimizing the support cell specific expression of the marker transgene, GFP. Several promoters have been identified that are active in support cells. Comparisons began in the rat and guinea pig models to determine which promoter provides optimum transgene expression within this population of cells. These are the first steps necessary in accomplishing the overall goal of this effort which is to develop a treatment to reverse noise-induced hearing loss by regenerating functional sensory cells in the cochlea.

FY 2008 Plan - Using Adeno-associated viral (AAV) vectors as the gene delivery vehicle, this effort will examine the ability of the S100A1, pGFA, and EAAT1 promoters to establish efficient support cell specific transgene expression within the guinea pig cochlea in vivo and rat cochlear explants in vitro. AAV will be used to deliver and express the Math-1 gene in support cells of the guinea pig cochlea and rat cochlear explants. The potential of support cell targeted expression of exogenous Math-1 to induce the transdifferentiation of support cells into functional hair cells will be examined.

	FY 2007	FY 2008
ATMOSPHERIC WATER HARVESTING	971	993

FY 2007 Accomplishments - This effort developed and delivered prototype water harvesting device(s) to condense water from the air. The device is self-powered, using photovoltaics to gather power from the sun and store it in batteries. The battery power was used to operate various mechanical and/or solid state cooling devices to condense vapor from the air.

FY 2008 Plan - The FY 2008 effort will focus on finishing the development of the prototype device into a potential commercial product for home use as a back-up system to condense potable water from air in the event of a loss in water supply. A larger, trailer mounted prototype will be build for potential military/ community use.

	FY 2007	FY 2008

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	FY 2007	FY 2008
BIOSENSORS FOR DEFENSE APPLICATIONS	996	1,989

FY 2007 Accomplishments - This research addressed the utility of proteomic signature approaches to human cell-based environmental responses and for identification of new pollutant exposure biomarkers (using statistical analysis of 2D protein gels). Assessed rapid, affordable analysis of single nucleotide polymorphisms to predict clinical outcomes of drug exposures (using artificial neural networks for analysis). Developed antibody-based biosensors for micro-autonomous underwater vehicle platforms and for harmful algal bloom toxins. Utilized Louisiana Optical Network Initiative for health monitoring of coastal and urban infrastructure systems and extreme event response. Conducted Center for Bioenviromental Research Summer Academy for undergraduate minority students. Planned and held an "Urban Geochemistry and Health" Conference.

FY 2008 Plan - Toxic agents, including environmental compounds, can adversely affect the preparedness of naval personnel. Portable monitors of such exposures coupled with effects measures are critically needed. This project will employ in silicon modeling of relevant environmental signaling endpoints established from exposure sensitive cell systems. These modeling systems will be coordinated with gene expression signature networks to provide biologic validation. The integration of these cell systems and in silico outputs with established biosensor will move studies in FY 2008 towards lab-on a chip platforms that can ultimately be field and individually deployed.

	FY 2007	FY 2008
CONTINUATION OF HYDRATE DESALINATION TECHNOLOGY	1,445	0

This effort addressed the development of novel methods to desalinate seawater using gas hydrate crystals. This process uses the formation kinetics of gas hydrate crystals at the sea floor and the exclusion of salts from these hydrated crystals. The natural buoyancy of the formed crystals should allow them to rise in a vertical pipe extending from the sea surface. As the crystals rise and are exposed to reduced hydrostatic pressure they will melt creating a steady state column in which fresh water rises to the top.

	FY 2007	FY 2008
DIGITAL DIRECTED MANUFACTURING PROJECT	0	1,273

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This effort seeks to conduct research on the use of digital manufacturing technologies (DDM). This type of technology can produce complex parts in a fraction of the time required by conventional manufacturing processes. This effort will investigate and develop process capabilities for DDM of thermoplastics and metal alloy parts and will characterize the complete range of physical and mechanical properties of these parts.

	FY 2007	FY 2008
DURABILITY OF COMPOSITE MATERIALS AND STRUCTURES	1,096	1,589

FY 2007 Accomplishments - This effort addressed applied research on the durability characteristics of composite materials used in naval structures in severe marine environment. This research focus' on the effect of moisture and sea water on marine composites, including degradation processes. This research provides a better understanding of performance and degradation mechanisms of composite materials in marine environments, leading to advanced or new materials systems.

FY 2008 Plan - This effort supports Durability Of Composite Materials and Structures for Naval use applied research.

	FY 2007	FY 2008
ENVIRONMENTAL MICRO-BIOLOGICAL ENERGY HARVESTING	996	0

This research addressed concepts to better understand microbe-electrode interactions in order to improve the power output of microbial fuel cells and the effectiveness of electrode-based strategies for environmental restoration.

	FY 2007	FY 2008
FRICTION STIR WELDING	1,096	0

This effort addressed applied research on the feasibility of expanding Friction Stir Welding (FSW) technology beyond aluminum alloys to High Strength Low Alloy (HSLA) steels that are of interest to the Navy and to expand the fundamental understanding of the FSW process to other metals. The specific focus of this effort will be to demonstrate a continuous 60-foot FSW in HSLA steel, develop new tools to weld 3/8-inch thick plate,

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demonstrate travel speeds up to 12-inches per minute, develop zero tilt-angle tools to enhance shipyard applications, and improve 2-D and 3-D numerical modeling capabilities.

	FY 2007	FY 2008
LOW OBSERVABLE AIRCRAFT	1,464	0

This research developed durable, lightweight, polymeric-based conductive gap sealants for use on Navy fighter aircraft, utilizing novel carbon nanotube blends. Conductive gap sealants based on polymers loaded with carbon nanotubes offers the potential for significant improvements over current technology, specifically in aircraft weight savings.

	FY 2007	FY 2008
MAGNETIC RESONANCE IMAGING & MAGNETIC RESONANCE	996	0

This effort supported magnetic resonance imaging and magnetic resonance angiography for accurate diagnosis of TBI research.

	FY 2007	FY 2008
MAST-MOUNTED IN PORT VIDEO FORCE PROTECTION SURVEILLANCE SYSTEM	996	1,589

FY 2007 Accomplishments - This research supported mast-mounted in-port video force protection surveillance system research. This effort developed techniques for display, analysis and communication of target clips within the wide field of view imagery. A medium resolution 360 degree EO sensor was mounted on the mast of a boat and the imagery and watercraft tracks were successfully integrated into a land-based sensor network monitoring harbor traffic.

FY 2008 Plan – A very high resolution 360 degree EO imager and 360 degree IR imager will be developed and evaluated for its ability to provide wide area and long range video surveillance from watercraft and unmanned surface vessels for force, ship and harbor protection.

	FY 2007	FY 2008
MATERIALS AND COATINGS ENHANCEMENTS THROUGH HIGH PERFORMANCE	8,619	0

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This research investigated new polymer coatings and materials for naval ship and aircraft applications. This initiative included the design, development, and utilization of polymers for applications with passive response capabilities, including materials to detect changes in the environment and active response materials designed to exhibit or deter failure, infiltration, permeation, and tampering. This effort also focused on adaptive materials, stimuli-responsive polymeric films and coatings, self-healing materials, biologically and chemically active polymeric materials, polymeric membranes and films for control transport properties, and nanocomposite materials.

	FY 2007	FY 2008
MINIATURIZATION, SYSTEMIZATION OF SEMICONDUCTING METAL OXIDE	0	795

This effort supports miniaurization, systemization of semiconducting metal oxide.

	FY 2007	FY 2008
MISSION DEPLOYABLE SURVEILLANCE BIOMETRICS	0	1,589

This effort supports mission deployable surveillance biometrics.

	FY 2007	FY 2008
NANOTECHNOLOGY ENGINEER & MANUFACTURING OPERATION (NEMO)	0	795

This effort will initiate development of nanostructured smart coatings that can reduce corrosion, wear and fouling utilizing innovative resin chemistry and surface modification methods to extend the service life and reliability of Navy assets while reducing cost and environmental impacts.

	FY 2007	FY 2008
NANOTECHNOLOGY RESEARCH	0	3,974

This effort supports nanotechnology research.

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	FY 2007	FY 2008
NATIONAL CENTER FOR ADVANCED SECURE SYSTEMS RESEARCH (NCASSR)	4,881	0

This effort supported research in information assurance. New approaches in the area of security tools, cyber informatics, network sensors and supervisory control are being developed. This will benefit national information infrastructure and national security by providing means to deploy monitor assess and react to cyber events.

	FY 2007	FY 2008
NEUROBIOLOGICALLY INSPIRED COMPUTATIONAL ARCHITECTURES AND METHODOLOGIES	3,188	0

This research expanded the capabilities of the individual neural core systems special purpose processor (SPP) to achieve 4 times the bandwidth of the data. This initiative included research that increased programmability of the computing device SPP with an increased repertoire of synaptic rules. This research also extended the design of the SPP to multiple homogeneous platforms and to facilitate sensor.

	FY 2007	FY 2008
PARTNERSHIP SIMULATION LAB FOR MILITARY HEALTH	1,345	0

This research focused on the use of the rapid learning authoring tool, to author problem based medical cases including bioterrorism, combat wound, catastrophic events and significant hazards to provide an immense pool of diverse case scenarios accessible in the virtual environment.

	FY 2007	FY 2008
SENSORY SUBSTITUTION FOR WOUNDED SERVICE MEMBERS	3,984	0

This effort supported research that developed novel, non-invasive methods of sensory augmentation and replacement to permit wounded naval personnel who suffered sight or vestibular dysfunction resultant from exposure to blast or other combat trauma to regain some level of basic sensation that will allow them to interact with others and with the environment around them.

BUDGET ACTIVITY: 02
PROGRAM ELEMENT: 0602236N PROGRAM ELEMENT TITLE: WARFIGHTER SUSTAINMENT APPLIED RESEARCH
PROJECT TITLE: WARFIGHTER SUSTAINMENT APPLIED RESEARCH

	FY 2007	FY 2008
VIRTUAL CLINICAL LEARNING LAB AND CENTER OF EXCELLENCE (PULSE)	996	2,384

FY 2007 Accomplishments - This effort addressed the Virtual Clinical Learning Lab program and demonstrated personal computer-based technologies to enable acquisition and rehearsal of critical skills and knowledge for military and civilian healthcare professionals.

FY 2008 Plan - This effort supports the Virtual Clinical Learning Lab and Center of Excellence.

C. OTHER PROGRAM FUNDING SUMMARY - NAVY RELATED RDT&E:
PE 0308601N Modeling and Simulation Support
PE 0601103N University Research Initiatives
PE 0601152N In-House Laboratory Independent Research
PE 0601153N Defense Research Sciences
PE 0602123N Force Protection Applied Research
PE 0602435N Ocean Warfighting Environment Applied Research
PE 0602747N Undersea Warfare Applied Research
PE 0603236N Warfighter Sustainment Advanced Technology
PE 0603512N Carrier Systems Development
PE 0603640M USMC Advanced Technology Demonstration (ATD)
PE 0603721N Environmental Protection
PE 0603724N Navy Energy Program
PE 0603729N Warfighter Protection Advanced Technology
PE 0604561N SSN-21 Developments
PE 0604703N Personnel, Training, Simulation, and Human Factors
PE 0604771N Medical Development
PE 0605152N Studies and Analysis Support - Navy
PE 0708011N Industrial Preparedness

OTHER PROGRAM FUNDING SUMMARY - NON-NAVY RELATED RDT&E:
PE 0601102A Defense Research Sciences
PE 0602105A Materials Technology

BUDGET ACTIVITY: 02
PROGRAM ELEMENT: 0602236N PROGRAM ELEMENT TITLE: WARFIGHTER SUSTAINMENT APPLIED RESEARCH
PROJECT TITLE: WARFIGHTER SUSTAINMENT APPLIED RESEARCH

PE 0602211A Aviation Technology
PE 0602303A Missile Technology
PE 0602601A Combat Vehicle and Automotive Technology
PE 0602705A Electronics and Electronic Devices
PE 0602709A Night Vision Technology
PE 0602716A Human Factors Engineering Technology
PE 0602785A Manpower/Personnel/Training Technology
PE 0602786A Warfighter Technology
PE 0602787A Medical Technology
PE 0603002A Medical Advanced Technology
PE 0603003A Aviation Advanced Technology
PE 0603716D8Z Strategic Environmental Research Program
PE 0603851D8Z Environmental Security Technical Certification Program
PE 0601102F Defense Research Sciences
PE 0602102F Materials
PE 0602202F Human Effectiveness Applied Research
PE 0602203F Aerospace Propulsion
PE 0602204F Aerospace Sensors
PE 0602702F Command Control and Communications
PE 0603216F Aerospace Propulsion and Power Technology

D. ACQUISITION STRATEGY:
Not applicable.

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

BUDGET ACTIVITY: 02
PROGRAM ELEMENT: 0602271N
PROGRAM ELEMENT TITLE: RF SYSTEMS APPLIED RESEARCH

COST: (Dollars in Thousands)

Project Number & Title	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
RF SYSTEMS APPLIED RESEARCH	52,059	52,529	54,830	49,764	55,626	60,296	64,854

A. MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: The efforts described in this Program Element (PE) are based on investment directions as defined in the Naval S&T Strategic Plan approved by the S&T Corporate Board (Jan 2007). This strategy is based on needs and capabilities from Navy and Marine Corps guidance and input from the Naval Research Enterprise (NRE) stakeholders (including the Naval enterprises, the combatant commands, the Chief of Naval Operations (CNO), and Headquarters Marine Corps). It provides the vision and key objectives for the essential science and technology efforts that will enable the continued supremacy of U.S. Naval forces in the 21st century. The Strategy focuses and aligns Naval S&T with Naval missions and future capability needs that address the complex challenges presented by both rising peer competitors and irregular/asymmetric warfare.

The Radio Frequency (RF) Systems Applied Research Program addresses technology opportunities associated with Naval platform opportunities for new capabilities in RF Surveillance, RF Electronic Warfare, Navigation, RF Solid State Power Amplifiers, RF Vacuum Electronics Power Amplifiers, and Supporting RF Electronics Technologies. The program supports development of technologies to enable capabilities in Missile Defense, Directed Energy, Platform Protection (including Electric Warship), Time Critical Strike, and Information Distribution. This program directly supports the Department of Defense Joint Warfighter Plan and the Defense Technology Area Plans. Activities and efforts within this Program have attributes that focus on enhancing the affordability of warfighting systems. The program also provides for technology efforts to maintain proactive connectivity and collaboration between Department of the Navy (DON) Science and Technology (S&T) and Joint, Navy, and Marine Corps commands worldwide. This PE supports the Future Naval Capabilities (FNC) Programs in Communications Technology, Supporting Technologies, and RF Electronic Warfare (EW) Technology.

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

BUDGET ACTIVITY: 02
PROGRAM ELEMENT: 0602271N
PROGRAM ELEMENT TITLE: RF SYSTEMS APPLIED RESEARCH

B. PROGRAM CHANGE SUMMARY:

	FY 2007	FY 2008	FY 2009
FY 2008/FY 2009 President's Budget Submission	50,327	45,451	45,692
Congressional Action	0	7,800	0
Congressional Undistributed Reductions/Rescissions	0	-338	0
Execution Adjustments	2,893	0	0
Program Adjustments	-486	0	9,382
Rate Adjustments	0	0	-244
SBIR Assessment	-675	-384	0
FY 2009 President's Budget Submission	52,059	52,529	54,830

PROGRAM CHANGE SUMMARY EXPLANATION:
Technical: Not applicable.

Schedule: Not applicable.

C. OTHER PROGRAM FUNDING SUMMARY:
Not applicable.

D. ACQUISITION STRATEGY:
Not applicable.

E. PERFORMANCE METRICS:
Performance Metrics are discussed within the R-2a.

BUDGET ACTIVITY: 02
PROGRAM ELEMENT: 0602271N PROGRAM ELEMENT TITLE: RF SYSTEMS APPLIED RESEARCH
PROJECT TITLE: RF SYSTEMS APPLIED RESEARCH

COST: (Dollars in Thousands)

Project Number & Title	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
RF SYSTEMS APPLIED RESEARCH	52,059	52,529	54,830	49,764	55,626	60,296	64,854

A. MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: This project addresses technology opportunities associated with Naval platform opportunities for new capabilities in Radar Frequency (RF) Surveillance, RF Electronic Warfare, Communications, Navigation, RF Solid State Power Amplifiers, Vacuum Electronics Power Amplifiers, and Supporting RF Electronics Technologies. The project supports development of technologies to enable capabilities in Missile Defense, Directed Energy, Platform Protection (including Electric Warship), Time Critical Strike, and Information Distribution. This program directly supports the Department of Defense Joint Warfighter Plan and the Defense Technology Area Plans. Activities and efforts within this Program have attributes that focus on enhancing the affordability of warfighting systems. The project also provides for technology efforts to maintain proactive connectivity and collaboration between Department of the Navy (DON) Science and Technology (S&T) and Joint, Navy, and Marine Corps commands worldwide.

B. ACCOMPLISHMENTS/PLANNED PROGRAM:

	FY 2007	FY 2008	FY 2009
ELECTRONICS AND COMMUNICATIONS TECHNOLOGIES	10,673	11,654	14,210

This activity provides technologies developed under the Future Naval Capabilities (FNC) Program; specifically the Multi-Source Intelligence, Surveillance, and Reconnaissance (ISR) to the Warfighter and the Advanced Electronic Sensor Systems. Emphasis is placed on the development of Electronic Warfare, Multi-Function and advanced multifunction RF and microwave electronic components. Included are the development of capabilities to increase the effectiveness in countering a broad range of threats from anti-ship missiles, and increasing the overall real time situational awareness of operational forces through the detection and processing of RF signals designed with low probability of detection characteristics. The electronics components are developed, optimized and demonstrated in component chains that must meet size, weight and power requirements. These component technologies will form the basis of new multifunction modules to help support these functions.

BUDGET ACTIVITY: 02
PROGRAM ELEMENT: 0602271N PROGRAM ELEMENT TITLE: RF SYSTEMS APPLIED RESEARCH
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The funding profile in FY 2007 reflects the reorganization of Future Naval Capabilities (FNC) Program investments into Enabling Capabilities (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: Multi-Source ISR to the Warfighter; Advanced Electronic Sensor Systems for Missile Defense; Affordable Electronically Scanned Array Technology; and low cost over the horizon communications.

The increase from FY 2008 to FY 2009 is due to increased investment in FY 2008 initiated FNC EC efforts for Next Generation Airborne Electronic Attack; Long Range Detection and Tracking; Low Cost Over the Horizon Communication, SATCOM and Line of Sight (LOS) Apertures; and Affordable Electronically Scanned Array Technology for Next Generation Naval Platforms.

FY 2007 Accomplishments:

- Continued highly integrated and affordable receiver (RX) component optimization supporting Advanced Multifunctional Radio Frequency Concept (AMRFC)/Multifunction Electronic Warfare (MFEW). This includes the optimization of entire component chains of Low Noise Amplifiers (LNA's), Analog-to-Digital Converters (ADC's), tunable filters, channelizers, radiating elements specific to the MFEW receiver, and 2-D electronically scanned arrays. Objectives are to reduce cost to 1/3 of current multi-function RF systems for a minimum of 6-18 GHz bandwidth.
- Continued the development of Radio Frequency (RF) technologies that support advances in receiver architecture, antenna performance, subsystem miniaturization, decoys and advanced signal processing.
- Continued component chain optimization for AMRFC MFEW transmitter technology with a target of meeting FY11 transition target date.
- Continued establishment of an industrial standard appropriate for the demonstration of >1E6 hour lifetime for RF life testing of Gallium Nitride (GaN) based Millimeter-Wave Integrated Circuits (MMICs) and devices, and began to apply this standard to state-of-the-art (SOA) MMICs and devices.
- Completed the EA Techniques to Counter Advanced Threats effort by development of 100% of the EA technique modules for counter terminal and counter targeting.
- Completed initial phase of GaN High Electron Mobility Transistor (HEMT) life testing with demonstration of greater than 1E4 hour lifetimes for 175 degree channel temperatures.
- Completed the Applied Research Phase (6.2) of the Shipboard Electro-optic/Infrared (EO/IR) Closed Loop Self Protection effort by developing additional jam codes and tracking algorithms to be used during final at-sea

testing of the Shipboard Integrated Electro-optic Defense System (SHIELDS) hardware in FY 2008. This effort previously funded in PE 0602123N.
- Completed MFEW program for DD(X), compliant to new DODI 5000.2 acquisition rules as the Technology Development Phase, to build an EW ADM for the DD(X) program using the technology from the AMRFC testbed.
- Initiated demonstration packaging techniques to provide cost reduction and affordability for modules, including component architecture, packaging, and scale of integration optimization.

FY 2008 Plans:

- Continue all efforts of FY 2007 less those noted as completed above.
- Complete highly integrated and affordable receiver (RX) component optimization supporting multifunction electronics and array technologies. This includes the optimization of entire component chains of LNA, ADC's, tunable filters, channelizers, radiating elements specific to the MFEW receiver, and 2-D electronically scanned arrays. Objectives are to reduce cost to 1/3 of current multi-function RF systems for a minimum of 6-18 GHz bandwidth.
- Initiate the Next Generation Airborne Electronic Attack effort by conducting a requirements validation and technology assessment review.
- Initiate development of technology to provide a set of apertures (Line of Sight, Satellite Communications) and link electronics that are suitable for broad Naval applications.
- Initiate development of technology to provide open, programmable core terminal components applicable to multiple platforms to include airborne applications and Marine vehicles.
- Initiate design and development of a X-Band Digital Array Radar.
- Initiate development of Maritime Classification and Identification modes for APY-6.
- Initiate effort on Affordable Electronically Scanned Array Technology to include electronics component technologies supporting S-band radar, X-band radar and electronic attack.

FY 2009 Plans:

- Continue all efforts of FY 2008 less those noted as completed above.
- Initiate the Enhanced Nulka Payload FNC effort by conducting a Transmitter and Receiver Technology Trade Space study.
- Initiate the Enhanced Surface Electronic Warfare Improvement Program (SEWIP) Transmitter FNC effort by conducting a Transmitter and Cooling Technology Trade Space study.

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PROGRAM ELEMENT: 0602271N PROGRAM ELEMENT TITLE: RF SYSTEMS APPLIED RESEARCH
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	FY 2007	FY 2008	FY 2009
RF ELECTRONIC WARFARE TECHNOLOGY	9,764	10,226	16,564

This activity supports technologies that enable the development of affordable, effective and robust Electronic Warfare (EW) systems that will increase the operational effectiveness and survivability of U.S. Naval units. Emphasis is placed on non-optical passive sensors and active and passive Radio Frequency Countermeasure (RFCM) systems that exploit and counter a broad range of electromagnetic threats. The focus is on maintaining near perfect real-time knowledge of the enemy; countering the threat of missiles to deployed Naval forces; precision identification and location of threat emitters; and development of technologies that have broad application across multiple disciplines within the EW mission area.

The increase from FY 2008 to FY 2009 is due to initiation of the following efforts: Antennas from VHF to THz, Cueing Receiver for Faster EA Response Management, the Digital Directional Correlator, and research for development of power amplifiers for future RF systems.

FY 2007 Accomplishments:

- Continued technology development in the areas of Tactical Aircraft, Surface Ships, Submarines, UAVs, and EW Enabling Technology.
- Continued the development of an integrated Digital EW, Electronic Attack (EA) and Electronic Support (ES) suite using a tightly coupled common architecture so that there is a synergistic coupling between the sub-functions of ES and EA. (NRL)
- Continued development of RF technologies that support advances in receiver architecture, antenna performance, subsystem miniaturization, decoys and advanced signal processing.
- Continued the EW Tactical Decision Algorithms (TDA) for Satellite Communications effort by evaluating two atmospheric propagation models to assist in visualizing the impact of satellite communications on future planning and tactics.
- Continued the investigation of Millimeter Wave (MMW) technologies to support the development of off board and onboard countermeasures.
- Continued the development and demonstration of a compact EA technology for tactical unmanned vehicle systems to counter wideband, spread spectrum active electronically steered array radars. (NRL)
- Completed the Autonomous Classification of Low Probability of Intercept (LPI) Radar Emitters effort by testing and evaluating feature extraction algorithms on actual digitized LPI radar signals.

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- Completed the Advanced Pulse De-interleaving effort by lab and field testing of the de-interleaving algorithms with an Electronic Support Enhancement (ESE) processor used for the SEWIP.
- Completed the Unmanned Vehicle Integrated Electronic Warfare Payload (UVIEWP) effort by conducting a multiplatform demonstration of an autonomous UVIEWP escort constellation that provides countertargeting and countersurveillance for expeditionary force ships.
- Completed the Specific Emitter Identification (SEI) Capabilities Extension effort with implementation of advanced SEI algorithms into Windows based SEI software and SEI hardware using a flexible architecture employing IFD-120 Field Programmable Gate Arrays (FPGA) with 3 million gates.
- Completed the development of a RF detection process at MMW using photonics. (NRL)
- Initiated the Ka/W Band Miniature Sensor Development effort with Ka/W Band architecture device selection and downconverter subsystem conceptual design.
- Initiated the Countermeasures to Anti-Helicopter Mines (AHM) effort by reviewing current and previous Army efforts and developing initial countermeasure concepts.
- Initiated the Compact Electro-Magnetic (EM) Source for Improvised Explosive Device (IED) and Engine Defeat effort by measuring the RF impedances of the materials and comparing the results with conventional theory.
- Initiated the design and development of a miniature coherent transponder to counter modern threats using advanced electronic protection techniques. (NRL)
- Initiated the development of a series of kinetically driven devices to generate RF. (NRL)

FY 2008 Plans:

- Continue all efforts of FY 2007 less those noted as completed above.
- Complete the development of an integrated Digital EW, EA and ES suite using a tightly coupled common architecture so that there is a synergistic coupling between the sub-functions of ES and EA. (NRL)
- Complete the development and demonstration of a compact EA technology for tactical unmanned vehicle systems to counter wideband, spread spectrum active electronically steered array radars. (NRL)
- Complete the Ka/W Band Miniature Sensor Development effort by testing and delivering a prototype sensor system.
- Complete the Countermeasures to Anti-Helicopter Mines effort by conducting a field test of the system against AHM or simulators.
- Complete the Compact EM Source for IED and Engine Defeat effort by conducting a field test of an advanced source.
- Initiate the development of a novel approach to near real time active digital augmentation to improve the isolation of shipboard EW systems. (NRL)

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FY 2009 Plans:

- Continue all efforts of FY 2008 less those noted as completed above.
- Complete the design and development of a miniature coherent transponder to counter modern threats using advanced electronic protection techniques. (NRL)
- Complete the development of a series of kinetically driven devices to generate RF. (NRL)
- Initiate the Miniature 2-70 GHz Integrated Optical Channelizer effort by starting Phase I and specifications development.
- Initiate the Antennas from VHF to THz effort through development of the log-periodic antenna.
- Initiate the Cueing Receiver for Faster EA Response Management effort by initiating system design.
- Initiate the Digital Directional Correlator effort by initiating by building and refining a more complete simulation of the correlator and determining via simulation and analysis the primary characteristics required for the system.
- Initiate the Exploiting Non-Traditional Signals Using a Photonics Based Signal Processor effort by performing proof-of-concept demonstrations for the three main modes of operation for the spatial spectral optical materials when used for Electronic Support Measures (ESM) applications.
- Initiate research for development of power amplifiers for future RF systems.

	FY 2007	FY 2008	FY 2009
RF SURVEILLANCE TECHNOLOGY	11,792	7,834	8,640

RF Surveillance emphasizes non-optical advanced sensor and sensor processing systems for continuous high volume theater-wide air and surface surveillance, battle group surveillance, real time reconnaissance and ship defense. Major technology goals include long-range target detection and discrimination, Target Identification (ID) and fire control quality target tracking in adverse weather, background clutter and electronic countermeasure environments.

Funding decreases from FY 2007 to FY 2008 are due to reduced level of investment to fund higher priority requirements identified as newly initiated efforts in RF Supporting Technologies R2 activity associated with NRL Base program.

Funding increases from FY 2008 to FY 2009 associated with newly initiated FNC effort to develop an Affordable Common Radar Architecture for surface ships.

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FY 2007 Accomplishments:

- Continued the Horizon Extension Sensor System (HESS) project with form factored integration of High Power Amplifier (HPA) and development of a Silicon Germanium (SiGe) downconverter in support of HESS and Digital Array Radar (DAR) efforts.
- Continued development efforts to demonstrate signal processing, waveform generation and one dimensional active phased array apertures for Harbor Surveillance and situational awareness.
- Continued demonstrations of advanced Non-Cooperative Target Recognition (NCTR) algorithms in congested harbor environments.
- Continued the design and development of a field probe and radome assembly for a real-time calibration technique that will utilize an optical-to-RF distribution network to inject a low-level RF Continuous Wave (CW) signal into each element of a phased array. (NRL)
- Continued an element level DAR effort on down conversion and digital beam formers.
- Continued a program to develop and demonstrate methodologies that provide small threat radar detection in the presence of large masking radar returns using an Adaptive Pulse Compression technique. (NRL)
- Completed the broadband-array effort by demonstrating a dual polarized array with coincident phase center and true time delay beam steering. (NRL)
- Completed the development and testing of reconfigurable/tunable Electromagnetic Bandgap (EBG) structures. (NRL)
- Initiated the assessment of vulnerabilities of modern side lobe canceling (SLC) algorithms to adversary jamming and develop mitigating SLC design improvements. (NRL)

FY 2008 Plans:

- Continue all efforts of FY 2007 less those noted as completed above.
- Complete the design and development of a field probe and radome assembly for a real-time calibration technique that will utilize an optical-to-RF distribution network to inject a low-level RF CW signal into each element of a phased array. Demonstrate the polarization properties of a wideband probe using a zero-bias optical detector. (NRL)

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FY 2009 Plans:

- Continue all efforts of FY 2008 less those noted as completed above.
- Complete a program to develop and demonstrate methodologies that provide small threat radar detection in the presence of large masking radar returns using an Adaptive Pulse Compression technique. (NRL)
- Initiate investigation of means of optimally combining mensuration, classification, and non-cooperative target recognition of surface craft.
- Initiate the requirements analysis and trade studies of an Advanced Common Radar Architecture.

	FY 2007	FY 2008	FY 2009
SUPPORTING TECHNOLOGIES	2,688	4,571	5,232

Supporting Technologies provide for the radiation, reception, signal control and processing of Very High Frequency (VHF), Ultra High Frequency (UHF), Micro Wave (MW), and Millimeter Wave (MMW) power for Navy all-weather radar, surveillance, reconnaissance, Electronic Attack (EA), communications, smart weapons, networked sensors, and precision time and navigation systems. Supporting Technologies is characterized by research outside of RF amplifiers, with emphasis in superconducting electronics and nanoelectronics technology. The technology developed which includes nanotechnology cannot, for the most part, be obtained through commercial off the shelf systems (COTS) as a result of the requirements placed on power, frequency, linearity, bandwidth, weight, and size.

The increase from FY 2007 to FY 2008 is due to increased level of investment associated with RF Solid State Devices, Enhanced Electronic Capabilities and Mitigation Technologies, RF Systems Technology for Surface Platforms, and Electronic and Electro-Optic Materials at the Naval Research Laboratory (NRL).

The increase from FY 2008 to FY 2009 is associated with initiation of Nanometer Scale Electronic Devices and Sensors research at NRL.

FY 2007 Accomplishments:

- Continued effort to develop carbon nanotube sensors for trace-level vapor detection of explosives, chemical agents, and toxic industrial chemicals. (NRL)
- Continued research to enable growth, fabrication, and testing of 6.2-6.3 Angstrom High Electron Mobility Transistors (HEMTS) with alloy channels and barriers.(NRL)

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- Continued development of 6.2-6.3 Angstrom Heterojunction Bipolar Transistor (HBT) operating at microwave frequencies. (NRL)
- Continued the development of analysis/modeling infrastructure and prototype improvement concepts for electronic countermeasures and counter-targeting against RF surveillance threats. (NRL)
- Continued the demonstration of a current recycling technology for superconducting digital circuits that is mature enough to yield a four fold reduction of bias current.
- Completed the proof of feasibility of hybrid Nb Josephson Junction/InP HBTs ADC modulator circuits operating properly at 4K and with 10 GHz clock when the hot InP transistors are <3mm away from the active Josephson junctions.
- Initiated demonstration of an improved signal processing technique that can be applied to state-of-the-art L, S, X, and Ka-band superconducting bandpass ADCs to realize an improvement in dynamic range of greater than 6dB.
- Initiated demonstration that arrays of Superconducting Quantum Inteference Devices (SQUIDs) having intentionally dissimilar loop area ("SQIF") can act as wideband (1MHz - 1GHz) trans-impedance amplifiers having large (>100 dB) linear dynamic range and provide the basis of cm scale antennas for these frequencies.

FY 2008 Plans:

- Continue all efforts of FY 2007 less those noted as completed above.
- Complete the development of analysis/modeling infrastructure and prototype improvement concepts for electronic countermeasures and counter-targeting against RF surveillance threats. (NRL)
- Initiate the development to assess the electronic protection capability of modern missiles using advanced processing and investigate the improvements needed to restore countermeasures effectiveness. (NRL)
- Initiate the development of techniques to identify and exploit the processing vulnerability of passive location systems. (NRL)
- Initiate development of Sb-based diodes and multipliers for the exploitation of the frequency spectrum from 94-1000 GHz. (NRL)
- Initiate development of an integrated tunable frequency selective and low noise integrated module. (NRL)

FY 2009 Plans:

- Continue all efforts of FY 2008 less those noted as completed above.
- Complete development of 6.2-6.3 Angstrom HBT operating at microwave frequencies. (NRL)
- Initiate development of next generation superconducting front-end receiver component critical to successful

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delivery of superior system performance.
- Initiate research supporting development of Nanometer Scale Electronic Devices and Sensors. (NRL)

	FY 2007	FY 2008	FY 2009
RF SOLID STATE POWER AMPLIFIERS	4,357	4,461	4,322

This activity provides for the generation of VHF, UHF, MW, and MMW power amplifiers for Navy all-weather radar, surveillance, reconnaissance, electronic attack, communications, and smart weapons systems. The technology developed cannot, for the most part, be obtained through Commercial-Off-the-Shelf (COTS) as a result of the simultaneous requirements placed on power, frequency, linearity, bandwidth, weight, and size.

FY 2007 Accomplishments:

- Continued development of MMW Aluminum Gallium Nitride/Gallium Nitride (AlGaN/GaN) wide bandgap High Electron Mobility Transistor (HEMT).
- Continued development of AlGaN HEMT broadband amplifiers for electronic warfare decoys with increased powers and efficiency than achieved with conventional solid state amplifiers.
- Continued the development of ultra-compact, low-loss ridge-waveguide frequency multiplexer. (NRL)
- Continued Field-Plate GaN HEMT Device development for MMW amplifiers.
- Continued high-efficiency microwave GaN HEMT amplifier development.
- Continued development of Wide Bandgap radiation detectors for celestial and nuclear monitoring applications. (NRL)
- Initiated work on GaN MMW components at >44 GHz to allow for Extremely High Frequency (EHF) SATCOM insertion and other MMW applications spanning to 95GHz.
- Initiated the expansion of scope of the GaN MMW device program.
- Initiated component development in support of multifunctional electronic warfare.

FY 2008 Plans:

- Continue all efforts of FY 2007.
- Complete and transition Wide Bandgap radiation detectors for celestial and nuclear monitoring applications. (NRL)
- Initiate transition GaN high-efficiency microwave HEMT amplifiers to radar and communications applications.
- Initiate development of MMW High efficiency Amplifiers for Satellite communications and compact high

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efficiency MMW sources for active denial systems.
- Initiate development of high-efficiency broadband GaN HEMT amplifiers for electronic warfare applications.
- Initiate Sub MMW GaN Device technology for communications, target identification and high speed data processing.
- Initiate development of high-current density cathodes using diamond for generating spatially-distributed beams. (NRL)

FY 2009 Plans:

- Continue all efforts of FY 2008 less those noted as completed above.
- Complete high efficiency microwave GaN HEMT amplifier development.
- Complete MMW field plate GaN HEMT development.
- Initiate mixed-signal GaN Monolithic Microwave Integrated Circuit (MMIC) technology development.
- Initiate sub MMW GaN Amplifier development.

	FY 2007	FY 2008	FY 2009
RF VACUUM ELECTRONICS POWER AMPLIFIERS	3,419	3,147	2,908

This activity provides for the development of MW, MMW, sub-millimeter wave power amplifiers for use in Naval all-weather radar, surveillance, reconnaissance, electronic attack, and communications systems. The technology developed cannot, for the most part, be obtained through commercial off the shelf (COTS) as a result of the simultaneous requirements placed on power, frequency, bandwidth, weight, and size. Responding to strong interests from the various user communities, efforts are focused on the development of technologies for high-data-rate communications and high-power high-frequency radar applications. Technologies include techniques for power and efficiency enhancement of millimeter-wave amplifiers, multiple-beam amplifiers, notably the Multi-Beam Klystron (MBK), and physics-based modeling and simulation.

FY 2007 Accomplishments:

- Continued research on 3D modeling of beam transport with quadrapole magnetic focusing for high power Ka band Traveling Wave Tube (TWT). (NRL)
- Continued research effort on generation and transport of sheet beam with 5:1 aspect ratio. (NRL)
- Continued effort on the gun/collector code MICHELLE with improved interface with the large signal codes CHRISTINE and Telegrapher's Equation Solution for Linear Amplifiers (TESLA).

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- Completed the effort to identify and test algorithms to implement in the TESLA design code for broadband single-beam klystron development.
- Completed the effort on the broadband (~ 6%) S-band Multiple Beam Klystron (MBK) performance. (NRL)
- Completed the effort on the release of the gun/collector code MICHELLE v4.0 with improved Graphical User Interface (GUI) and postprocessor.
- Initiated the effort on developing algorithms and models in large signal code TESLA for multiple beam klystrons.
- Initiated the effort on developing algorithms and models in 1D Christine_CC for coupled cavity TWT application to the high power, MMW regime.
- Initiated the effort on the development and implementation of models and algorithms for electron emission physics in gun/collector code MICHELLE.
- Initiated the effort on developing and implementing models for multi-gap cavity coupling in TESLA for klystron.

FY 2008 Plans:

- Continue all efforts of FY 2007 less those noted as completed above.
- Complete effort on experimental demonstration of beam propagation with quadrapole magnetic focusing that will result in a factor of 3 reduction in magnet volume and weight compared to Permanent Periodic Magnet (PPM) focusing system. (NRL)
- Complete the effort on the development and implementation of models and algorithms for electron emission physics in gun/collector code MICHELLE.
- Complete the effort on developing algorithms and models in 1D CHRISTINE_CC for coupled cavity TWT's.
- Initiate the effort on the development and implementation of models and algorithms in the large signal CHRISTINE 3D code to create capabilities for an end-to-end analysis of a Helix TWT.
- Initiate the effort on the development and implementation of models and algorithms in a large signal klystron code to model sheet electron beam – wave interaction.
- Initiate the effort on developing models and algorithms based on generalized model expansion (GENOME) techniques for large signal modeling of extended interaction klystrons (EIK).

FY 2009 Plans:

- Continue all efforts of FY 2008 less those noted as completed above.
- Complete the effort on developing and implementing models for multi-gap cavity coupling in TESLA for

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klystron.
- Complete research effort on generation and transport of sheet beam with 5:1 aspect ratio. (NRL)
- Initiate the effort on the development and implementation of models and algorithms in a large signal TWT code to model sheet electron beam – wave interaction.
- Initiate the effort on the development of nonlinear stability analysis for broadband CC-TWT.

	FY 2007	FY 2008	FY 2009
RF NAVIGATION TECHNOLOGY	1,496	2,885	2,954

This activity develops key navigation technologies for Naval Battle Groups, Aircraft, Unmanned Air Vehicles (UAVs), Unmanned Underwater Vehicles (UUVs), Ships, Submarines and other Navy vehicles and platforms. This activity applies leading-edge Science and Technology (S&T) to enhance Global Positioning System (GPS) capabilities in order to make GPS more resistant to noise and jamming. Much of the near-term effort concerns the development of antennas with special features.

Funding increases from FY 2007 to FY 2008 are due to initiation of multiple navigation research efforts in FY 2008 while continuing all prior year initiatives based on overall increased emphasis and level of investment in RF Navigation Technology research.

FY 2007 Accomplishments:

- Continued the development of GPS Anti-Jam (AJ) Antenna Electronics (AE) with low-cost analog processor technique for Direction of Arrival (DOA) estimation and nulling (up to 60dB nulling capability).
- Completed the design and development of a Space-Frequency Adaptive Processing (SFAP) processor for GPS AJ antenna to improve receiver AJ performance by adding channelization to the existing Code Gated Maximum Likelihood (CGML) receiver.
- Completed the evaluation of the effectiveness of the Poly-Channelized CGML technique by simulation and build it in software radios (up to 8 jammers with 4 array elements).
- Initiated the development of SFAP for GPS Anti-Spoofer using the existing CGML receiver.
- Initiated the Deeply Integrated Navigation Grade GPS Inertial System project.
- Initiated the Improved GPS/Inertial Navigation System (INS) Integration using Particle Filter Accelerometer project.
- Initiated the Advanced Spoofer Mitigation and Geolocation through Spoofer Tracking project.
- Initiated the development of GPS Anti-Spoofer Test Facility at NRL.

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- Initiated the installation of GPS simulator at NRL with GAS-1 and other antennas in an anechoic chamber and conduct tests for four GPS AJ systems.

FY 2008 Plans:

- Continue all efforts of FY 2007 less those noted as completed above.
- Initiate the Self-Locked Intra-Cavity Alkali Vapor Laser (ICAL) Opto-Atomic Clock project.
- Initiate the Precise and Accurate Stamping for Time Transfer Applications (PASTTA)project.
- Initiate the GPS Anti-spoofer mitigation by Direction of Arrival (DOA) project.
- Initiate the Micro Fiber Optical Gyro (MFOG) project.
- Initiate the Acquisition Problem in Deeply Integrated GPS Systems project.
- Initiate the Ship's Passive Inertial Navigation System (SPINS) project.

FY 2009 Plans:

- Continue all efforts of FY 2008.
- Complete the Improved GPS/INS Integration using a Particle Filter Accelerator project.
- Complete the Advanced Spoofer Mitigation and Geolocation through Spoofer Tracking project.
- Complete the development of GPS Anti-Spoofer Test Facility at NRL.
- Complete the installation of GPS simulator at NRL with GAS-1 and other antennas in an anechoic chamber and conduct tests for four GPS AJ systems.
- Complete the Precise and Accurate Stamping for Time Transfer Applications (PASTTA) project.
- Complete the GPS Anti-spoofer mitigation by Direction of Arrival (DOA) project.
- Complete the Acquisition Problem in Deeply Integrated GPS Systems project.
- Initiate the GPS Dual Receiver Hot Start Acquisition (DRHSA) project.
- Initiate the GPS Threat Assessment project at NRL.
- Initiate the Sonar Aided Inertial Navigation Technology (SAINT) project.
- Initiate the Multi-Frequency Continuously Operating GPS Anomalous Event Monitor (GAEM) project.
- Initiate the Evolved Global Navigation Satellite System (GNSS) Signal Monitoring Receiver Element project.

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CONGRESSIONAL PLUS-UPS:

	FY 2007	FY 2008
ADVANCED MICROWAVE FERRITE RESEARCH PHASE IV	996	0

Development of hexagonal ferrite films has concluded with significantly decreased losses and higher magnetic coercivity for RF device applications and performance. Microwave loss and insertion characterization has also ended with significant materials improvements. Microwave radar circuit tuning has completed, and planar MMW antenna compatible with RF system receivers is being transitioned to defense contractors.

	FY 2007	FY 2008
DOD REPARATIVE MEDICINE INITIATIVE	994	0

This effort supported the DoD Reparative Medicine Initiative.

	FY 2007	FY 2008
GALLIUM NITRIDE RF POWER TECHNOLOGY	995	1,986

FY 2007 - A comprehensive statistical analysis of fabrication process parameters and device test parameters was undertaken to advance the device reliability in discrete GaN HEMT transistor devices applicable to military communication systems such as the Joint Tactical Radio System (JTRS) and S-band RF systems. Test devices for evaluation were delivered to NRL.

FY 2008 – The activities related to the improvement in device reliability will continue, and the incorporation of Gallium Nitride discrete devices into high reliability (Hi-Rel) packaging process will be started. High reliability packaged parts will be provided to NRL for testing and evaluation.

	FY 2007	FY 2008
MICROWAVE FERRITES AND MULTIFUNCTIONAL INTEGRATED CIRCUITS	0	795

Thin film epitaxial growth of complex oxide structures involving magnetic ions will be initiated. Magnetic properties of resulting ferrites will be assessed for microwave passive element compatibility.

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	FY 2007	FY 2008
NATIONAL INITIATIVES FOR APPLICATIONS OF MULTIFUNCTIONAL MATERIALS	0	1,591

A crystal growth facility will be established at the University of Texas with the capability of growing thin oxide films with in-situ real-time surface characterization. A process for growing SrTiO3 on Si as a virtual substrate for growth of functional oxides will then be developed. Figures of performance merit of these artificial structures, of interest for Navy's next generation sensors and RF applications, will be assessed.

	FY 2007	FY 2008
NOTRE DAME CENTER FOR THE ENGINEERING OF OXIDE NITRIDE STRUCTURES (CEONS)	1,297	1,591

FY 2007 – Procured equipment and materials and prepared facility for the preparation, characterization and application of monolithically integrated passive device elements in Gallium Nitride (GaN) RF circuits. Initial GaN RF experiments were performed.

FY 2008 - The prototype test deposition system will be delivered, installed and calibrated. Initial growths of Oxide thin films from metal organic sources will be initiated. A full scale molecular beam epitaxy (MBE) system for oxide hetero-junctions formation and investigation will be designed and acquired.

	FY 2007	FY 2008
PACIFIC THEATER DATA FUSION TESTBED	1,596	0

The deliverables included a demonstration and final report of an AEGIS radar electro-optic real-time fusion algorithm.

	FY 2007	FY 2008
REPARATIVE CORE MEDICINE	996	993

FY 2007 – This effort supported research that helped develop a methodology for the production of blood platelets from stem cells. The use of stem cells will provide a defined, pathogen-free, source of platelets

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for use in controlling hemorrhage in combat casualties.

FY 2008 - This effort is to develop the methods to permit the production of safe functioning blood cells for transfusion, eliminating the need for human donors of blood.

	FY 2007	FY 2008
SILICON CARBIDE MOSFETS FOR ELECTRIC POWER SYSTEMS	996	0

Specified and developed Silicon Carbide MOSFET devices and circuits to enable on board power conversion (for platforms such as towed decoys) that can utilize 600-1000V power feeds for 24-48 volt applications. Devices for testing and development of prototype power converters were delivered to NRL.

	FY 2007	FY 2008
ULTRA STABLE COHERENT LASER	0	795

This effort supports Ultra Stable Coherent Laser research.

C. OTHER PROGRAM FUNDING SUMMARY - NAVY RELATED RDT&E:
PE 0601153N Defense Research Sciences
PE 0602114N Power Projection Applied Research
PE 0602123N Force Protection Applied Research
PE 0603114N Power Projection Advanced Technology
PE 0603123N Force Protection Advanced Technology
PE 0603271N RF Systems Advanced Technology

OTHER PROGRAM FUNDING SUMMARY - NON-NAVY RELATED RDT&E:
PE 0601102A Defense Research Sciences
PE 0602716E Electronics Technology
PE 0601102F Defense Research Sciences
PE 0602204F Aerospace Sensors
PE 0602702F Command Control and Communications

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D. ACQUISITION STRATEGY:
Not applicable.

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

BUDGET ACTIVITY: 02
PROGRAM ELEMENT: 0602435N
PROGRAM ELEMENT TITLE: OCEAN WARFIGHTING ENVIRONMENT APPLIED RESEARCH

COST: (Dollars in Thousands)

Project Number & Title	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
OCEAN WARFIGHTING ENVIRONMENT APPLIED RESEARCH	56,462	53,967	47,278	51,422	52,000	52,592	53,193

A. MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: The efforts described in this Program Element (PE) are based on investment directions as defined in the Naval S&T Strategic Plan approved by the S&T Corporate Board (Jan 2007). This strategy is based on needs and capabilities from Navy and Marine Corps guidance and input from the Naval Research Enterprise (NRE) stakeholders (including the Naval enterprises, the combatant commands, the Chief of Naval Operations (CNO), and Headquarters Marine Corps). It provides the vision and key objectives for the essential science and technology efforts that will enable the continued supremacy of U.S. Naval forces in the 21st century. The Strategy focuses and aligns Naval S&T with Naval missions and future capability needs that address the complex challenges presented by both rising peer competitors and irregular/asymmetric warfare.

This PE provides the unique, fundamental programmatic instrument by which basic research on the natural environment is transformed into technological developments that provide new or enhanced warfare capabilities for the Battlespace Environment (BSE). The objectives of this program are met through measuring, analyzing, modeling and simulating, and applying environmental factors affecting naval material and operations in the BSE. This program provides for BSE technological developments that contribute to meeting top joint warfare capabilities established by the Joint Chiefs of Staff, with primary emphasis on Joint Littoral Warfare and Joint Strike Warfare.

This PE fully supports the Director of Defense Research and Engineering's Science and Technology Strategy and is coordinated with other DoD Components through the Defense Science and Technology Reliance process. Work in this program is related to and fully coordinated with efforts in accordance with the on-going Reliance joint planning process. There is close coordination with the US Air Force and US Army under the Reliance program in the BSE categories of Lower Atmosphere, Ocean Environments, Space & Upper Atmosphere, and Terrestrial Environments. Within the Naval Transformation Roadmap, the investment will contribute toward achieving each of the "key transformational capabilities" required by Sea Strike, Sea Shield, and Sea Basing. Moreover,

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environmental information, environmental models, and environmental tactical decision aids that emerge from this investment will form one of the essential components of FORCEnet (which is the architecture for a highly adaptive, human-centric, comprehensive maritime system that operates from seabed to space). The Navy program includes efforts that focus on, or have attributes that enhance, the affordability of warfighting systems.

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

BUDGET ACTIVITY: 02
PROGRAM ELEMENT: 0602435N
PROGRAM ELEMENT TITLE: OCEAN WARFIGHTING ENVIRONMENT APPLIED RESEARCH

B. PROGRAM CHANGE SUMMARY:

	FY 2007	FY 2008	FY 2009
FY 2008/FY 2009 President's Budget Submission	53,515	49,869	48,430
Congressional Action	1,000	4,800	0
Congressional Undistributed Reductions/Rescissions	0	-347	0
Execution Adjustments	2,650	0	0
Program Adjustments	0	0	-802
Rate Adjustments	0	0	-350
SBIR Assessment	-703	-355	0
FY 2009 President's Budget Submission	56,462	53,967	47,278

PROGRAM CHANGE SUMMARY EXPLANATION:
Technical: Not applicable.

Schedule: Not applicable.

C. OTHER PROGRAM FUNDING SUMMARY:
Not applicable.

D. ACQUISITION STRATEGY:
Not applicable.

E. PERFORMANCE METRICS:
All Science and Technology model improvements undergo a rigorous validation, verification and evaluation against quantifiable metrics before being accepted for transition into operations. In Marine Meteorology, for example, typical improvements over the past decade have amounted to a gain in skill of one forecast-day (i.e., the 4-day forecast is now as skillful as the 3-day forecast of a decade ago), and tropical cyclone forecast track error has been reduced by 50%. It is expected that future increases in skill will continue at or above this pace.

FY 2009 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2008
Exhibit R-2a

BUDGET ACTIVITY: 02
PROGRAM ELEMENT: 0602435N PROGRAM ELEMENT TITLE: OCEAN WARFIGHTING ENVIRONMENT APPLIED RESEARCH
PROJECT TITLE: OCEAN WARFIGHTING ENVIRONMENT APPLIED RESEARCH

COST: (Dollars in Thousands)

Project Number & Title	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
OCEAN WARFIGHTING ENVIRONMENT APPLIED RESEARCH	56,462	53,967	47,278	51,422	52,000	52,592	53,193

A. MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: This project provides technologies that form the natural environment technical base on which all systems development and advanced technology depend. Furthermore, this technical base provides developments that may be utilized in the Future Naval Capabilities programs: Organic Mine Countermeasures (MCM) and Autonomous Operations. This project contains the National Oceanographic Partnership Program (NOPP) (Title II, subtitle E, of Public Law 104-201) and efforts aimed at understanding and predicting the impacts of underwater sound on marine mammals.

Major efforts of this project are devoted to: gaining real-time knowledge of the BSE, determining the natural environment needs of regional warfare, providing the on-scene commander with the capability to exploit the environment to tactical advantage and, developing atmospheric research related to detection of sea-skimming missiles and strike warfare. This project provides natural environment applied research for all fleet operations and for current or emerging systems. Major developments are routinely transitioned to the Fleet Numerical Meteorology and Oceanography Center and to the Naval Oceanographic Office where they are used to provide timely information about the natural environment for all fleet operations.

Joint Littoral Warfare efforts address issues in undersea, surface, and air battlespace. Efforts include ocean and atmospheric analysis and prediction for real-time description of the operational environment, shallow water acoustics, multiple-influence sensors for undersea surveillance and weapon systems, and influences of the natural environment on MCM and Anti-Submarine Warfare (ASW) systems. Joint Strike Warfare efforts address issues in air battlespace dominance. Efforts include influences of the natural environment on air operations, electromagnetic (EM)/electro-optic (EO) systems used in intelligence, surveillance, reconnaissance, targeting, bomb damage assessment, and detection of missile weapon systems. They also include improvements in tactical information management about the BSE.

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B. ACCOMPLISHMENTS/PLANNED PROGRAM:

	FY 2007	FY 2008	FY 2009
MARINE METEOROLOGY	10,364	10,234	11,438

The marine atmosphere affects most aspects of naval operations. This activity develops observing technologies, models, Numerical Weather Prediction (NWP) systems and Tactical Decision Aids (TDA) that describe the atmospheric environment and its impacts on naval sensors and operations. This activity focuses on uniquely marine aspects of atmospheric science such as air-sea interaction, coupled ocean-atmosphere modeling, EM and EO propagation, coastal meteorology, Tropical Cyclone (TC) prediction, and the use of remote sensing to obtain quantitative observations of atmospheric properties. Aspects of the atmospheric environment of particular interest include near-surface phenomena that affect refractivity, marine boundary layer dynamics that affect clouds, rain, visibility and fog, and processes that control TC structure, track, and intensity. Objectives of this activity are improved NWP systems and TDAs that provide NOWCAST and forecast skill at global, regional, and tactical scales for operational support, sensor and system development, and performance prediction.

FY 2009 increased to emphasize support for DoN stated requirement for Battlelspace on Demand.

FY 2007 Accomplishments:

ONR
- Continued developments in atmospheric effects on EMs and EOs because of the central importance of EM and EO propagation to many modern warfare systems.
- Continued development of an EO propagation model that accounts for the atmospheric effects of near-surface refraction, scintillation, aerosol extinction, illumination and target, background and sensor characteristics for incorporation into EO tactical decision aids and for supporting warfare systems development.

NRL
- Continued application of predictability concepts to optimize use of new-generation satellite data to target observation selection for maximum forecast impact in military areas of interest. (NRL)
- Continued exploitation of optimal methods for capturing uncertainty of environmental predictions on regional and local scales for reliability estimates of tactical parameters. (NRL)
- Continued program to develop the ability to assimilate data from the next generation of operational weather satellites to benefit real-time analysis of the battlespace environment as well as improving the global

forecasting skill. (NRL)
- Initiated development and validation of the Advanced Propagation Model to account for atmospheric effects on EM radiation, in particular, by the addition of the capability to describe high frequency radio frequencies.
- Initiated development of new methods, that account for a wider range of atmospheric conditions, for determination of refractivity from clutter as an inverse method of obtaining the critical refractivity properties of the atmosphere that affect EM propagation.
ONR and NRL
- Continued effort to optimize rapid environmental assessment using coupled air-sea systems to support multiple warfare and mission areas, with a particular emphasis on Special Warfare. (ONR and NRL)
- Initiated the development of a real-time meteorological and oceanographic battlespace characterization capability (NOWCAST) that collects, processes and exploits on-scene environmental data for rapid environmental assessment. The system will combine high-resolution atmospheric forecast information with 4-D data assimilation of on-scene observations (radar, satellite, conventional observations, etc) for customized display at time and space scales relevant for tactical operation support. (ONR & NRL)
- Initiated the development of global and mesoscale aerosol/radiation models that account for the major sources (desert dust, sea spray, biomass burning, industrial pollution) of visibility degradation in the atmosphere and integrate with numerical weather prediction systems for an aerosol predictive capability that can support militarily relevant time and space scales. (ONR & NRL)
- Initiated the development and validation of a next-generation TC model that can analyze, initialize, and predict TC position, structure and intensity, using a high-resolution (< 3 km) mesoscale model. The development will leverage emerging data assimilation and modeling techniques as well as observational results from the scientific community to build upon existing modeling capabilities. (ONR & NRL)

FY 2008 Plans:

- Continue all efforts of FY 2007.
ONR and NRL
- Initiate development of methods to retrieve and assimilate remotely-sensed aerosol data into aerosol prediction models. (ONR & NRL)
- Initiate effort to exploit probabilistic parameter ensembles for model improvement and construct a basis for observation-informed stochastic model integration. (NRL)
- Initiate effort to improve understanding of atmospheric physical processes in the Arctic. (NRL)

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FY 2009 Plans:

- Continue all efforts of FY 2008.
ONR and NRL
- Complete the development and validation of a next-generation TC model that can analyze, initialize, and predict TC position, structure and intensity, using a high-resolution (< 3 km) mesoscale model. The development will leverage emerging data assimilation and modeling techniques as well as observational results from the scientific community to build upon existing modeling capabilities. (ONR & NRL)

	FY 2007	FY 2008	FY 2009
PHYSICAL OCEANOGRAPHY	13,458	8,398	8,646

The goal of this activity is to develop naval tactical uses of knowledge of the physics of the ocean within the BSE. This is achieved through the development of predictive models of the water mass structure, waves, currents, and air-sea interactions and developing measurement/observation technology. Other applications utilize knowledge of the interaction of the water column hydrodynamics and the acoustics to predict the undersea transmission characteristics and sources of uncertainty in these statistics. Utilizing knowledge of the ocean surface physics, the physical oceanography program seeks to exploit the combination of remotely sensed data, in-situ data, and adaptively sampled data to optimize predictions of ocean currents and water column structure. These predictions, custom databases, adaptive sampling schemes and data programs serve ASW, Naval Special Warfare (NSW), Sea-Basing, and mine warfare needs.

Decrease between FY 2007 and FY 2008 is due to a realignment to support marine mammal research in the Coastal Geosciences/Optics R-2 Activity.

FY 2007 Accomplishments:

ONR
- Continued to employ ocean models to complete 3-D acoustic simulations of space-time coherence of the acoustic field, which is a primary characteristic related to detection performance of acoustic systems. (ONR)
NRL
- Continued development of mass conserving baroclinic finite element models using discontinuous Galerkin methods. (NRL)

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- Continued to extend current theory dealing with tidal variations in sound-speed to sound-speed events with strong range-dependence. (NRL)
- Continued the development of a data assimilative nearshore modeling capability using measurements to guide hydrodynamic forecasts including data sampling strategies and model sensitivity to data. (NRL)
- Continued the integration of hyperspectral imagery into underwater autonomous vehicles and derive river environmental properties through a combination of models and observations. (NRL)
- Completed Undersea Persistent Surveillance (UPS) effort with field experimentation using ocean gliders to provide water column structure influencing acoustic propagation and allowing adaptation in sampling locations for optimal inputs to ocean predictive models; major in-water experiment in late summer/early fall 2007. The research products from this effort will transition to the Innovative Naval Prototype (INP) Persistent Littoral Undersea Surveillance (PLUS) effort in PE 0603747N.
- Initiated the development and implementation of new techniques for parameterizing fluxes of mass and energy across the air-sea interface in coupled ocean-atmosphere models, to improve operational predictions of the BSE. (ONR)
- Initiated development and testing of acoustic communications, disposable environmental instruments, and Unmanned Undersea Vehicles (UUV) and gliders for NSW mission support.
- Initiated developing Delft3-D-Coupled Ocean Atmosphere Mesoscale Prediction System (COAMPS) to include new options for riverine input and transport and behavior of contaminants in support of NSW mission planning.
- Initiated development of the knowledge layer of the internal wave tactical decision aid.
- Initiated development and testing of optimizing remote environmental monitoring units and other autonomous devices for NSW-Meteorological and Oceanographic Command (METOC) uses in assessing METOC conditions and providing data for assimilation.
- Initiated development and testing of glider uses in ASW METOC, adaptive sampling, and NSW support.
- Initiated the development of synthetic aperture radar and hyperspectral imagery exploitation for NSW and Marine Expeditionary Forces as well as the support of new riverine units.

ONR and NRL
- Continued studies of the monitoring and evaluation of ocean currents and water mass properties near topographic control points in marginal seas. (ONR and NRL)
- Continued to develop improved ocean wave prediction, especially shoaling waves, based on the extensive basic research measurement programs in this area over the past decade. (ONR and NRL)
- Continued developments in atmospheric and ocean model NOWCAST/forecast systems at a variety of scales (global, regional, semi-enclosed seas, local) including relocateable and nested models dependent on other priorities in this area. (ONR and NRL)
- Continued development of predictive capability of internal wave affects on the battlespace, including

affects on acoustic transmission. (ONR and NRL)
- Initiated the development of the coupled Delft3d-COAMPS model within the larger Naval forecast system for use in NSW mission planning
- Initiated the development of adaptive sampling algorithms for minimizing acoustic uncertainty using persistent, reconfigurable sampling by UUVs.

FY 2008 Plans:

- Continue all efforts of FY 2007 less those noted as completed above.
ONR
- Complete the development and implementation of new techniques for parameterizing fluxes of mass and energy across the air-sea interface in coupled ocean-atmosphere models, to improve operational predictions of the battle space environment. (ONR)
- Initiate on-board processing of METOC data on gliders/UUV for exfiltration consistent with operational concept of operations. (ONR)
ONR and NRL
- Complete Phase 1 of the development of adaptive sampling algorithms for minimizing acoustic uncertainty using persistent, reconfigurable sampling by UUVs. (ONR and NRL)
- Initiate the custom installation of adaptive sampling algorithms for minimizing acoustic uncertainty using persistent, reconfigurable sampling by UUVs using Naval Oceanographic (NAVO) modeling systems. (ONR and NRL)
- Initiate effort to develop a coupled, high-resolution, comprehensive ocean prediction system for the study of complex air-sea processes. (NRL)

FY 2009 Plans:

- Continue all efforts of FY 2008 less those noted as completed above.
ONR
- Complete development and testing of glider uses in ASW METOC, adaptive sampling, and NSW support. (ONR)

	FY 2007	FY 2008	FY 2009
COASTAL GEOSCIENCES/OPTICS	11,420	15,874	6,176

The goal of this activity is to determine the sources, distribution, and natural variability (concentration

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and properties) of optically important matters in the coastal ocean in support of Naval Mine, Undersea, and Special Warfare. Research investments in this activity support the development and testing of expendable and autonomous bioluminescence sensors, the continued development of extended range underwater imaging technologies, and algorithm development and testing for application to ocean color remote sensing from aircraft and space in order to characterize key features of the coastal battle space such as bathymetry, shallow-water bottom types, and the distribution of ocean water optical properties.

Decrease from FY 2007 to FY 2008 is due to a realignment from the Physical Oceanography R2 Activity to support the marine mammals effort.

Decreased from FY 2008 to FY 2009 is due to a realignment of funding from the Coastal Geosciences/Optics R2 Activity to the newly created Marine Mammal and Biology R-2 Activity in support of CNO requirements, and to reflect an overall trend in program direction toward ocean science.

FY 2007 Accomplishments:

ONR
- Continued bioluminescence sensor effort with emphasis on needs of the Special Warfare (SPECWAR) forces and Naval Oceanographic Office survey capabilities, and use of the bioluminescence sensors in joint field measurements with ocean sensors to determine persistence of the bioluminescence signal and the ocean factors controlling the persistence. (ONR)
- Continued efforts to use space-based optical sensors as input for both active and passive optical MCM sensor performance prediction models. (ONR)
- Continued development of innovative naval biosensors, biomaterials, and bioprocess technology. (ONR)
- Continued engineering development and optimization of sea-floor sediment energy harvesting system for sustainable and autonomous powering of underwater sensor networks (coordinated with NRL Benthic Unattended Generator effort in this area). (ONR)
- Continued development of bio-sensors, -materials, and -process technology, with a focus on development of marine mammal pathogen diagnostics (for bacteria, viruses and fungal infections) to support Navy’s Fleet Marine Mammal Systems. (Transfers to 0602236N in FY08)
- Continued engineering development and optimization of sea-floor sediment energy harvesting system for sustainable and autonomous powering of underwater sensor networks (coordinated with NRL Benthic Unattended Generator effort in this area). (Transfers to 0602236N in FY08)
- Initiated a program to develop systems to monitor marine mammals during fleet activities using 1) passive

acoustic sensors on autonomous underwater vehicles and 2) through radar signal processing algorithms.
- Initiated behavioral response studies to develop threshold criteria for marine mammal reactivity to naval sonars and other manmade sound sources of interest.
NRL
- Continued development and testing of an underwater geo-magnetic noise model. (NRL)
- Continued development of adaptive algorithms to improve MCM EO sensor performance. (NRL)
- Continued to refine algorithms that fuse sediment information extracted from operational sonar with historical sediment databases. (NRL)
- Continued development of a Benthic Unattended Generator to power an autonomous ocean environmental profiler and provided demonstration. (NRL)
- Continued experiments (and data collection) to test user performance as a function of display clutter. (NRL)
- Continued development of small satellite calibration targets to determine atmospheric drag due to neutral density via Light Detection And Ranging (LIDAR) remote sensing. (NRL)
- Completed development and testing of undersea noise models to improve sensor prediction performance in the Littoral Zone (LZ). (NRL)
- Completed development of adaptive algorithms to improve MCM EO sensor and system performance and provide a demonstration. (NRL)
- Completed development of gravity-based navigation by deploying a conventional gravimeter on a submarine. (NRL)
- Completed development of web services registry search algorithms. (NRL)
- Completed innovative translator methods to apply mappings to XML request/response objects. (NRL)
- Completed process to refine Naval Postgraduate School (NPS's) METOC ontology. (NRL)
- Completed investigation into appropriate measures of reliability of data and data sources discovered by Advanced Metoc Broker (AMB). (NRL)
- Completed experiments (and data collection) to test user performance as a function of display clutter. (NRL)

FY 2008 Plans:

- Continue all efforts of FY 2007 less those noted as completed above.
- Initiate at-sea demonstration of radar and acoustics systems to monitor marine mammals in fleet activities. This effort moves to the Marine Mammals and Biology R2 activity in FY 2009. (NRL)
- Complete refining algorithms that fuse sediment information extracted from operational sonars with historical sediment databases. (NRL)
- Complete development of a Benthic Unattended Generator to power an autonomous ocean environmental profiler

BUDGET ACTIVITY: 02
PROGRAM ELEMENT: 0602435N PROGRAM ELEMENT TITLE: OCEAN WARFIGHTING ENVIRONMENT APPLIED RESEARCH
PROJECT TITLE: OCEAN WARFIGHTING ENVIRONMENT APPLIED RESEARCH

and provide demonstration. (NRL)
- Initiate effort to develop visible/near infrared hyperspectral imagery algorithms for autonomous, near real time, retrieval of environmental products, such as diver visibility, bottom type and reflectivity, and bathymetry. (NRL)
- Initiate effort to develop automatic coordination and utilization of distributed web services. (NRL)

FY 2009 Plans:

- Continue all efforts of FY 2008 less those noted as completed above.
- Complete tracking analysis of small satellite calibration targets to determine atmospheric drag due to neutral density via LIDAR remote sensing. (NRL)

	FY 2007	FY 2008	FY 2009
OCEAN ACOUSTICS	5,229	4,882	6,078

This activity is dedicated to the determination of the impact of the natural ocean environment on acoustic wave phenomena in support of Naval undersea warfare and underwater force protection operations. This activity studies underwater acoustic propagation, scattering from ocean boundaries, and ambient noise issues that impact the development and employment of acoustic systems. The LZ has been the ocean environment of greatest interest. Aspects of this environment, that greatly impact underwater acoustic systems, are the shallow water included in the LZ, the consequent closeness and physical significance of the ocean bottom, and the complexities inherent to rapid changes of the ocean structure. The objectives of this program are met through measuring, analyzing, modeling and simulating, and exploiting ocean acoustic factors to gain advantage over potential adversaries using undersea acoustic systems. Results of this activity support acoustic sensor and system development, performance prediction, and tactical decision aids.

Increase from FY 2008 to FY 2009 reflects increased level of investment in ocean acoustics research at the Naval Research Laboratory (NRL).

FY 2007 Accomplishments:

NRL
- Continued development of an integrated hydrodynamic/acoustic propagation modeling capability for littoral

regions to predict acoustic ASW system performance in dynamic environments. (NRL)
- Continued development of a TDA that can predict the dynamic oceanographic characteristics of shallow-water internal waves and their effects on underwater acoustic signals. (NRL)
- Completed development of a method to optimize 3-D sonar search path by incorporating environmental uncertainty into the acoustic propagation estimates. (NRL)
- Initiated development of a validated, physics-based processing algorithm that diagnoses acoustic performance directly from oceanographic data. (NRL)
- Initiated development of a set of physics-based environmental acoustic metrics to evaluate the predictions of TDAs that are used in planning asset allocation and placement of distributed Autonomous Undersea Vehicles (AUVs) in a time evolving scenario. (NRL)
- Initiated development of improved performance predictions for sonar surveillance systems that utilize horizontal line arrays operating in shelf-break environments and relate horizontal-array signal gain and coherence length to the statistics and scale lengths of transverse environmental inhomogeneities. (NRL)

FY 2008 Plans:

- Continue all efforts of FY 2007 less those noted as completed above.
NRL
- Complete development of an integrated hydrodynamic/acoustic propagation modeling capability for littoral regions to predict acoustic ASW system performance in dynamic environments. (NRL)
- Complete development of a TDA that can predict the dynamic oceanographic characteristics of shallow-water internal waves and their effects on underwater acoustic signals. (NRL)
- Initiate development of glider ocean sampling strategies to minimize acoustic detection range uncertainty for anti-submarine warfare predictions. (NRL)
- Initiate development of a broadband, bistatic reverberation time-series simulator for range-dependent underwater environments. (NRL)
- Initiate development of an ocean magnetic prediction system for magnetic fields generated by high amplitude internal waves, internal bores, and internal solitary waves. (NRL)

FY 2009 Plans:

– Continue all efforts of FY 2008 less those noted as completed above.

BUDGET ACTIVITY: 02
PROGRAM ELEMENT: 0602435N PROGRAM ELEMENT TITLE: OCEAN WARFIGHTING ENVIRONMENT APPLIED RESEARCH
PROJECT TITLE: OCEAN WARFIGHTING ENVIRONMENT APPLIED RESEARCH

	FY 2007	FY 2008	FY 2009
NATIONAL OCEANOGRAPHIC PARTNERSHIP PROGRAM (NOPP)	10,040	9,810	9,440

This activity focuses on US Navy investments in the NOPP. NOPP, established by the US Congress (Public Law 104-201) in Fiscal Year 1997, is a unique collaboration among 15 federal agencies involved in conducting, funding, or utilizing results of ocean research. NOPP's value to the Navy derives from the capacity of the partnership to enable and ensure multi-agency efforts where such collaboration enhances efficiency or effectiveness, and/or reduces costs. Major areas of investment by NOPP include: development of an integrated coastal ocean observation system and development of sensors, communications and data acquisition, storage and processing tools required to effect it, modernization of ocean research and observation infrastructure, and marine mammal-related research.

FY 2007 Accomplishments:

ONR
- Continued marine mammal program on noise mitigation
- Continued The Partnership for Advancing Interdisciplinary Global Modeling.
- Continued Global Ocean Data Assimilation Experiment (GODAE) including assessment of GODAE boundary conditions for use in coastal ocean predictions.
- Continued Hybrid Coordinate Ocean Model (HYCOM).
- Completed real-time forecasting system of winds, waves and surge in TCs.
- Initiated new methods for detection of fish, fish populations and mapping of fish habitat.
- Initiated development of sensors for sustained, autonomous measurement of chemical or biological parameters in the ocean.
- Initiated marine mammal program on methods for detection and tracking of marine mammals and mapping their habitat.
- Initiated and completed wireless communications for the coastal ocean.

FY 2008 Plans:

- Continue all efforts of FY 2007 less those noted as completed above.
ONR
- Complete HYCOM.

BUDGET ACTIVITY: 02
PROGRAM ELEMENT: 0602435N PROGRAM ELEMENT TITLE: OCEAN WARFIGHTING ENVIRONMENT APPLIED RESEARCH
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FY 2009 Plans:

- Continue all efforts of FY 2008 less those noted as completed above.

	FY 2007	FY 2008	FY 2009
MARINE MAMMALS AND BIOLOGY	0	0	5,500

This activity consolidates and expands research conducted in previous years in Coastal Geosciences/Optics and the Physical Oceanography Activities and expands these efforts. The sensitivity of Marine Mammals to sound produced by Naval operations and training will continue. This program is to assure that Navy decisions can be based on scientifically defensible positions.

The goal of this activity is to support: (1) marine mammal research related to understanding impacts of sound (especially sonar) on marine mammal behavior, hearing, physiology, distributions and ecology; (2) development and testing of new technologies for the detection of marine mammals at sea; (3) research on the bio-acoustic properties, use of sound for detection of, and effects of sound on fish and lesser marine organisms; and (4) research on optically important biota in the coastal ocean in support of Naval Mine, Undersea, and Special Warfare (including oceanic bioluminescence and the development and testing of bioluminescence sensors).

The marine mammals research conducted in this PE represents part of a total effort executed in coordination with complementary research performed in PE 0602747N.

FY 2009 reflects the realignment of funds from the Coastal Geosciences/Optics R2 Activity to fund expansion of the marine mammal noise study/mitigation effort per CNO requirement and to reflect an overall trend in program direction toward ocean sciences.

FY 2009 Plans:

- Complete an accelerated effort for marine mammal detection involving signal processing of surface radar and the use of autonomous vehicles to allow passive acoustic and electromagnetic detection and monitoring of marine mammals off ranges during fleet ASW experimentation exercises and demonstrations when sound is transmitted underwater. (This effort transitioned from the Coastal Geosciences/Optics R2 activity).
- Initiate multi-investigator, coordinated field research to test responses of marine mammals (especially

beaked whales) to controlled sound exposures.
- Initiate development of new technologies for detection and localization of marine mammals, including (but not restricted to) gliders equipped with passive acoustic sensors, radar and thermal imagery.
- Initiate research examining hearing sensitivity of marine mammals (including temporary and permanent threshold shifts).
- Initiate research efforts examining distributions and abundances of marine mammals relative to prey fields and basic oceanographic parameters.
- Initiate development of and evaluate models that predict time- and space-dependent sound fields produced by anthropogenic noise sources and mammal responses to the noise.
- Initiate development and testing of multi-frequency acoustic technologies for detection, identification and enumeration of fish.
- Initiate research to examine sensitivity of fish to anthropogenic sound.
- Initiate research leading to better predictability of bioluminescent and pigment-bearing planktonic organisms.

CONGRESSIONAL PLUS-UPS:

	FY 2007	FY 2008
AUTONOMOUS MARINE SENSORS AND NETWORKS FOR RAPID LITTORAL ASSESSMENT	3,985	1,591

This effort funded research into the development of small, low-power sensors to use on small autonomous underwater vehicles designed for clandestine rapid environmental assessment in FY07 and continued development of advanced underwater sensing systems and associated systems in FY08.

	FY 2007	FY 2008
AUTONOMOUS UNDERSEA VEHICLE APPLICATIONS CENTER	0	1,192

This effort supports the Autonomous Undersea Vehicle Applications Center.

BUDGET ACTIVITY: 02
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	FY 2007	FY 2008
EXTENDED CAPABILITY UNDERWATER OPTICS	996	0

Laboratory tank experiments were conducted to optimize the architecture of compact underwater imaging sensors resulting in a prototype engineering sensor that can be applied in controlled laboratory imaging scenarios and serves as the foundation for future autonomous sensor systems.

	FY 2007	FY 2008
INSTITUTE FOR EXPLORATION (IFE)	970	0

Funding supported mobilization, demobilization and at-sea ship time on a NATO Research Vessel to conduct evaluations to develop technology for remotely operated vehicles and provided real-time underwater exploration research telecasts to children worldwide.

	FY 2007	FY 2008
LITTORAL BATTLESPACE SENSING (LBS) & AUTONOMOUS UNDERWATER VEHICLE SYSTEM (UAV) PROGRAM	0	993

Funds provided to support LITTORAL BATTLESPACE SENSING (LBS) & AUTONOMOUS UNDERWATER VEHICLE SYSTEM (UAV) PROGRAM.

	FY 2007	FY 2008
UNDERWATER ACOUSTIC IMAGING FOR MARITIME DOMAIN AWARENESS	0	993

Funding to be used for the development of underwater 3-D acoustic imaging for ship and port security.

C. OTHER PROGRAM FUNDING SUMMARY - NAVY RELATED RDT&E:
PE 0601153N Defense Research Sciences
PE 0602114N Power Projection Applied Research
PE 0602123N Force Protection Applied Research
PE 0602235N Common Picture Applied Research

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PE 0602271N RF Systems Applied Research
PE 0602747N Undersea Warfare Applied Research
PE 0602782N Mine and Expeditionary Warfare Applied Research
PE 0603207N Air/Ocean Tactical Applications
PE 0603271N RF Systems Advanced Technology
PE 0603747N Undersea Warfare Advanced Technology
PE 0603782N Mine and Expeditionary Warfare Advanced Technology
PE 0604218N Air/Ocean Equipment Engineering

OTHER PROGRAM FUNDING SUMMARY - NON-NAVY RELATED RDT&E:
PE 0602784A Military Engineering Technology
PE 0602601F Space Technology
PE 0603401F Advanced Spacecraft Technology

D. ACQUISITION STRATEGY:
Not applicable.

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

BUDGET ACTIVITY: 02
PROGRAM ELEMENT: 0602651M
PROGRAM ELEMENT TITLE: JOINT NON-LETHAL WEAPONS APPLIED RESEARCH

COST: (Dollars in Thousands)

Project Number & Title	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
JOINT NON-LETHAL WEAPONS APPLIED RESEARCH	5,875	5,997	6,084	6,087	6,082	6,033	6,022

A. MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: The DOD's Joint Non-Lethal Weapons Program (JNLWP) was established by the Secretary of Defense, who assigned centralized responsibility for DOD joint research and development of non-lethal technology to the Commandant of the Marine Corps as the Executive Agent. The Under Secretary of Defense for Acquisition, Technology and Logistics provides direct oversight of the JNLWP.

The efforts described in this Program Element (PE) reflect science and technology (S&T) investment decisions provided by the Joint NLW Integrated Product Team, a multi-service flag level corporate board that executes the JNLWP for the Commandant of the Marine Corps. This direction is based on the needs and capabilities of the Services, the Special Operations Command, and the Coast Guard, as identified in the DoD's Non-Lethal Weapons Joint Capabilities Document. This coordinated joint S&T development approach addresses mutual capability gaps and assures the best non-lethal technologies and equipment areprovided to the operating forces while eliminating duplicative service S&T investment.

This program funds the applied research, study, assessment, and demonstration of technologies that could provide a non-lethal capability or target effect. Investment areas include applied research related to: non-lethal directed energy weapons (lasers, millimeter wave and high power microwave) for counter-personnel and counter-material missions; non-lethal acoustic and optical technologies; advanced non-lethal materials (including materials for vehicle/vessel stopping and advanced anti-traction materials); associated human effects and effectiveness for new non-lethal stimuli; injury potential and effectiveness of directed energy, electric stun, ocular, and acoustic based non-lethal technologies; and developing models of crowd behavior and dynamics. This program transitioned from PE 0602114N, Power Projection Applied Research by order of the Under Secretary of Defense for Acquisition, Technology, and Logistics, USD(AT&L), to a separate PE for Joint Non-Lethal Weapons Applied Research and established the Marine Corps as the executive agent for DoD Joint Non-Lethal Weapons RDT&E.

BUDGET ACTIVITY: 02
PROGRAM ELEMENT: 0602651M
PROGRAM ELEMENT TITLE: JOINT NON-LETHAL WEAPONS APPLIED RESEARCH

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

BUDGET ACTIVITY: 02
PROGRAM ELEMENT: 0602651M
PROGRAM ELEMENT TITLE: JOINT NON-LETHAL WEAPONS APPLIED RESEARCH

B. PROGRAM CHANGE SUMMARY:

	FY 2007	FY 2008	FY 2009
FY 2008/FY 2009 President's Budget Submission	6,013	6,081	6,101
Congressional Undistributed Reductions/Rescissions	0	-39	0
Rate Adjustments	0	0	-17
SBIR Assessment	-138	-45	0
FY 2009 President's Budget Submission	5,875	5,997	6,084

PROGRAM CHANGE SUMMARY EXPLANATION:
Technical: Not applicable.

Schedule: Not applicable.

C. OTHER PROGRAM FUNDING SUMMARY:
Not applicable.

D. ACQUISITION STRATEGY:
Not applicable.

E. PERFORMANCE METRICS:
The primary objective of this Program Element is the development of technologies that lead to the next-generation of Non-Lethal Weapons. The program consists of a collection of projects that range from studies and analyses to the development and evaluation of feasibility demonstration models. Individual project metrics reflect the technical goals of each specific project. Typical metrics include both the effectiveness of the technology, human effects and effectiveness, and potential for compliance with policy and legislation. Overarching considerations include the advancement of related Technology Readiness Levels and Human Effects Readiness Levels, the degree to which project investments are leveraged with other performers, reduction in life cycle cost upon application of the technology, and the identification of opportunities to transition technology to higher categories of development.

BUDGET ACTIVITY: 02
PROGRAM ELEMENT: 0602651M PROGRAM ELEMENT TITLE: JOINT NON-LETHAL WEAPONS APPLIED RESEARCH
PROJECT TITLE: JOINT NON-LETHAL WEAPONS APPLIED RESEARCH

COST: (Dollars in Thousands)

Project Number & Title	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
JOINT NON-LETHAL WEAPONS APPLIED RESEARCH	5,875	5,997	6,084	6,087	6,082	6,033	6,022

A. MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: This project funds the applied research, study, assessment, and demonstration of technologies that could provide a non-lethal capability or target effect. Investment areas include applied research related to: non-lethal directed energy weapons (lasers, millimeter wave and high power microwave) for counter-personnel and counter-material missions; non-lethal acoustic and optical technologies; advanced non-lethal materials (including materials for vehicle/vessel stopping and advanced anti-traction materials); associated human effects and effectiveness for new non-lethal stimuli; injury potential and effectiveness of directed energy, electric stun, ocular, and acoustic based non-lethal technologies; and developing models of crowd behavior and dynamics.

B. ACCOMPLISHMENTS/PLANNED PROGRAM:

	FY 2007	FY 2008	FY 2009
JOINT NON-LETHAL WEAPONS APPLIED RESEARCH	5,875	5,997	6,084

FY 2007 Accomplishments:

- Continued examination of target effects/characterization and assessed the resulting crowd behavior and effectiveness of non-lethal acoustic and optical (light stun/distract) technologies.
- Continued investigation of the characteristics, optimization, and control of Laser Induced Plasma (LIP) phenomena for its non-lethal applications to both counter-personnel and counter-material missions. LIP is a phenomenon of high energy, short pulse lasers that have several potential applications to produce or transmit non-lethal stimuli.
- Continued investigation of several advanced non-lethal material technologies with non-lethal weapons applications, including engine suffocates, morphing materials for new non-lethal rounds or flight bodies, and new non-lethal nano-materials.

BUDGET ACTIVITY: 02
PROGRAM ELEMENT: 0602651M PROGRAM ELEMENT TITLE: JOINT NON-LETHAL WEAPONS APPLIED RESEARCH
PROJECT TITLE: JOINT NON-LETHAL WEAPONS APPLIED RESEARCH

- Continued examination of specific non-lethal effects and effectiveness associated with the laser-induced plasma phenomenon.
- Completed evaluation of advanced non-lethal material technologies, such as new anti-traction materials, for advanced non-lethal weapons.
- Initiated refinement of directed energy weapon models through research into non-lethal phenomena and assessment of human effects and weapon effectiveness.
- Initiated exploration of the use of light and sound combinations to produce non-lethal human effects, to include saccade motion, discomfort and disability glare, flash-blindness, and potential cognitive effects, with level of light/sound stimuli below hazardous levels.
- Initiated exploration of long range, wireless, extended duration electrically induced neuromuscular incapacitation.
- Initiated applied research in the development of counter-personnel and counter-material directed energy non-lethal weapons, including counter-vehicle and advanced active denial activities.
- Initiated the Advanced Total Body Model (ATBM) development effort to enable modeling and simulation of human effects from non-lethal weapons in support of legal, treaty and policy decisions.

FY 2008 Plans:

- Continue all efforts of FY 2007, less those noted as completed above.
- Complete the ATBM development effort to enable modeling and simulation of human effects from non-lethal weapons in support of legal, treaty and policy decisions.
- Complete exploration of long range, wireless, extended duration electrically induced neuromuscular incapacitation.
- Complete examination of specific non-lethal effects and effectiveness associated with the laser-induced plasma phenomenon.
- Initiate academic research into technology areas with relevance to non-lethal weapon capabilities.

FY 2009 Plans:

- Continue all efforts from FY 2008, less those noted as complete above.
- Complete and transition to higher categories of development the use of light and sound combinations to produce non-lethal human effects, to include saccade motion, discomfort and disability glare, flash-blindness, and potential cognitive effects, with level of light/sound stimuli below hazardous levels.
- Initiate investigations of alternative technologies with potential to address emerging capability gaps.

BUDGET ACTIVITY: 02
PROGRAM ELEMENT: 0602651M PROGRAM ELEMENT TITLE: JOINT NON-LETHAL WEAPONS APPLIED RESEARCH
PROJECT TITLE: JOINT NON-LETHAL WEAPONS APPLIED RESEARCH

- Initiate characterization efforts of alternative directed energy technologies by building upon the ATBM model as part of the Human Effects Modeling Analysis Program (HEAP) to incorporate suitable sensors capable of measuring directed energy effects (millimeter – wave, high powered microwave, etc).
- Initiate investigation of candidate technologies applicable to delivering laser induced plasma effects.

C. OTHER PROGRAM FUNDING SUMMARY - NAVY RELATED RDT&E:
PE 0603651M Joint Non-Lethal Weapons Technology Development

OTHER PROGRAM FUNDING SUMMARY - NON-NAVY RELATED RDT&E:
Not applicable

D. ACQUISITION STRATEGY:
Not applicable.

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

BUDGET ACTIVITY: 02
PROGRAM ELEMENT: 0602747N
PROGRAM ELEMENT TITLE: UNDERSEA WARFARE APPLIED RESEARCH

COST: (Dollars in Thousands)

Project Number & Title	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
UNDERSEA WARFARE APPLIED RESEARCH	92,455	71,764	58,658	60,792	63,916	70,730	80,440

A. MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: The efforts described in this Program Element (PE) are based on investment directions as defined in the Naval S&T Strategic Plan approved by the S&T Corporate Board (Jan 2007). This strategy is based on needs and capabilities from Navy and Marine Corps guidance and input from the Naval Research Enterprise (NRE) stakeholders (including the Naval enterprises, the combatant commands, the Chief of Naval Operations (CNO), and Headquarters Marine Corps). It provides the vision and key objectives for the essential science and technology efforts that will enable the continued supremacy of U.S. Naval forces in the 21st century. The Strategy focuses and aligns Naval S&T with Naval missions and future capability needs that address the complex challenges presented by both rising peer competitors and irregular/asymmetric warfare.

All Navy applied research in undersea target detection, classification, localization, tracking, and neutralization is funded through this PE. Technologies being developed within this PE are aimed at enabling Sea Shield, one of the core operational concepts detailed in the Naval Transformational Roadmap. Associated efforts focus on new Anti-Submarine Warfare (ASW) operational concepts that promise to improve wide-area surveillance, detection, localization, tracking, and attack capabilities against quiet adversary submarines operating in noisy and cluttered shallow water environments. Related efforts are aimed at leveraging technologies that will protect the country’s current capital investment in surveillance, submarine, surface ship, and air ASW assets. Research focused on understanding the impacts on marine mammals of manmade underwater sound is also conducted in the Program Element.

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

BUDGET ACTIVITY: 02
PROGRAM ELEMENT: 0602747N
PROGRAM ELEMENT TITLE: UNDERSEA WARFARE APPLIED RESEARCH

B. PROGRAM CHANGE SUMMARY:

	FY 2007	FY 2008	FY 2009
FY 2008/FY 2009 President's Budget Submission	93,224	68,455	65,254
Congressional Action	0	4,400	0
Congressional Undistributed Reductions/Rescissions	0	-491	0
Execution Adjustments	1,309	0	0
Program Adjustments	-287	0	-6,386
Rate Adjustments	0	0	-210
SBIR Assessment	-1,791	-600	0
FY 2009 President's Budget Submission	92,455	71,764	58,658

PROGRAM CHANGE SUMMARY EXPLANATION:
Technical: Not applicable.

Schedule: Not applicable.

C. OTHER PROGRAM FUNDING SUMMARY:
Not applicable.

D. ACQUISITION STRATEGY:
Not applicable.

E. PERFORMANCE METRICS:
The overall metrics of applied research in undersea warfare are to develop technologies aimed at improving target detection, classification, localization, tracking, increasing attack capabilities against quiet adversary submarines operating in noisy and cluttered shallow water environments, countering enemy torpedoes, providing the ability to conduct long-range engagements, increasing weapons load-out, providing multi-platform connectivity, increasing endurance/survivability, and reducing size and power requirements.

BUDGET ACTIVITY: 02
PROGRAM ELEMENT: 0602747N PROGRAM ELEMENT TITLE: UNDERSEA WARFARE APPLIED RESEARCH
PROJECT TITLE: UNDERSEA WARFARE APPLIED RESEARCH

COST: (Dollars in Thousands)

Project Number & Title	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
UNDERSEA WARFARE APPLIED RESEARCH	92,455	71,764	58,658	60,792	63,916	70,730	80,440

A. MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: All Navy applied research in undersea target detection, classification, localization, tracking, and neutralization is funded through this project. Technologies being developed within this project are aimed at enabling Sea Shield which is one of the core operational concepts detailed in the Naval Transformational Roadmap. Associated efforts focus on new ASW operational concepts that promise to improve wide-area surveillance, detection, localization, tracking, and attack capabilities against quiet adversary submarines operating in noisy and cluttered shallow water environments. Related efforts are aimed at leveraging technologies that will protect the country's current capital investment in surveillance, submarine, surface ship, and air ASW assets.

B. ACCOMPLISHMENTS/PLANNED PROGRAM:

	FY 2007	FY 2008	FY 2009
WIDE AREA ANTI-SUBMARINE WARFARE (ASW) SURVEILLANCE	43,279	30,292	25,642

Wide Area ASW Surveillance is focused on dramatically improving the capability to sanitize large areas relative to the capabilities of legacy ASW sensors. Efforts include the development of affordable off-board systems with associated processing and robust, high bandwidth communications links. The cornerstone of Wide Area Surveillance is the ability to rapidly distribute acoustic and non-acoustic sensors from air, surface, and sub-surface platforms as well as to develop long-endurance sensors and unmanned ASW vehicles. This activity represents a shift from traditional fixed surveillance systems to autonomous, networked-components, multi-static operation, and supported by passive/active signal processing all with the objective of increased detection capabilities.

The decrease from FY 2007 to FY 2008 is associated with the transition of the Innovative Naval Prototype (INP) Persistent Littoral Undersea Surveillance (PLUS) to PE 0603747N. The decrease from FY 2008 to FY 2009 is due

BUDGET ACTIVITY: 02
PROGRAM ELEMENT: 0602747N PROGRAM ELEMENT TITLE: UNDERSEA WARFARE APPLIED RESEARCH
PROJECT TITLE: UNDERSEA WARFARE APPLIED RESEARCH

to zero-sum realignment within the Future Naval Capability program of record to fund Technology Oversight Group approved Enabling Capabilities. Additionally, FY 2009 funds were moved to the newly established Marine Mammals Activity ($1.2M)

FY 2007 Accomplishments:

- Continued development of signal processing algorithms aimed at reducing clutter-generated false alerts.
- Continued development/improvement of multi-static signal processing techniques for systems employing coherent sound sources.
- Continued development of "intelligent" algorithms aimed at optimizing distributed multistatic sources/receivers.
- Continued development of a non-traditional tracking system for deployment on undersea vehicles.
- Continued testing of a non-traditional tracking system.
- Continued development of alternative active optical sources and sensor devices for Non-Acoustic ASW systems.
- Continued development of tracking and classification algorithms for broadband Doppler sensitive waveforms for wide area surveillance.
- Continued an effort to extend the technology base for blue laser sources for Undersea Warfare applications including underwater communications.
- Continued an effort to extend the technology base for high performance electro-optic detectors suitable for Undersea Warfare applications including underwater communications.
- Continued an effort to extend the technology base for high performance electro-optic filters suitable for Undersea Warfare applications including underwater communications.
- Continued an effort to develop consistent and comprehensive modeling and simulation tools for photonic Undersea Warfare and underwater communications components and systems.
- Continued an effort to develop optical signal processing technology appropriate for Undersea Warfare and underwater communications systems.
- Continued and completed third geomagnetic noise coherence investigation from cooperating airborne measurement platforms.
- Continued magnetic mapping and localization study and component development for small-diameter Autonomous Undersea Vehicles.
- Completed development of Telesonar technologies to enable deployable system acoustic communications.
- Completed testing of advanced node design and associated technologies.
- Completed development of multistatic signal processing algorithms with controllable transmit waveform type and ping schedule to enable improved detection and tracking of threat submarines.

BUDGET ACTIVITY: 02
PROGRAM ELEMENT: 0602747N PROGRAM ELEMENT TITLE: UNDERSEA WARFARE APPLIED RESEARCH
PROJECT TITLE: UNDERSEA WARFARE APPLIED RESEARCH

- Completed integration of a prototype system for undersea persistent surveillance.
- Completed investigation of undersea persistent surveillance system performance through simulation and subsystem tests.
- Completed development and testing of components of a prototype system for undersea persistent surveillance.
- Completed evaluation of undersea persistent surveillance system performance and trade-offs.
- Completed demonstration of a prototype system for undersea persistent surveillance.
- Completed development of a prototype system for PLUS. PLUS transitions to PE 0603747N (Undersea Warfare Advanced Technology) for advanced technology development beginning in FY 2008.
- Completed efforts to develop an underwater intruder defense system, including comprehensive active and passive signatures from swimmers, harbor environment noise characteristics, and fiber optic array technology. (NRL)
- Completed analysis and modeling of high frequency underwater acoustic communications techniques between Unmanned Undersea Vehicles (UUVs) and demonstrated its capability. (NRL)
- Completed development of a Helium-3 scalar magnetometer for stationary magnetic arrays.
- Completed Next Generation Autonomous Sensor (NGAS) Joint Research Project (JRP) collaboration and related Overhauser scalar magnetometer investigations.
- Completed efforts to measure, quantify, and model reverberation and clutter from biologics and the seafloor and provide a prediction tool for multistatic active sonars. (NRL)
- Initiated the development of technologies for a low source-level, light-weight ship-protection system against underwater intruders, including vessels with explosives. (NRL)
- Initiated development of signal processing algorithms for operational and pipeline ASW active sonar systems by extending NRL’s broadband, beam-based theory for the Time Reversal Operator. (NRL)

The following efforts contribute to the Littoral Anti-Submarine Warfare FNC:

- Continued experimental test planning for Palantir sensor.
- Continued Submarine Track and Trail applied research efforts for UUV technology in the areas of advanced undersea sensors, communications, and autonomy. This effort transferred from PE 0602114N due to Enabling Capability (EC) realignments.
- Initiated an applied research effort to improve distributed system processing techniques and capabilities.
- Initiated development of automatic signal processing algorithms for use with a Deep Water Active Deployable System (DWADS) for surveillance of deep ocean submarine threats.
- Initiated development of a transmit/receive array for use with a DWADS for surveillance of deep ocean submarine threats.

BUDGET ACTIVITY: 02
PROGRAM ELEMENT: 0602747N PROGRAM ELEMENT TITLE: UNDERSEA WARFARE APPLIED RESEARCH
PROJECT TITLE: UNDERSEA WARFARE APPLIED RESEARCH

FY 2008 Plans:

- Continue all FY 2007 efforts less those noted as completed above.
- Complete development of tracking and classification algorithms for broadband Doppler sensitive waveforms for wide area surveillance.
- Complete magnetic mapping and localization study and component development for small-diameter Autonomous Undersea Vehicles.
- Initiate design of a "Sea Star" undersea local area network to link peripheral sensors to a centralized node through high-bandwidth, short-haul acoustic communications.
- Initiate development of spin-dependent tunneling and coupled magnetostrictive/piezoelctric passive magnetometer device technologies.
-Initiate development of new acoustic and magnetic sensors for autonomous, networked underwater threat monitoring over large spatial scales. (NRL)
-Initiate development of models that accurately characterize short and long range forward scattering from the ocean boundaries for surveillance through tactical sonar frequencies. (NRL)
-Initiate fiber optic technology development to support the next generation of submarine hull arrays including new transducers, optical multiplexing, and optical components. (NRL)

The following efforts contribute to the Littoral Anti-Submarine Warfare FNC:

- Continue all FY 2007 efforts.
- Complete Submarine Track and Trail applied research efforts for UUV technology in the areas of advanced undersea sensors, communications, and autonomy.
- Complete experimental test planning for Palantir sensor.
- Initiate incorporation and enhancement of technology from real-time data fusion technologies into Distributed System Processing (DSP).
- Initiate and complete a FY 2008 Palantir data collection exercise. All Palantir system related products developed in this PE transition to PE 0603747N where Palantir system development continue.
- Initiate development of algorithms to optimize the placement of uncontrolled drifting systems.
- Initiate development of a simulator for placement of uncontrolled drifting systems.
- Initiate development of technologies to provide rapid localization of threat submarines for On-Demand Detection, Classification and Localization (On-Demand DCL).

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PROGRAM ELEMENT: 0602747N PROGRAM ELEMENT TITLE: UNDERSEA WARFARE APPLIED RESEARCH
PROJECT TITLE: UNDERSEA WARFARE APPLIED RESEARCH

FY 2009 Plans:

- Continue all FY 2008 efforts less those noted as completed above.
- Complete development of technologies for a low source-level, light-weight ship-protection system against underwater intruders, including vessels with explosives. (NRL)
- Complete development of signal processing algorithms for operational and pipeline ASW active sonar systems by extending NRL's broadband, beam-based theory for the Time Reversal Operator. (NRL)
- Initiate a research effort to accomplish array shape estimation using fiber-optic interferometric methods.
- Initiate a collaborative follow-on Joint Research Project for Next Generation Autonomous Sensing (NGAS).

The following efforts contribute to the Littoral Anti-Submarine Warfare FNC:

- Continue all FY 2008 efforts less those noted as completed above.
- Complete incorporation and enhancement of technology from real-time data fusion technologies into Distributed System Processing (DSP).
- Complete development of automatic signal processing algorithms for use with a DWADS for surveillance of deep ocean submarine threats.
- Complete development of a transmit/receive array for use with DWADS for surveillance of deep ocean submarine threats.
- Initiate algorithm testing of uncontrolled drifting systems using a simulator.
- Initiate research effort aimed at the ideal placement and control of acoustic sources and drifting sensor systems.
- Initiate a research effort focusing on distributed system in-situational environmental characterization and system monitoring.
- Initiate a research effort to determine the placement of and follow-on control and pattern keeping of acoustic sources and distributed sensor systems.

	FY 2007	FY 2008	FY 2009
BATTLEGROUP ANTI-SUBMARINE WARFARE (ASW) DEFENSE	15,491	15,110	10,294

Battlegroup ASW Defense technology focuses on the development of platform-based sources and receivers aimed at denying submarines the ability to target grey ships. This technology area is primarily concerned with detections inside 10 nautical miles. Battlegroup ASW Defense integrates next-generation technologies, automatic target recognition, sensors that adjust to complex acoustic environments, and environmentally

adaptive processing techniques. Research aimed at understanding and predicting the impacts of manmade underwater sound on marine mammals is also conducted in this activity. Battlegroup ASW Defense will enable smaller, lighter, and cheaper acoustic/non-acoustic arrays, large multi-line arrays, and submarine flank arrays (all with environmental adaptation capabilities).

The FY 2008 to FY 2009 decrease is associated with the movement of funds to establish the new Marine Mammals Activity ($4.3M)

FY 2007 Accomplishments:

- Continued development of signal processing improvements for coherent tactical active sonar systems aimed at improving Detection, Classification, and Localization of small, slow moving submarines in shallow water.
- Continued design and development of underwater projectors using structural magnetostrictive materials.
- Continued development of improved techniques to distinguish submarine echoes from those produced by ocean bottom features.
- Continued development of an acoustic/magnetic hybrid sensor.
- Continued development of low cost, compact, combined acoustic sensor.
- Continued development of advanced sonar signal processing algorithms that integrate target classification and tracking into a combined system for autonomous deployable sensor processing.
- Continued electroactive polymer smart sensor development.
- Continued dipole projector array design and development.
- Completed investigation of synthetic aperture sonar techniques for improving target versus clutter classification performance.
- Completed development of Acoustic Flux Sensor for affordable improvement of sonar signal-to-noise.
- Completed development of line arrays with piezocrystal vector sensors for improved signal-to-noise and bandwidth.
- Initiated compact low frequency projector developments.

The following efforts contribute to the Littoral Anti-Submarine Warfare FNC:

- Continued development of signal processing and system control algorithms for the AN/WSQ-11 “Tripwire” torpedo protection system.
- Continued development of an AN/WSQ-11 “Tripwire” testbed for the testing of algorithms.
- Completed hardware component integration, testing and installation of the acoustic array test bed.

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PROGRAM ELEMENT: 0602747N PROGRAM ELEMENT TITLE: UNDERSEA WARFARE APPLIED RESEARCH
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- Initiated a focused research study to evaluate sonar performance using the acoustic array testbed.

FY 2008 Plans:

- Continue all FY 2007 efforts less those noted as completed above.
- Complete development of advanced sonar signal processing algorithms that integrate target classification and tracking into a combined system for autonomous deployable sensor processing.
- Initiate development of target classification algorithms that adapt to local shipping noise conditions, thereby reducing false alarm probability.
- Initiate development of environmentally adaptive target detection and classification algorithms for deep water operating environments.
- Initiate an accelerated effort for marine mammal detection involving signal processing of surface radar and the use of autonomous vehicles to allow passive acoustic and electromagnetic detection and monitoring of marine mammals off ranges during fleet ASW experimentation exercises and demonstrations when sound is transmitted underwater. This effort transfers to the newly established Marine Mammals Activity in FY 2009.

The following efforts contribute to the Littoral Anti-Submarine Warfare FNC:

- Continue all FY 2007 efforts less those noted as completed above.
- Complete a focused research study to evaluate sonar performance using the acoustic array testbed.

FY 2009 Plans:

- Continue all FY 2008 efforts less those noted as completed above.
- Initiate single crystal and hybrid projector design and development.
- Initiate research to improve detection of quiet diesel-electric submarines using passive sonar arrays in deep ocean environments.

The following efforts contribute to the Littoral Anti-Submarine Warfare FNC:

- Continue all FY 2008 efforts.

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	FY 2007	FY 2008	FY 2009
COOPERATIVE ASW	728	0	0

Cooperative ASW technology developments enable ASW platforms to work together effectively to detect, classify, and localize very quiet undersea targets. Many of the tools required to achieve this objective were being developed as components of the Littoral Anti-Submarine Warfare FNC under the heading of Integrated Anti-Submarine Warfare (IASW) in PEs 0602235N and 0603235N. The focus of this effort is to leverage those concepts and technologies previously investigated under IASW in order to develop technologies that enable the exchange and fusion of ASW sensor data among the technologies developed under Battlegroup ASW Defense, Wide Area ASW Surveillance, and Neutralization program areas.

The funding profile from FY 2007 to FY 2008 reflects the completion of the real-time data fusion effort.

FY 2007 Accomplishments:

- Completed the incorporation of estimates of environmental uncertainty into the fusion of sensor information.
- Completed planning for and conducted at-sea technology demonstration of real-time data fusion technologies and analyzed results. Real-time data fusion technologies transition to the Distributed System Processing effort described under the Wide Area ASW Surveillance activity in this Program Element.

	FY 2007	FY 2008	FY 2009
MARINE MAMMALS	0	0	5,500

This activity consolidates and expands research associated with marine mammals and conducted in FY 2008 in the Battlegroup Anti-Submarine Warfare Activity. The sensitivity of Marine Mammals to sound produced by Naval operations and training will continue. This program is to assure that Navy decisions can be based on scientifically defensible positions.

The goal of this activity is to support: (1) marine mammal research related to understanding impacts of underwater sound (especially sonar) on marine mammal behavior, hearing, physiology, distributions and ecology; (2) development and testing of new technologies for the detection of marine mammals at sea; (3) research on the bio-acoustic properties, use of sound for detection of, and effects of sound on fish and lesser marine

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organisms; and (4)research on optically important biota in the coastal ocean in support of Naval Mine, Undersea, and Special Warfare (including oceanic bioluminescence and the development and testing of bioluminescence sensors).

The marine mammals research conducted in this Program Element (P.E.) represents part of a total effort executed in coordination with complementary research performed in P.E. 0602435N.

This Activity has been created to specifically address the work associated with determining and mitigating the effects on the behavior of marine mammals of manmade sound transmitted underwater. The FY 2009 funding associated with this newly created Activity came from the Battlegroup Anti-Submarine Warfare Activity ($4.3M) and the Wide Area Anti-Submarine Warfare Surveillance Activity ($1.2M).

FY 2009 Plans:

- Complete an accelerated effort for marine mammal detection involving signal processing of surface radar and the use of autonomous vehicles to allow passive acoustic and electromagnetic detection and monitoring of marine mammals off ranges during fleet Anti-Submarine Warfare experimentation exercises and demonstrations when sound is transmitted underwater. This effort transferred to this newly established Activity from the Battlegroup Anti-Submarine Warfare Defense Activity.
- Initiate multi-investigator, coordinated field research to test responses of marine mammals (especially beaked whales) to controlled sound exposures.
- Initiate development of new technologies for detection and localization of marine mammals, including (but not restricted to) gliders equipped with passive acoustic sensors, radar and thermal imagery.
- Initiate research examining hearing sensitivity of marine mammals (including temporary and permanent threshold shifts).
- Initiate research efforts examining distributions and abundances of marine mammals relative to prey fields and basic oceanographic parameters.
- Initiate development of and evaluate models that predict time- and space-dependent sound fields produced by anthropogenic noise sources and mammal responses to the noise.
- Initiate development and testing of multi-frequency acoustic technologies for detection, identification and enumeration of fish.
- Initiate research to examine sensitivity of fish to anthropogenic sound.
- Initiate research leading to better predictability of bioluminescent and pigment-bearing planktonic organisms.

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	FY 2007	FY 2008	FY 2009
NEUTRALIZATION	22,845	21,990	17,222

Neutralization focuses on the development of enabling technologies for undersea weapons to counter threat submarines and surface vessels by increasing Probability of Kill and platform survivability. Weapon technology focus areas include: Explosives and Warheads, Guidance and Control (G&C), Multidisciplinary Systems Design & Optimization (MSDO) (comprising Simulation Based Design, Silencing, and Propulsion), Power Sources, Supercavitation, and Torpedo Defense (TD).

The following demonstration FNC projects are included in this activity: 1) the Lightweight Torpedo Technology (LTT) project (begins transition to PE 0603747N in FY 2008), and 2) the Compact Rapid Attack Weapon (CRAW) project.

The ultimate goal of this activity is to develop modular and reduced sized undersea weapons based on common technology enablers (where possible), to provide revolutionary capabilities needed to fill Sea Shield Warfighter Capability Gaps, and enable new undersea weapon concepts of operations to rapidly transition to submarine neutralization/engagement in deep and shallow water under unique payload limitations posed by unmanned platforms, external stowage, and future Naval platforms.

The funding decrease from FY 2008 to FY 2009 represents the phased movement of technologies from Applied (6.2) to Advanced (6.3) Research as the technologies mature in the areas of Wide Area Surveillance and Neutralization.

FY 2007 Accomplishments:

- Continued development of technologies for terminal defense against close-in waterborne/underwater threats and high-speed weapons (examine experimentally, in water, the physics of interactions among multiple supercavitating projectiles in a projectile burst).
- Continued optimization of undersea weapons system design using MSDO with respect to constraints in cost and performance.
- Continued development of enhanced performance for torpedo warheads through the use of focused energy technologies for Light Weight Torpedo (LWT) Improvement and CRAW applications.

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- Continued validation of computational models for torpedo lethality.
- Continued effort to conduct full ship validation effort for Explosion Response simulation code, using Dynamic System Mechanics Advanced Simulation (DYSMAS) Hydrocode (test plan developed, finite element ship model was completed, pretest simulations were conducted).
- Continued implementation of MSDO tools in hybrid propulsion and Weapons Silencing systems development.
- Continued development of high-speed supercavitating torpedo vehicle control and homing sensor.
- Continued to conduct experiments and tests on vehicle control concepts and homing sensors.
- Continued fourth quarter (of the fiscal year) explosive testing for warhead projects.
- Continued conduct of computer code refinements and investigation of supercavitating vehicle dynamics and instability.
- Continued development of a supercavitating 6.75-inch (or full-scale) vehicle with vehicle control devices and homing sensors.
- Continued feasibility investigations (including acoustic element construction) to test the ability of single crystal to operate at high field, high drive, and high duty cycle for both torpedo Tonpiltz transducer and broadband cylindrical projector applications.
- Continued fin and cavitator control, and integrate with controller for the supercavitating 6.75-inch vehicle.
- Continued torpedo design and optimization to support the external weapon stowage effort in DARPA Tango Bravo Program.
- Continued data collection on a technology test-bed for surface ship close in torpedo defensive system using supercavitating projectiles.
- Completed Low Acoustic Motor Propulsor (LAMPrEy) technology transition to DARPA Tango Bravo Program. Transition to DARPA PE 0603766E, Project NET-02.
- Completed development of improved threat models and torpedo system simulation capabilities under the Torpedo Enterprise Advanced Modeling and Simulation initiative.
- Completed transition of appropriate supercavitating vehicle control technology and control devices to DARPA Underwater Express program.
- Initiated efforts in electric propulsion for the Next Generation Torpedo.
- Initiated signal processing and homing algorithms for supercavitating vehicle.
- Initiated efforts that enhance undersea weapons G&C capabilities in autonomy, sensors, sensor processing, communication and networking by leveraging current, or contribute to developing, technologies for UUVs.

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The following efforts support the Sea Shield FNC in the Littoral Anti-Submarine Warfare Mission Area:

- Continued application of MSDO tools probabilistic methods and uncertainty analysis for LWT design.
- Continued feasibility investigations under LTT to quantify adjunct sensor configurations and signal processing approaches to enable positive discrimination of artificial targets at standoff ranges. This feasibility investigation is expected to result in five (5) new patent applications. (Transitions to PE 0603747N in FY 2008)
- Continued LTT feasibility investigations to select the stealth and propulsion technologies for future integration as a low cost propulsion replacement for the Mk 54 LWT. (Transitions to PE 0603747N in FY 2008)
- Continued LTT feasibility investigations and selected geo-coordinate based navigation system technologies and connectivity methods (i.e. acoustic communications, fiber link) for future development of technologies for LWT demonstration). (Transitions to PE 0603747N in FY 2008)
- Continued data collection for LWT broadband and counter-countermeasures in the harsh shallow water environment of the Shore Bombardment Area site off the Southern California Off-Shore Range using an experimental test vehicle fitted with a broadband Mk 54 array. (Transitions to PE 0603747N in FY 2008)
- Continued LTT sensor package development to achieve integrated coherent broadband sonar and novel adjunct sensors homing and classification capabilities for LWT. (Transitions to PE 0603747N in FY 2008)
- Continued LTT advanced counter-countermeasure algorithm and tactics development for LWT. (Transitions to PE 0603747N in FY 2008)
- Continued feasibility assessment of LTT to best utilize precision targeting and distributed sensors for weapon employment from high altitude and standoff range. (Transitions to PE 0603747N in FY 2008)
- Continued development and integration of adjunct sensors into a lightweight torpedo sensor and design signal processing and data fusion techniques to improve target classification in areas of high contact density. (Transitions to PE 0603747N in FY 2008)
- Continued a high fidelity weapon frequency model development effort to parallel adjunct sensor developments and provide accurate synthetic data for algorithm design and measurement. (Transitions to PE 0603747N in FY 2008)
- Initiated development of a reduced size/weight CRAW for air deployment. This effort included sensor, guidance and control, warhead, propulsion, and air frame integration tasks.
- Initiated an iterative algorithm development to enable the CRAW to search, home, and terminally home against targets in deep and shallow water both without and with countermeasures.
- Initiated technology to enable a CRAW warhead to achieve required lethality against submarine targets.
- Initiated use of design techniques for LWT using undersea weapons system design tools transitioned from Discovery and Innovation to FNC.

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FY 2008 Plans:

- Continue all efforts of FY 2007 less those noted as completed above.
- Continue weaponization study for unmanned undersea vehicle initiated in FY 2007.
- Complete validation of computational models for torpedo lethality and transition to PMS415.
- Initiate weaponization study for unmanned surface vehicle.
- Initiate test and evaluation of signal processing and homing algorithms for supercavitating vehicle.
- Initiate integration of hydroreactive shaped charge technology into CRAW warhead development. (Technology transitioning from PE 0602123N)
- Initiate long pulse concept to exploit explosion bubble technology to enhance undersea warhead performance with smaller volumetric requirements.
- Initiate efforts to develop air and underwater delivered kinetic energy enhanced lethality warhead concepts.
- Initiate hybrid propulsion for Heavyweight Torpedo.

The following efforts support the Sea Shield FNC in the Littoral Anti-Submarine Warfare Mission Area:

- Continue all efforts of FY 2007 less those noted as completed above.
- Continue development of a shaped charge liner for CRAW warhead initiated in FY 2007.
- Complete an iterative algorithm development to enable the CRAW to search, home, and terminally home against targets in deep and shallow water both without and with countermeasures.
- Initiate LTT development of an underwater acoustics communications capability to enable coordinated attack and net-centric connectivity. (Transitions to PE 0603747N in FY 2009)
- Initiate LTT development of salvo weapons tactics utilizing behavior-based control. (Transitions to PE 0603747N in FY 2009)

FY 2009 Plans:

- Continue all efforts of FY 2008 less those noted as completed above.
- Complete transition of appropriate supercavitating vehicle control technology and devices to DARPA Underwater Express Program.
- Complete efforts in electric propulsion for LWT.
- Complete signal processing and homing algorithms for supercavitating vehicle.
- Complete the evaluation of the integration of hydroreactive shaped charge technology into CRAW warhead

development.
- Initiate development of advanced undersea warhead fuzing concepts.
- Initiate development of enhanced yield explosive concepts for undersea warhead applications.
- Initiate quiet propulsion systems development for torpedoes.

The following efforts support the Sea Shield FNC in the Littoral Anti-Submarine Warfare Mission Area:

- Continue all efforts of FY 2008 less those noted as completed above.
- Complete the development of algorithms for CRAW to search, home and terminally home in deep and shallow water against targets both without and with countermeasures.

CONGRESSIONAL PLUS-UPS:

	FY 2007	FY 2008
ACOUSTIC LITTORAL GLIDER	4,782	0

Continued at-sea testing of prototype acoustic undersea gliders and began integration of undersea warfare payloads into twenty-five gliders. Conducted operational testing of the gliders to demonstrate the ability to carry and/or deploy undersea acoustic sensors.

	FY 2007	FY 2008
ADVANCED ACOUSTIC TRANSDUCER CONCEPTS	1,943	0

Continued development of materials and processing techniques for Galfenol. Investigated texture and chemistry, grain growth inhibitors, and other alloying additions that can result in texture enhancements. Also, studied new insulating coating practices to prevent electrical shorts between laminates. Undertook a cost reduction program to reduce the cost of the Terfenol-D/magnet active element in the HUNTER transducer. Developed a fully coupled, nonlinear, dynamic model to enable understanding of the behavior of Magnetostrictive Materials. Developed a test bed to characterize new concepts and designs. Investigated Magnetostrictive sensors to determine their viability as underwater acoustic pressure sensors.

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	FY 2007	FY 2008
ANTI-TORPEDO TORPEDO (6.75 INCH DIAMETER) MULTI-MISSION WEAPON	1,444	0

Continued research to support optimization of signal processing and 6.75" weapon tactics used in ATT for offensive applications. Continued collection of in-water data to evaluate proposed multi-mission guidance and control technologies. Initiated research on extending multi-mission ATT performance assessment software tools to address air dropped compact rapid attack weapon concept.

	FY 2007	FY 2008
AUTONOMOUS UNMANNED UNDERSEA VEHICLE (UUV) DELIVERY & COMMUNICATIONS DEMONSTRATION	0	1,988

This effort will focus on feasibility studies and the design of a payload module for a large unmanned undersea vehicle (UUV) to deliver and communicate with smaller UUVs for anti-submarine warfare and mine countermeasures.

	FY 2007	FY 2008
GALFENOL ENERGY HARVESTING	0	1,589

Initiate research to develop Galfenol (Iron Gallium) alloys for use in energy harvesting devices. Develop processing techniques for texture development in rolled sheet, improvements in directional solidification practices and welding/joining studies.

	FY 2007	FY 2008
HIGH POWER LITHIUM BATTERY	0	795

This effort is a follow-on to an FY 2006 Congressionally directed program. This year's effort will incorporate the capabilities developed in FY 2006 into a D-cell form factor.

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	FY 2007	FY 2008
MICRO ELECTRO MECHANICAL SYSTEMS-INERTIAL MEASUREMENTS UNITS (MEMS-IMU)	1,943	0

Continued research and design of Micro Electro Mechanical Systems (MEMS) sensors for various applications including weapons safety and health monitoring. Continued development of advanced manufacturing processes for MEMS and demonstrated their reliability and application in system prototyping and low volume output for these applications. Initiated research into application of MEMS based projectile control devices.

C. OTHER PROGRAM FUNDING SUMMARY - NAVY RELATED RDT&E:
PE 0601153N Defense Research Sciences
PE 0602114N Power Projection Applied Research
PE 0602123N Force Protection Applied Research
PE 0602435N Ocean Warfighting Environment Applied Research
PE 0602782N Mine and Expeditionary Warfare Applied Research
PE 0603114N Power Projection Advanced Technology
PE 0603123N Force Protection Advanced Technology
PE 0603506N Surface Ship Torpedo Defense
PE 0603553N Surface ASW
PE 0603561N Advanced Submarine System Development
PE 0603747N Undersea Warfare Advanced Technology
PE 0603758N Navy Warfighting Experiments and Demonstrations
PE 0604221N P-3 Modernization Program
PE 0604261N Acoustic Search Sensors
PE 0604784N Distributed Surveillance System

OTHER PROGRAM FUNDING SUMMARY - NON-NAVY RELATED RDT&E:
PE 0602702E Tactical Technology
PE 0603739E Advanced Electronics Technologies

D. ACQUISITION STRATEGY:
N/A

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

BUDGET ACTIVITY: 02
PROGRAM ELEMENT: 0602782N
PROGRAM ELEMENT TITLE: MINE AND EXPEDITIONARY WARFARE APPLIED RESEARCH

COST: (Dollars in Thousands)

Project Number & Title	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
MINE AND EXPEDITIONARY WARFARE APPLIED RESEARCH	56,035	70,504	47,869	45,234	47,016	51,308	60,597

A. MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: The efforts described in this Program Element (PE) are based on investment directions as defined in the Naval S&T Strategic Plan approved by the S&T Corporate Board (Jan 2007). This strategy is based on needs and capabilities from Navy and Marine Corps guidance and input from the Naval Research Enterprise (NRE) stakeholders (including the Naval enterprises, the combatant commands, the Chief of Naval Operations (CNO), and Headquarters Marine Corps). It provides the vision and key objectives for the essential science and technology efforts that will enable the continued supremacy of U.S. Naval forces in the 21st century. The Strategy focuses and aligns Naval S&T with Naval missions and future capability needs that address the complex challenges presented by both rising peer competitors and irregular/asymmetric warfare.

This PE provides technologies for Naval Mine Countermeasures (MCM), Expeditionary Warfare, U.S. Naval sea mining, Naval Special Warfare (NSW), and Joint Tri-Service Explosive Ordnance Disposal (EOD). This program is strongly aligned with the Joint Chiefs of Staff Joint Warfighting Capability Objectives through the development of technologies to achieve military objectives with minimal casualties and collateral damage. Within the Naval Transformation Roadmap, this investment will achieve one of three "key transformational capabilities" required by "Sea Shield" as well as technically enable the Ship to Objective Maneuver (STOM) key transformational capability within "Sea Strike" by focusing on technologies that will provide the Naval Force with the capability to dominate the battlespace, project power from the sea, and support forces ashore with particular emphasis on rapid MCM operations. These efforts concentrate on the development and transition of technologies for the MCM-related and Urban Asymmetric/Expeditionary Warfare Operations (UAEO)-related Future Naval Capabilities (FNC) Enabling Capabilities (ECs). The Mine and Obstacle Detection/Neutralization efforts include technologies for clandestine and overt minefield reconnaissance, organic ship self-protection, organic minehunting and neutralization/breaching. The Urban Asymmetric Operation effort includes critical warfighting functions such as Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance (C4ISR), fires, maneuver, sustainment, etc. The Naval Special Warfare and Explosive Ordnance Disposal

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technology efforts concentrate on the development of technologies for safe near-shore mine detection, diver mobility and survivability, and ordnance disposal operations.

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

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PROGRAM ELEMENT: 0602782N
PROGRAM ELEMENT TITLE: MINE AND EXPEDITIONARY WARFARE APPLIED RESEARCH

B. PROGRAM CHANGE SUMMARY:

	FY 2007	FY 2008	FY 2009
FY 2008/FY 2009 President's Budget Submission	56,868	59,874	56,648
Congressional Action	0	11,600	0
Congressional Undistributed Reductions/Rescissions	0	-455	0
Execution Adjustments	-1	0	0
Program Adjustments	0	0	-8,592
Rate Adjustments	0	0	-187
SBIR Assessment	-832	-515	0
FY 2009 President's Budget Submission	56,035	70,504	47,869

PROGRAM CHANGE SUMMARY EXPLANATION:
Technical: Not applicable.

Schedule: Not applicable.

C. OTHER PROGRAM FUNDING SUMMARY:
Not applicable.

D. ACQUISITION STRATEGY:
Not applicable.

E. PERFORMANCE METRICS:
The overall metrics of this applied research program are the development of technologies which focus on the Expeditionary Warfare challenge of speeding the tactical timeline and increasing safe standoff from minefields. Individual project metrics include the transition of 6.2 technology solutions into 6.3 advanced technology programs.

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PROGRAM ELEMENT: 0602782N PROGRAM ELEMENT TITLE: MINE AND EXPEDITIONARY WARFARE APPLIED RESEARCH
PROJECT TITLE: MINE AND EXPEDITIONARY WARFARE APPLIED RESEARCH

COST: (Dollars in Thousands)

Project Number & Title	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
MINE AND EXPEDITIONARY WARFARE APPLIED RESEARCH	56,035	70,504	47,869	45,234	47,016	51,308	60,597

A. MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: This project focuses on reducing the time involved in conducting MCM operations and increasing safe standoff from minefields. It develops and transitions technologies for MCM-related and UAEO-related FNC ECs. The MCM effort includes technologies for clandestine and overt minefield reconnaissance, organic ship self-protection, organic minehunting, neutralization/breaching and clearance. The Littoral Warfare effort includes critical warfighting functions such as C4ISR, fires, maneuver, sustainment, etc. The sea mining effort emphasizes technologies for future sea mines. The Naval Special Warfare and Explosive Ordnance technology efforts concentrate on the development of technologies to enhance diver capabilities including: safe near-shore mine sensing, mobility and survivability, and ordnance disposal operations.

B. ACCOMPLISHMENTS/PLANNED PROGRAM:

	FY 2007	FY 2008	FY 2009
MINE/OBSTACLE DETECTION	28,697	41,663	32,817

This activity focuses on applied research to enable longer detection ranges and precise mine location with fewer false alarms in a variety of challenging environments. It supports Discovery and Invention (D&I) and MCM-related FNC ECs. Efforts in Synthetic Aperture Sonar (SAS) technologies for longer range detection and classification of mine-like targets and magnetic gradiometer sensing and electro-optic (EO) technology for buried mine identification, and sensor integration onto Autonomous Underwater Vehicles (AUVs) are being addressed. EO sensor research develops algorithms to enable image processing for rapid overt reconnaissance from an Unmanned Aerial Vehicle (UAV). Other processing, classification and data fusion techniques to reduce operator workload, and a mine burial prediction “expert system” are also being developed. Efforts also support development of MCM Mission Modules for Littoral Combat Ships (LCS).

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PROGRAM ELEMENT: 0602782N PROGRAM ELEMENT TITLE: MINE AND EXPEDITIONARY WARFARE APPLIED RESEARCH
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The investment increase from FY 2007 to FY 2008 reflects critical navy MCM efforts supporting the following FNC products: Buried Mine Sensors and Processing; Undersea Cooperative Cueing (for Unmanned Underwater Vehicles (UUVs)); MCM Sensors for the LCS; and MCM Data Fusion. These 6.2 investment areas are maturing technologies such that they are ready for advanced tech development (6.3) and subsequent transition to acquisition programs. These are all high priority MCM investment areas and are reflected in the input to the FY 2008/FY 2009 MCM Master Plan submitted yearly to Congress. In FY 2009, funding programmed for new FNC ECs was realigned to reflect the priorities of the Navy's Technology Oversight Group (TOG).

FY 2007 Accomplishments:

-Continued development of data fusion algorithms for underwater EO, magnetic and acoustic sensors to enhance probability of classification and probability of identification and reduce false alarm rate for proud and buried mine hunting.
-Continued development of long range, forward-looking Integrated Precision Underwater Mapping (iPUMA) sonar for small (12.75") UUVs.
-Continued at-sea testing of prototype Low Frequency Broadband (LFBB) acoustic scattering sonar focusing on multi-aspect mine classification/identification and characterization of clutter in various environments.
-Continued the development of a low-cost, 12.75" UUV-based EO sensor for mine identification.
-Continued development of multi-platform fusion of data from high-resolution mine hunting systems (e.g. AN/AQS-20 and submarine-launched Mine warfare (MIW) UUVs via registration with those from the Mine Warfare Environmental Data Library (MEDAL) for improved mine detection and avoidance.
-Continued development of automatic mine detection and classification algorithms for integrated forward-looking iPUMA sonar and side-looking sonars.
-Continued phenomenology studies for improved mine detection algorithms for UAV sensors.
-Completed development of multi-static AUV-based minehunting integrating navigation, communication and sensor elements.
-Completed development of automated broadband, physics-based target recognition algorithms utilizing data collected by prototype sonar; and begun transition to Naval Sea Systems Command (NAVSEA) codes PMS-403 and PMS-495.
-Completed the development of active electromagnetic sensing for short-range mine classification.
-Completed development and field testing of 12.75" UUV platforms.
-Completed effort to define the interface between MEDAL and the SQS-53C Integrated Peer Review (IPS) required to support transition of this registration capability.
-Completed development of Over the Horizon (OTH) deployment concepts for UUVs.

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-Completed mine burial expert system and transition to the Naval Oceanographic Office (NAVOCEANO).
-Completed buried and proud mine target acoustic scattering measurements in the presence of bottom roughness using parametric and conventional sonars.
-Initiated large area search and survey based upon multiple, cooperating UUVs.
-Initiated technology development for MCM Mission Module systems for Advanced Flight LCS.
-Initiated technology development for a Tactical UAV (TUAV) buried minefield detection sensor.

D&I Efforts (ONR followed by NRL):
ONR
-Continued development of UUV-based extended range electro-optic identification sensors and supporting meteorology and oceanography and planning systems.
-Continued design and development of Broadband interferometric SAS.
-Continued evaluation of Littoral Remote Sensing (LRS) algorithm development requirements utilizing data streams available from national and organic sensors.
-Continued the development of multi-static acoustic sensing and processing for cooperating, unmanned vehicles.
NRL
-Continued the primary sub-system design efforts to extend mine identification using acoustic color concept to longer ranges. (NRL)
-Continued development of UltraWideBand (UWB) Synthetic Aperture Radar (SAR) imaging algorithms and design, and construction of SAR breadboard experimental system. (NRL)
-Continued the development of a numerical simulation capability for exploring SAS system sensitivities to seafloor sediment parameters. (NRL)
-Completed evaluation of sediment poro-elastic and elastic propagation models to understand high-frequency acoustic-bottom interactions. (NRL)
-Initiated model prediction verification for acoustic interactions with ocean bottoms containing configurations of inclusions, multiple scattering from clusters, rough surface shadowing effects and layers to improve model performance in buried mine identification. (NRL)

FY 2008 Plans:

-Continue all efforts of FY 2007 less those noted as completed above.
-Complete the development of a low-cost, 12.75” UUV-based EO sensor for mine identification and conduct initial sea testing of sensor performance.
-Complete development of long range, forward-looking iPUMA sonar for small (12.75”) UUVs and begin at-sea

testing.
-Initiate integration of iPUMA and SAS systems in a single vehicle to obtain 100% area coverage.

D&I Efforts (ONR followed by NRL):
ONR
-Continue all efforts of FY 2007.
-Complete design and development of Broadband interferometric SAS - and complete at-sea testing.
-Initiate development of algorithms exploiting broadband acoustic transmit waveforms for improved automatic classification of buried mines from clutter.
NRL
-Continue all efforts of FY 2007 less those noted as completed above.
-Complete the primary sub-system design efforts to extend mine identification using acoustic color concept to longer ranges. (NRL)
-Complete development of UWB SAR imaging algorithms and design, and construction of SAR breadboard experimental system. (NRL)
-Initiate development of Multiple Input Multiple Output (MIMO) UUV communications by determining channel capacity and extending use to moving platforms. (NRL)
-Initiate demonstration of flapping fin propulsion on an inexpensive, stealthy undersea vehicle to enable new mine warfare mission capabilities. (NRL)
-Initiate development of an ultrafast silicon carbide (SiC) avalanche transistor and a SiC drift step recovery diode. (NRL)

FY 2009 Plans:

-Continue all efforts of FY 2008 less those noted as completed above.
-Complete development of multi-platform fusion of data from high-resolution mine hunting systems (e.g. AN/AQS-20 and submarine-launched MIW UUVs via registration with those from the MEDAL for improved mine detection and avoidance.
-Complete development of data fusion algorithms for underwater electro-optic, magnetic and acoustic sensors to enhance probability of classification (Pc) and probability of identification (Pid) and reduce false alarm rate for proud and buried mine hunting.

D&I Efforts (ONR followed by NRL):
ONR

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-Continue all efforts of FY 2008 less those noted as completed above.
-Complete the development of multi-static acoustic sensing and processing for cooperating, unmanned vehicles.
-Complete evaluation of LRS algorithm development requirements utilizing data streams available from national and organic sensors.
-Complete development of algorithms exploiting broadband acoustic transmit waveforms for improved automatic classification of buried mines from clutter.
-Investigate and develop signal processing algorithms in areas of research such as environmentally adaptive channel estimation/equalization, multi-carrier modulation techniques, and spatial diversity exploitation to enable reliable, high-rate communication between fixed and/or mobile nodes in an ad hoc underwater acoustic communication network.
NRL
-Continue all efforts of FY 2008 less those noted as completed above.
-Complete the development of a numerical simulation capability for exploring SAS system sensitivities to seafloor sediment parameters. (NRL)

	FY 2007	FY 2008	FY 2009
SPECIAL WARFARE/EOD	11,079	11,199	10,360

The goal of this effort is to develop technologies to extend stand-off of special operations and EOD forces in clandestine hydrography, mine clearance and port security missions while increasing the range and effectiveness of divers. Advanced technologies are needed to gain access to areas contaminated by area-denial sensors and/or booby traps. Developed technologies will transition to the Joint Service EOD Program, the Naval EOD Program, or the DOD Technical Response Group. This activity includes applied research in sensor technology for NSW and EOD autonomous and handheld sonar systems to increase detection range and accuracy in harsh environments. Other efforts include mission support technology improvements for AUVs and human divers – such as communications, navigation and life support.

The reduction in FY 2009 represents a change in NRL categorization of investment between the R-2 activities of Mine and Obstacle Detection and Special Warfare/EOD. It does NOT represent a reduction in the priority of this activity.

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FY 2007 Accomplishments:

ONR
-Continued development of dual-mode visible sensor for clandestine tracking of near-shore craft and other objects.
-Continued development of technology to detect, monitor, and disrupt operation of Explosive Safe and Arming (ESA) devices.
-Continued development of low probability of intercept/low probability of detection (LPI/LPD) underwater communications.
-Continued development of AUV technologies for autonomous inspection of ship hulls.
-Continued development of robotic manipulators, actuators and control algorithms based on artificial muscle materials.
-Continued development of a Swimmer Delivery Vehicle (SDV) low-observable periscope.
-Continued development of buried ordnance identification sensor.
-Completed development of a diver heating system for SDV.
-Initiated development of metal-hydride based thermal control technology for combat divers.
-Initiated assessment of x-ray fluorescence technologies for the detection of bulk explosive compounds in containers and vehicles.
NRL
-Continued all efforts.
-Completed prototype of an AUV using a deformable fin by performing self-propulsion tests on a working vehicle and provided a demonstration. (NRL)

FY 2008 Plans:

ONR
-Continue all efforts of FY 2007 less those noted as completed above.
-Complete development of robotic manipulators, actuators and control algorithms based on artificial muscle materials.
-Complete development of an SDV low-observable periscope.
-Initiate development of technologies for portable hand-held detection of concealed Improvised Explosive Devices (IEDs).
-Initiate development of tactile-feedback robotic manipulators.
NRL

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-Continue all efforts of FY 2007 less those noted as completed above.
-Initiate design of an underwater riverine autonomous surveillance system that uses multiple small sensor nodes to provide persistent surveillance. (NRL)

FY 2009 Plans:

-Continue all efforts of FY 2008 less those noted as completed above.

	FY 2007	FY 2008	FY 2009
MINE/OBSTACLE NEUTRALIZATION	9,509	5,918	4,500

Activity includes applied research to support selected MCM related FNC ECs for rapid mine and obstacle neutralization and sea mine jamming techniques to increase surface ship safe standoff from threat mines. It includes various lethality, vulnerability and dispensing computational tools, models and assessments to support the various far-term Surf Zone (SZ) and Beach Zone (BZ) mine and obstacle breaching concepts.

The funding profile for FY 2007 reflected the initiation of important UUV Neutralization products addressing autonomous neutralization of sea mines. This technology, when developed over the Future Years Defense Plan will remove the necessity for divers to perform these dangerous missions and reduce the time necessary for such missions by an order of magnitude. This effort also has NAVSEA transition sponsors. The investment decrease from FY 2007 to FY 2008 reflects the completion and transfer of a major program at the end of FY 2007. In FY 2009, funding programmed for new FNC ECs was realigned to reflect the priorities of the Navy's TOG.

FY 2007 Accomplishments:

-Continued development of models to assess performance of bombs against mines in Very Shallow Water (VSW).
-Continued development of advanced computational models for high speed water entry and penetration.
-Continued development of advanced computational tools for predicting soil penetration by countermine darts.
-Completed development of platform concepts for autonomous mine neutralization by AUVs.
-Completed assessment of dart dispenser concepts using computational tools and engineering level models.
-Completed mine jamming development efforts with a demo on a steel-hulled combatant ship.
-Completed development of a tool to assess mine jamming effectiveness on future ship designs.
-Initiated technology development for autonomous neutralization of sea mines in VSW areas.

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-Initiated development of stand-off, assault breaching warhead fuse to extend effectiveness of unitary warheads to greater water depths.
-Initiated development of precision navigation capability for targeting, safe navigation through assault lanes including lane marking.

FY 2008 Plans:

-Continue all efforts of FY 2007 less those noted as completed above.
-Initiate development of AUV technologies for neutralization of littoral sea mines.
-Initiate acoustic organic mine jamming investigations as a follow-on to FNC work in electromagnetic organic mine jamming.

FY 2009 Plans:

-Continue all efforts of FY 2008.
-Complete development of models to assess performance of bombs against mines in VSW.
-Complete development of advanced computational models for high speed water entry and penetration.
-Complete development of advanced computational tools for predicting soil penetration by countermine darts.
-Complete assessment of stand-off, assault breaching warhead fuse to extend effectiveness of unitary warheads to greater water depths.

	FY 2007	FY 2008	FY 2009
MINE TECHNOLOGY	194	198	192

This activity assesses advanced sea mine technologies to maintain expertise in this Naval Warfare area.

FY 2007 Accomplishments:

-Continued assessment of sea mine technologies in order to maintain a level of expertise in naval mines.

FY 2008 Plans:

-Continue all efforts of FY 2007.

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FY 2009 Plans:

-Continue all efforts of FY 2008.

CONGRESSIONAL PLUS-UPS:

	FY 2007	FY 2008
AUTONOMOUS UNDERWATER VEHICLE (AUV) DOCKING AND RECHARGING STATION	1,749	2,783

FY07: This project initiated support for the concept, design, and development of a large, mobile, unmanned, underwater vehicle to provide docking and energy-refresh capabilities for smaller AUVs.

FY08: This project supports the continued development and demonstration of the AUV docking and recharging station, which will consist of a mobile, unmanned, undersea vehicle capable of docking and replenishing smaller AUVs.

	FY 2007	FY 2008
CENTER FOR DETECTION AND NEUTRALIZATION OF ELECTRONICALLY INITIATED IMPROVED EXPLOSIVE DEVISES (IEDS)	1,644	2,384

FY07: This project initiated support for the concept, design, and development of an effective and reliable means of detecting and neutralizing IEDs through exploration of a magnetic pulse system developed under ONR funding and management.

FY08: This project supports the continued development and demonstration of an effective and suitable IED detection and neutralization system through use of a magnetic pulse system. The system will also provide a viable means of neutralization verification.

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PROGRAM ELEMENT: 0602782N PROGRAM ELEMENT TITLE: MINE AND EXPEDITIONARY WARFARE APPLIED RESEARCH
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	FY 2007	FY 2008
ELECTROMAGNETIC SIGNATURE ASSESSMENT SYSTEM USING MULTIPLE AUTONOMOUS UNDERWATER VEHICLES	0	1,987

This project develops algorithms needed to control a fleet of small autonomous underwater vehicles through integration of inexpensive, easily deployable electromagnetic and possibly acoustic measurement systems to be trained to work together to assess the electromagnetic or acoustic signature of a forward deployed vessel.

	FY 2007	FY 2008
NAVY SPECIAL WARFARE (NSW) UNATTENDED SENSOR NETWORK	2,192	1,589

FY07: This project initiated support for the conceptual design and development of an unattended sensor network for use by NSW forces for covert Sea-Air-Land missions throughout the littorals and across the nearshore.

FY08: This project supports the continued development, testing, and refinement of the unattended sensor network for covert use by NSW forces during littoral and nearshore Sea-Air-Land missions.

	FY 2007	FY 2008
NMSU WATER SECURITY PROGRAM	971	795

FY07: This project initiated the development of a database of technologies for inland desalinization. Additional assessments will provide detailed economic assessments on where additional research funding should be spent. The analysis will determine the costs of the main components of treating brackish water.

FY08: This project continues to develop a comprehensive inland desalinization technologies database. The analysis will determine the costs of the main components of treating brackish water and will provide detailed economic assessments on where additional research funding should be spent.

	FY 2007	FY 2008
REMOTE CONTROLLED SURVEILLANCE SONAR SYSTEM (RCSSS)	0	994

This project supports the development of low-cost, high resolution, remote controlled Side Scan Sonar for

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underwater threats and port protection.

	FY 2007	FY 2008
VIRTUAL ONBOARD ANALYST (VIRONA) FOR MULTI-SENSOR MINE DETECTION	0	994

This project supports development to provide greater diversity in data covering the wide range of phenomenology needed to remove clutter and improve false alarms with regard to base and operate littoral mine countermeasure systems.

C. OTHER PROGRAM FUNDING SUMMARY - NAVY RELATED RDT&E:
PE 0601153N Defense Research Sciences
PE 0602131M Marine Corps Landing Force Technology
PE 0602435N Ocean Warfighting Environment Applied Research
PE 0603502N Surface and Shallow Water Mine Countermeasures
PE 0603640M USMC Advanced Technology Demonstration (ATD)
PE 0603654N Joint Service Explosive Ordnance Development
PE 0603782N Mine and Expeditionary Warfare Advanced Technology
PE 0604654N Joint Service Explosive Ordnance Development

OTHER PROGRAM FUNDING SUMMARY - NON-NAVY RELATED RDT&E:
PE 0602712A Countermine Systems
PE 0603606A Landmine Warfare and Barrier Advanced Technology
PE 1160401BB Special Operations Technology Development
PE 1160402BB Special Operations Advanced Technology Development

D. ACQUISITION STRATEGY:
Not applicable.

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

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603114N
PROGRAM ELEMENT TITLE: POWER PROJECTION ADVANCED TECHNOLOGY

COST: (Dollars in Thousands)

Project Number & Title	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
Total PE	111,176	85,977	60,360	70,519	44,461	55,875	55,593
2911 POWER PROJECTION ADVANCED TECHNOLOGY	70,474	48,914	60,360	70,519	44,461	55,875	55,593
9999 CONGRESSIONAL PLUS-UPS	40,702	37,063	0	0	0	0	0

A. MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: The efforts described in this Program Element (PE) are based on investment directions as defined in the Naval S&T Strategic Plan approved by the S&T Corporate Board (Jan 2007). This strategy is based on needs and capabilities from Navy and Marine Corps guidance and input from the Naval Research Enterprise (NRE) stakeholders (including the Naval enterprises, the combatant commands, the Chief of Naval Operations (CNO), and Headquarters Marine Corps). It provides the vision and key objectives for the essential science and technology efforts that will enable the continued supremacy of U.S. Naval forces in the 21st century. The Strategy focuses and aligns Naval S&T with Naval missions and future capability needs that address the complex challenges presented by both rising peer competitors and irregular/asymmetric warfare.

This program develops and demonstrates advanced technologies, including Directed Energy, for naval weapon systems, and the Electric Warship. This Program Element (PE) includes elements of the following Future Naval Capabilities (FNCs); Time Critical Strike, and ForceNet. Within the Naval Transformation Roadmap, this investment will achieve one of four key transformational capabilities required by Sea Strike as well as technically enable elements of both Sea Shield and Force Net.

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

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PROGRAM ELEMENT: 0603114N
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B. PROGRAM CHANGE SUMMARY:

	FY 2007	FY 2008	FY 2009
FY 2008/FY 2009 President's Budget Submission	114,221	49,684	59,984
Congressional Action	0	37,300	0
Congressional Action - Realigned to Army/Defensewide RDTE	-996	0	0
Congressional Undistributed Reductions/Rescissions	0	-573	0
Execution Adjustments	435	0	0
Program Adjustments	0	0	487
Rate Adjustments	0	0	-111
SBIR Assessment	-2,484	-434	0
FY 2009 President's Budget Submission	111,176	85,977	60,360

PROGRAM CHANGE SUMMARY EXPLANATION:
Technical: Not applicable.

Schedule: Not applicable.

C. OTHER PROGRAM FUNDING SUMMARY:
Not applicable.

D. ACQUISITION STRATEGY:
Not applicable.

E. PERFORMANCE METRICS:
The metrics used are programmatic milestones and technical milestones such as flight test and testing of projectile concepts for technical demonstration programs; Technology Transition Agreements (TTAs) which are agreements between the Office of Naval Research and an acquisition program office to transition FNC 6.3 technologies into an acquisition program.

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PROGRAM ELEMENT: 0603114N PROGRAM ELEMENT TITLE: POWER PROJECTION ADVANCED TECHNOLOGY
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COST: (Dollars in Thousands)

Project Number & Title	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
2911 POWER PROJECTION ADVANCED TECHNOLOGY	70,474	48,914	60,360	70,519	44,461	55,875	55,593

A. MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: This project supports the Time Critical Strike (TCS) and ForceNet FNC components which address technological issues associated with the development of strike weapons to significantly decrease the launch to engagement timeline; provide the Navy of the future the ability to quickly locate, target, and strike critical targets; and enhance mission capabilities and operational utility of Naval forces by dramatically increasing the autonomy, performance, and affordability of Naval organic Unmanned Vehicle systems.

B. ACCOMPLISHMENTS/PLANNED PROGRAM:

	FY 2007	FY 2008	FY 2009
PRECISION STRIKE TECHNOLOGY	41,828	22,926	27,958

This activity focuses on the development of high speed (Mach 3 to Mach 4+) propulsion technologies supporting the development of strike weapons which significantly decrease the launch to engagement timeline. Investments under this activity were previously reported under the Time Critical Strike FNC. This new activity breakout provides improved clarification of the overall investment scope.

Decrease in funding between FY 2007 and FY 2008 is due to the completion of the Hypersonic Flight Demonstration Program (HyFly). The increase in funding between FY 2008 and FY 2009 is due to the significant increase in the 6.3 demonstration portion of the Electromagnetic (EM) Railgun program.

FY 2007 Accomplishments:

- RATTLRS: Completed critical design review and fabrication of an affordable/efficient aero-configuration, complete testing of a Mach 3+ expendable turbine engine, perform system checkouts in advance of demonstrating

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high speed aero-propulsion integration in flight tests.
- HyFly: Conducted one fully powered HyFly flight to demonstrate Hypersonic and long range flight performance.
- EM Gun: Initiated procurement for the first set of new capacitor banks to support the 32 mega-joule (MJ) muzzle energy demonstration. Additional sets will be purchased in FY 2008 and FY 2009 to provide a total of 100MJ of energy to the system. Conducted testing of initial barrel design components from the three vendors currently under contract to design and build the tactical barrel. Conducted system level testing of the energy storage and power delivery system through the rails of the railgun to ensure the initial design will support the full scale power and current requirements in FY 2009 and FY 2010. Supported testing of initial projectile concepts from two vendors currently under contract for projectile development.

FY 2008 Plans:

- RATTLRS: Initiate RATTLRS flight tests demonstrating high speed aero-propulsion integration. Initiate data reduction of flight demonstrations and prepare final program report.
- HyFly: Conduct final fully powered HyFly flight to demonstrate Hypersonic and long range flight performance.
- EM Gun: Continue procurement of capacitor banks. Continue testing components and designs up to 16 MJ muzzle velocity. Continue testing of initial barrel design components and system level testing of the energy storage and power delivery system. Continue Ship integration efforts and support to testing of initial projectile component concepts. Initiate detailed design electromagnetic demonstration launcher with industry partners. Initiate firing of EM lab launcher to test components and designs up to 16 MJ.

FY 2009 Plans:

- EM Gun: Plan for FY 2009 is Go/No Go Decision testing and analysis. Continue testing of initial barrel design components. Continue ship integration efforts. Continue the conduct of system level testing of the energy storage and power delivery system. Continue to support testing of initial projectile concepts. Continue electromagnetic demonstration launcher detailed design. Continue firing of EM lab launcher to continue testing of components and designs up to 16 MJ muzzle velocity. Complete procurement of capacitor banks and continue installation of equipment and system integration into Electromagnetic Launch Facility (EMLF) at NSWC Dahlgren, VA. Initiate Integrated Launch Packages (ILP) flight demonstrations at 20 Kgs. Initiate preliminary designs for mid-range testing.

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	FY 2007	FY 2008	FY 2009
STRIKE AND LITTORAL COMBAT TECHNOLOGIES	20,133	25,988	32,402

The focus of this activity is on those technologies that will support the Naval Precision Strike Operations and provide the Navy of the future the ability to quickly locate, target, and strike critical targets. This activity includes support to the following FNC Enabling Capabilities (ECs): Advanced Naval Fires Technology, Hostile Fire Detection and Response, Dynamic Target Engagement & Enhanced Sensor Capabilities, and Discriminate and Provide Terminal Guidance for Weapons Targeted at Moving Targets.

The increase from FY 2007 through FY 2009 is due to funding additional FNC projects. This Activity reflects the alignment of investments for the following ECs: Advanced Naval Fires Technology Spiral 1, Hostile Fire Detection and Response Spiral 1, Dynamic Target Engagement & Enhanced Sensor Capabilities, Discriminate and Provide Terminal Guidance for Weapons Targeted at Moving Targets and Enhanced Weapons Technologies.

FY 2007 Accomplishments:

- Advanced Naval Fires Technology (ANF): Initiated and completed effort to reduce time delay from target acquisition to engagement through information sharing interfaces; accurate mobile, lightweight fire control systems and improved forward digital target acquisition and hand off. Specific tasks included: adaptive expeditionary maneuver warfare system, advanced gun barrel technology, advanced weapons material technology, indirect weapon aiming/pointing system size/weight reduction, Marine Air/Ground Task Force (MAGTF)/Joint fires information exchange connectivity and interoperability, Vertical Assault force lightweight computational interface capability, and universal fire control software for indirect weapon systems.
- Hostile Fire Detection and Response (HFDR): Developed technologies for hostile fire detection and active response capabilities to increase individual Marine and tactical level unit survivability and mobility. Specific efforts included: advanced ammo packaging, Electronic Warfare (EW) Integrated System for Small Platforms (EWISSP) and GUNSLINGER hostile fire detection and counter fire system.
- Dynamic Target Engagement & Enhanced Sensor Capabilities (includes Ground Moving Target Indicator (GMTI) and Ultra Endurance Unmanned Air Vehicle (UAV) projects): Developing the capability to improve the processing of dynamic targets from 100 to 400 per day. Developed UAVs with increased endurance and support for more autonomous operations. Specific tasks included development of: decision support algorithms for dynamic target engagement, remote sensor fusion hardware for ground sensors, an ultra endurance UAV, and a GMTI radar system for use on UAVs. Continued effort to provide a low-cost, single board radar system suitable for use on a long endurance UAV. Continued effort to provide affordable, high endurance platform/propulsion with Commercial Off

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the Shelf (COTS) and modified COTS components for persistent Intelligence, Surveillance and Reconnaissance (ISR), targeting, Bomb Damage Assessment/Bomb Damage Indication (BDA/BDI), and weapon delivery. Continued development of Electro Optic/Infrared (EO/IR) sensors and foliage penetration radars suitable for high resolution imaging of ground threats through rain, fog, and camouflage from small UAVs.
- Discriminated and Provided Terminal Guidance for Weapons Targeted at Moving Targets: Provided products to discriminate targets from non-combatants and provided terminal guidance to engage targets that are operating in close proximity to noncombatants. The effort developed advanced sensors, communications, and planning systems. Specific tasks included: the development of a Low-Cost Imaging Terminal Seeker (LCITS). LCITS conducted a successful Program Round (PR) #1 Shot which met all PR-1 Flight Objectives.

FY 2008 Plans:

- Hostile Fire Detection and Response: Complete Reconfigurable Surveillance UAV for Warfighters which developed EO/IR sensors and foliage penetration radars suitable for high resolution imaging of ground threats through rain, fog, and camouflage from small UAVs.
- Discriminate and Provide Terminal Guidance for Weapons Targeted at Moving Targets: Continue Low Cost Imaging Terminal Seeker projects. Initiate Weapons Data Link (WDL) project to develop a weapons data link terminal that will allow robust in-flight control of strike weapons at greater standoff ranges with reduced power/space/weight requirements, and improved protection against Electronic Counter Measures (ECM).
- Dynamic Target Engagement & Enhanced Sensor Capabilities: Continue Ultra Endurance UAV project. Complete GMTI Scout, and Remote Sensor Fusion Card efforts. Initiate Decision Support for Dynamic Target Engagement.
- Increased Capability Against Moving and Stationary Targets: Initiate Direct Attack Seeker Head (DASH) project to use active millimeter wave (mmW) radar and Imaging Infrared (IIR) seekers to develop and demonstrate a low cost multi-sensor array technology to engage moving targets in adverse weather battlefield conditions. The DASH common aperture architecture is applicable to a variety of weapon airframes such as Hellfire, High Speed Anti-Radiation Missile (HARM), Joint Direct Attack Munition (JDAM), and Harpoon. Initiate Multi-Mode Sensor/Seeker (MMSS) project to develop a tri-mode sensor/seeker for use on surveillance platforms such as Fire Scout. MMSS will develop and demonstrate the capability to provide increased range target search, acquisition, identification, and tracking in both clear and adverse battlefield weather.

FY 2009 Plans:

- Discriminate and Provide Terminal Guidance for Weapons Targeted at Moving Targets: Complete LCITS project, including captive carry of the weapon integrated seeker and upgraded launcher and firing two guided rounds

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within a tactically relevant environment. Continue WDL hardware and software demonstration of a weapons data link terminal that will allow robust in-flight control of strike weapons at greater standoff ranges with reduced power/space/weight requirements, and improved protection against ECM.
- Dynamic Target Engagement & Enhanced Sensor Capabilities: Complete Decision Support for Dynamic Target Engagement, and Ultra Endurance UAV efforts.
- Increased Capability Against Moving and Stationary Targets: Continue the DASH project to drive down seeker cost during the procurement and test of the infrared imaging seeker components. Continue MMSS project to conduct a Concept Design Review (CDR) and initiate the build of a common aperture Laser Radar (LADAR) and infrared sensor system.
- Enhanced Weapons Technologies: Initiate three new products to address short-falls in current Counter Air (CA) and Counter Air Defense (CAD) capabilities by providing improved range and end-game maneuverability while decreasing Time-of-Flight. Initiate definition and documentation of system level requirements for airframe, thrust level, insensitive-munitions and safety/reliability for CA Advanced Mid-Range Air-to-Air Missile (AMRAAM) Improvements. Initiate definition and documentation of system level requirements for CAD. Initiate definition and documentation of system level requirements for High Speed Components.
- Continue development of advanced technologies that support delivery of Technology Oversight Group approved FNC ECs structured to close operational capability gaps in power projection. Package advanced power projection technologies into deliverable FNC products and ECs that can be integrated into acquisition programs within a five year period. Mature power projection technologies that support naval requirements identified within the Sea Strike and FORCEnet naval capability pillars.

	FY 2007	FY 2008	FY 2009
AUTONOMOUS OPERATIONS (AO)	8,513	0	0

The Autonomous Operations (AO) FNC activity aims to enhance the mission capability and operational utility of Naval forces by developing technologies that will dramatically increase the autonomy, performance, and affordability of Naval organic Unmanned Vehicle systems. By defining and focusing risk reduction overarching Intelligent Autonomy (IA) S&T principles, transitional products will be developed in four areas: UAV Technology, which includes IA reasoning, technologies to enhance "see and avoid" capabilities, object identification, vehicle awareness, and vehicle and mission management; UUV, which will demonstrate the technical feasibility for a UUV system to effectively search, detect, track and trail undersea threats while maintaining a robust communications link to enable appropriate command, control and transmission of collected data; UGV, which focus on the increasing utility of UGV systems in urban and littoral terrain to Marine Corps units; and UAV Propulsion, which will develop innovative propulsion and power technologies unique to Naval

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UAVs operating from surface combatants. This activity also contains a task from the Knowledge Superiority Assurance FNC.

This Activity reflects the alignment of investments for the following ECs: Marine and UxV Tactical Intelligence, and Surveillance and Reconnaissance (ISR). The elimination of funding after FY 2007 is a result of the completion in FY 2007 of all of the Autonomous Operations tasks including multi-vehicle cooperation technologies, multi-modal interface control, and the UAV propulsion tasks.

FY 2007 Accomplishments:

- IA Task: Completed testing and demonstration of multi-vehicle cooperation technologies including high-fidelity simulation of multiple heterogeneous Naval unmanned vehicles in a simulated warfare environment, hardware, and in-water demonstrations.
- UAV Technology: Completed testing and demonstration of multi-modal interface control.
- UAV Propulsion: Completed integration of power generation, distribution, prognostic and engine diagnostic and thermal management technologies on the WLE-67/A1 demonstrator engine and ground test. The propulsion system and associated technologies developed and demonstrated are applicable towards Joint-Unmanned Combat Air System (J-UCAS), and Broad Area Maritime Surveillance (BAMS) UAV. Completed ground test of the XTE-67/A1 UAV demonstrator engine with naval-unique technologies and integrated with an enhanced next-generation commercial core and a Mach 3.5 capable expendable turbine engine for missile applications.

C. OTHER PROGRAM FUNDING SUMMARY - NAVY RELATED RDT&E:
PE 0305204N Tactical Unmanned Aerial Vehicles
PE 0601153N Defense Research Sciences
PE 0602114N Power Projection Applied Research
PE 0602131M Marine Corps Landing Force Technology
PE 0602236N Warfighter Sustainment Applied Research
PE 0603123N Force Protection Advanced Technology
PE 0603236N Warfighter Sustainment Advanced Technology
PE 0603502N Surface and Shallow Water Mine Countermeasures
PE 0603654N Joint Service Explosive Ordnance Development
PE 0603782N Mine and Expeditionary Warfare Advanced Technology
PE 0603790N NATO Research and Development

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OTHER PROGRAM FUNDING SUMMARY - NON-NAVY RELATED RDT&E:
PE 0603709D8Z Joint Robotics Program
PE 0604709D8Z Joint Robotics Program
PE 0602203F Aerospace Propulsion

D. ACQUISITION STRATEGY:
Not applicable.

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PROGRAM ELEMENT: 0603114N PROGRAM ELEMENT TITLE: POWER PROJECTION ADVANCED TECHNOLOGY
PROJECT NUMBER: 9999 PROJECT TITLE: CONGRESSIONAL PLUS-UPS

CONGRESSIONAL PLUS-UPS:

	FY 2007	FY 2008
ADVANCED LIFTING BODY SHIP RESEARCH	5,438	0

This effort supported issues arising from commercialization efforts coming from technology transfer.

	FY 2007	FY 2008
ADVANCED MOTOR-PROPULSOR DEVELOPMENT AND TESTING	0	3,974

This effort supports Advanced Motor-Propulsor Development and Testing.

	FY 2007	FY 2008
ARTICULATED STABLE OCEAN PLATFORM	1,554	0

This effort supported the extension of predictive methods, previously developed, to elastically connect bodies with further extension to ship-to-ship connectors.

	FY 2007	FY 2008
AUTONOMOUS UNMANNED SURFACE VESSEL	1,749	0

This effort continued development and testing of the Autonomous Unmanned Surface Vessel prototype. This program also modified and outfitted the prototype to develop, integrate and demonstrate a wing sail, command and control software/algorithms, a navigation system and a hydrofoil.

	FY 2007	FY 2008
DP-2 VECTORED THRUST AIRCRAFT	3,797	0

This effort upgraded the simulation to allow for better prediction of performance, improved test design, and testing of aircraft engine hot gas ingestion in ground effect using aircraft and models.

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	FY 2007	FY 2008
EXCALIBUR	0	795

This effort supports Excalibur research.

	FY 2007	FY 2008
EXPEDITIONARY CRAFT	9,128	19,871

The FY 2007 effort supported the construction of the experimental expeditionary vessel demonstrator (E-Craft, or MV Susitna) and preparation for Navy trials to occur when the ship is complete.

The FY 2008 effort supports Expeditionary Craft research.

	FY 2007	FY 2008
FLOW PATH ANALYSIS TOOL (FPAT)	0	994

This effort supports flow path analysis tool (FPAT) research.

	FY 2007	FY 2008
HIGH ENERGY LASER SYSTEMS TEST FACILITY	2,526	0

This effort upgraded the Mid-Wave Infrared (MWIR) and the Long-Wave Infrared (LWIR) sensors to provide improved target acquisition in clutter and more precise tracking of the target during the laser engagement.

	FY 2007	FY 2008
HIGH SPEED ANTI-RADIATION DEMONSTRATION (HSAD)	0	1,593

This effort supports high speed anti-radiation demonstration (HSAD) research.

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	FY 2007	FY 2008
INFORMATION SHARING FOR ISRTE	1,749	994

The FY 2007 effort supported the development of algorithms to: detect, track, and engage a moving target using the in-flight weapon; evaluate the communication requirements of the weapon to receive the initial targeting information and to update targeting information in flight; and developed a simulation capability that will allow the new weapon algorithms to be tested and verified against moving targets. Pattern recognition algorithms to aid in target reacquisition were developed. The simulation software supported a simulation of the end game over water or land with inserted targets.

The FY 2008 effort will support information sharing for Intelligence, Surveillance, Reconnaissance, Targeting and Engagement (ISRTE) of mobile targets research.

	FY 2007	FY 2008
LASER RADAR (LADAR)	3,163	0

This effort demonstrated increased laser power to provide increased sensor range and resolution. Eye-safe capabilities were explored to enhance sensor regimes.

	FY 2007	FY 2008
LASER RADAR (LADAR) - NAVAL AIR WARFARE CENTER CHINA LAKE	943	0

This effort supported development of a laser radar at the Naval Air Warfare Center, China Lake.

FY 2009 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2008
Exhibit R-2a

BUDGET ACTIVITY: 03
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	FY 2007	FY 2008
LONG WAVELENGTH ARRAY	1,611	2,384

The FY 2007 effort developed a prototype low-frequency radio telescope designed to study small scale irregularities in the Earth's ionosphere and to produce high-sensitivity, high-resolution images of cosmic radio sources in the frequency range of 20-80 MHz, thus providing an entirely new probe of ionospheric and astronomical phenomena at scales never before achieved. This was accomplished with a large collecting area (approaching 1 square kilometer at its lowest frequencies) spread over an interferometric array with baselines of at least 400 km, located mainly in the state of New Mexico.

The FY 2008 effort will support long wavelength array research.

	FY 2007	FY 2008
MAGDALENA RIDGE OBSERVATORY (MRO)	3,795	6,458

The FY 2007 effort focused on acceptance testing for a single 2.4m telescope and design and development of various systems associated with an interferometer.

The FY 2008 effort will support research at the Magdalena Ridge Observatory.

	FY 2007	FY 2008
QUIET HIGH SPEED PROPULSION	4,273	0

This effort focused on reducing the risk associated with integrating a high power density motor with a large length to diameter ratio into a podded propulsor housing. A prototype Quiet High Speed Podded Motor was constructed and underwent land-based in-water testing to demonstrate and validate acoustic and electromagnetic signature performance.

FY 2009 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2008
Exhibit R-2a

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603114N PROGRAM ELEMENT TITLE: POWER PROJECTION ADVANCED TECHNOLOGY
PROJECT NUMBER: 9999 PROJECT TITLE: CONGRESSIONAL PLUS-UPS

	FY 2007	FY 2008
TIME CRITICAL STRIKE RAMJET	976	0

This effort focused on performing a successful flight test demonstration of the High-Speed Anti-radiation Demonstration (HSAD) weapons system and supported HSAD Airframe/Propulsion Section development with the maturing of key technology areas that were investigated in the previous year's research.

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Exhibit R-2

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603123N
PROGRAM ELEMENT TITLE: FORCE PROTECTION ADVANCED TECHNOLOGY

COST: (Dollars in Thousands)

Project Number & Title	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
Total PE	142,926	119,562	55,099	63,845	64,236	48,147	42,296
2912 FORCE PROTECTION ADVANCED TECHNOLOGY	55,323	67,552	52,863	61,468	61,712	45,575	39,671
3049 FORCE PROTECTION	2,602	2,079	2,236	2,377	2,524	2,572	2,625
9999 CONGRESSIONAL PLUS-UPS	85,001	49,931	0	0	0	0	0

A. MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: The efforts described in this Program Element (PE) are based on investment directions as defined in the Naval S&T Strategic Plan approved by the S&T Corporate Board (Jan 2007). This strategy is based on needs and capabilities from Navy and Marine Corps guidance and input from the Naval Research Enterprise (NRE) stakeholders (including the Naval enterprises, the combatant commands, the Chief of Naval Operations (CNO), and Headquarters Marine Corps). It provides the vision and key objectives for the essential science and technology efforts that will enable the continued supremacy of U.S. Naval forces in the 21st century. The Strategy focuses and aligns Naval S&T with Naval missions and future capability needs that address the complex challenges presented by both rising peer competitors and irregular/asymmetric warfare.

This PE addresses advanced technology development associated with providing the capability of Platform and Force Protection for the U.S. Navy. This program supports the development of technologies associated with all naval platforms (surface, subsurface, terrestrial and air) and the protection of those platforms. This PE supports the Future Naval Capabilities (FNC) in the areas of Sea Shield and Cross Pillar Enablers, and Enterprise and Platform Enablers (EPE). The goal of this program is to provide the ability to win or avoid engagements with other platforms or weapons and, in the event of engagement, to resist and control damage while preserving operational capability. Surface Ship & Submarine, Hull, Mechanical & Electrical (HM&E),

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Missile Defense, Fleet Force Protection and Defense against Undersea Threats, and Emerging Threats activities all support FNC efforts.

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

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603123N
PROGRAM ELEMENT TITLE: FORCE PROTECTION ADVANCED TECHNOLOGY

B. PROGRAM CHANGE SUMMARY:

	FY 2007	FY 2008	FY 2009
FY 2008/FY 2009 President's Budget Submission	147,111	70,850	58,615
Congressional Action	1,300	50,250	0
Congressional Undistributed Reductions/Rescissions	-5	-787	0
Execution Adjustments	-2,184	0	0
Program Adjustments	0	0	-3,347
Rate Adjustments	0	0	-169
SBIR Assessment	-3,296	-751	0
FY 2009 President's Budget Submission	142,926	119,562	55,099

PROGRAM CHANGE SUMMARY EXPLANATION:
Technical: Not applicable.

Schedule: Not applicable.

C. OTHER PROGRAM FUNDING SUMMARY:
Not applicable.

D. ACQUISITION STRATEGY:
Not applicable.

E. PERFORMANCE METRICS:
The overall goals of this advanced technology program are the development of technologies which focus on the warfighter and providing the ability to win or avoid engagements with other platforms or weapons and, in the event of engagement, to resist and control damage while preserving operational capability. Overall metric goals are to transition the advanced technology projects into acquisition programs. Each Activity within this PE has unique goals and metrics, some of which include classified quantitative measurements.

Specific examples of metrics under this PE include:

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- Demonstrate improved performance of main propulsion electric motors and controllers (50% reduced weight and volume) by FY 2011.
- Demonstration of a Medium Voltage Direct Current (MVDC) architecture containing Commercial Off the Shelf (COTS) components to assess the viability of MVDC distribution for CG (X) cruiser by the end of FY 2011.
- In-water successful demonstration of warhead lethality against specified threat at required Closest Point of Approach (CPA).
- Items included within the Missile Defense Activity description.

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PROGRAM ELEMENT: 0603123N PROGRAM ELEMENT TITLE: FORCE PROTECTION ADVANCED TECHNOLOGY
PROJECT NUMBER: 2912 PROJECT TITLE: FORCE PROTECTION ADVANCED TECHNOLOGY

COST: (Dollars in Thousands)

Project Number & Title	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
2912 FORCE PROTECTION ADVANCED TECHNOLOGY	55,323	67,552	52,863	61,468	61,712	45,575	39,671

A. MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: This project addresses advanced technology development associated with providing the capability of Platform and Force Protection for the U.S. Navy. This project supports the development of technologies associated with all naval platforms (surface, subsurface, terrestrial, and air) and the protection of those platforms. It supports the Sea Shield and Cross Pillar Enablers, and Enterprise and Platform Enablers (EPE) -- Future Naval Capabilities (FNCs). The goals of this project are to provide the ability to win or avoid engagements with other platforms or weapons and, in the event of engagement, to resist and control damage while preserving operational capability.

This Project reflects the alignment of investments for the following ECs: Total Ship Survivability Damage Tolerance and Recoverability; Over-the-Horizon Missile Defense; Two-Torpedo Salvo Defense; Defense of Harbor and Near-Shore Naval Infrastructure Against Asymmetric Threats; Sea Based Missile Defense of Ships & Littoral Installations; Aircraft Integrated Self-Protection Suites; Hostile Fire Detection and Response Spirals 1 and 2; Four-Torpedo Salvo Defense; Shipboard Force Protection in Port and Restricted Waters - Detection and Classification; and Underwater Total Ship Survivability.

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B. ACCOMPLISHMENTS/PLANNED PROGRAM:

	FY 2007	FY 2008	FY 2009
SURFACE SHIP & SUBMARINE HULL MECHANICAL & ELECTRICAL (HM&E)	16,889	10,160	18,439

Activity includes: Signature Reduction, Hull Life Assurance, and Advanced Capability Electric Systems. Signature Reduction addresses electromagnetic (EM), infrared (IR), and acoustic signature tailoring, both topside and underwater. Hull Life Assurance addresses development of new structural system approaches for surface ships and submarines, including the management of weapon effects to control structural damage and the improvement of structural materials. Advanced Capability Electric Systems area addresses electrical and auxiliary systems and component technology to provide improvements in system energy and power density, system operating efficiency, and recoverability from casualties. Advanced Damage Control Countermeasures addresses fire, smoke, and flooding detection using a volume sensor and the use of a hybrid water-mist for electronic space protection. This activity includes support to the Sea Strike, Cross Pillar Enablers, and Enterprise and Platform Enablers (EPE) FNC programs.

Funding decrease from FY 2007 to FY 2008 is due to completion of construction of the 36.5 MW Superconducting Motor and completion of Total Ownership Cost efforts. The increase of funding from FY 2008 to FY 2009 is due to the initiation of new FNC Enabling Capabilities including Underwater Total Ship Survivability, and Affordable Submarine Propulsion and Control Actuator; and the realignment of Compact Power Conversion Technologies from PE 0603236N/Turbine Engine Technology.

FY 2007 Accomplishments:

- Continued development of diesel fuel reforming technology for molten carbonate and proton exchange membrane fuel cells.
- Continued development of advanced superconducting homopolar main propulsion motor with General Atomics.
- Continued development of autonomous recovery system for Unmanned Sea Surface Vehicles from a host ship.
- Completed development of on-board vehicle power system technologies for future Marine Corps Battlefield Power System.
- Completed testing of superconducting synchronous main propulsion motor with American Superconductor.
- Initiated development of Integrated Damage Control Systems which includes Integrated Damage Control

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Communications and Advanced Magazine Protection System.

FY 2008 Plans:

- Continue all efforts of FY 2007, less those noted as completed above.
- Initiate Total Ship Survivability Damage Tolerance and Recoverability efforts which include integrated damage control situation awareness technologies.

FY 2009 Plans:

- Continue all efforts of FY 2008.
- Continue compact power conversion technologies FNC transitioned from PE 0603236N/Turbine Engine Technology.
- Initiate expansion of Next Generation Integrated Power Systems (NGIPS) technology development, to de-risk and demonstrate applicable Medium Voltage Direct Current (MVDC) power dense, efficient, and fault tolerant technologies needed for future surface, and subsurface platforms.
- Initiate expanded demonstration of superconductive degaussing coil in a relevant environment.
- Initiate Affordable Submarine Propulsion and Control Surface Actuator technologies focused on the development and demonstration of affordable composite propellers and torque dense and quiet actuation of submarine control surface efforts.
- Initiate Underwater Total Ship Survivability/Payload Implosion and Platform Damage Avoidance efforts.

	FY 2007	FY 2008	FY 2009
FLEET FORCE PROTECTION AND DEFENSE AGAINST UNDERSEA THREATS	25,551	21,846	13,976

Fleet Force Protection and Defense against Undersea Threats addresses efforts that include applied research for complementary sensor and processing technologies for platform protection and shipboard technologies to increase the survivability of surface ship and submarine platforms against torpedo threats.

The first major goal of this activity is to develop complementary sensor and processing technologies for 21st century warfighting success and platform protection. Current small platforms (both surface and airborne) have little or no situational awareness (SA) or self-protection against air, surface, and asymmetric threats. This activity will provide tactical aircraft (TACAIR) and other platforms with effective threat warning and self-

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protection. The technology areas specific to platform protection will develop individual or multi-spectral [Electro-Optic (EO), IR, radio frequency (RF), EM, visual, and acoustic] sensors and associated processing. To defend platforms from current and advanced threats in at-sea littoral environments and in port, these technologies must improve multi-spectral detection and distribution of specific threat information.

The Fleet Force Protection portion of this activity includes support to the FNC Enabling Capabilities for: Aircraft Integrated Self-protection Suites; Intent Determination – EO/IR Enhancements; Proof-of-Concept for Non-lethal Approach; Advanced Electronic Sensor Systems for Missile Defense; Hostile Fire Detection and Response Spirals 1 and 2; Defense of Harbor and Near-Shore Naval Infrastructure Against Asymmetric Threats; Four-Torpedo Salvo Defense; and Shipboard Force Protection in Port and Restricted Waters - Detection and Classification.

The second major goal of this activity is to develop enabling technologies that will increase the survivability of surface ship and submarine platforms against torpedo threats. Proposed technologies focus on defeating high priority threats including torpedoes (i.e. straight running, wake homing, acoustic homing, air dropped torpedoes, and salvoes of torpedoes). Technologies developed will minimize shipboard impact and require no shipboard organizational maintenance. Two major efforts are ongoing: 1) The Next Generation Countermeasure (NGCM) is a mobile adaptive acoustic countermeasure (CM) for defeating threat torpedoes; NGCM capabilities will include acoustic communication links to enable connectivity from each CM to other CMs (in the group) and to the host platform; and 2) The Anti-Torpedo Torpedo (ATT)/Tripwire provides technologies that enable an ATT to engage threat torpedoes detected by a surface ship towed sensor system. The ultimate goal is to develop technologies to enable a torpedo defense capability, including ship self-defense against salvo torpedo attacks, to fill the FNC Sea Shield Warfighting Capability Gap/Enabling Capability: Platform Defense against Undersea Threats. Ultimately the goal is to deliver a netted set of decoys and an anti-torpedo-torpedo for use in defeating a four-torpedo salvo attack against a surface or subsurface platform.

The funding decrease from FY 2007 to FY 2008 reflects completions and transitions of demonstration activities. The decrease from FY 2008 to FY 2009 reflects the completion of FNC Enabling Capabilities Two-Torpedo Salvo Defense, Aircraft Integrated Self-Protection Suites, and Hostile Fire Detection and Response Spiral 2; and decreased effort in Defense of Harbor and Near-Shore Naval Infrastructure Against Asymmetric Threats.

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FY 2007 Accomplishments:

Sensors & Associated Processing -

- Continued laboratory demonstration of a coated carbon fiber cable that survives 27 times longer than Zylon under direct flame at temperatures >1800 degrees Fahrenheit. Integrated Defensive Electronic Countermeasures Pre-Planned Product Improvement (IDECM P3I).
- Continued laboratory demonstration of the upgraded multiband laser towards a goal of 5W in all bands for EO/IR Jammer for TACAIR.
- Continued the End User Terminal (EUT) effort by conducting a side-by-side laboratory demonstration of the Dismounted-Digital Automated Computing Terminal (D-DACT) including the integrated 256 color Organic Light Emitting Diode (OLED) display with a Liquid Crystal Display D-DACT.
- Continued the Shipboard EO/IR Closed Loop Self-Protection effort by demonstrating a pulse-gated visible receiver operating at 10kHz frame rate.
- Continued the integration of the Gallium Arsenide (GaAs) transmitter with an ALE-55 sized Fiber-Optic Towed Decoy (FOTD) and onboard power supply for the Integrated Defensive Electronic Countermeasures Pre-Planned Product Improvement (IDECM P3I) effort.
- Continued the integration of a noncryogenic solid-state Mid-wave Infrared (MWIR) multiband laser into a prototype Tactical Aircraft Directed IR Countermeasures (TADIRCM) pod that will undergo an Early Operational Assessment (EOA) in FY06 (EO/IR Laser Jammer for TACAIR).
- Continued the Integrated EO/IR Self Protection Suite for Rotary Wing Aircraft effort by evaluating and demonstrating an uncooled missile warning system (MWS) sensor operating in the visible/near-infrared (500-1100 nanometer) spectral band.
- Continued the integration and laboratory testing of the multiband laser jammer, stabilized pointer, and closed-loop EO/IR receivers for the Shipboard EO/IR Closed-Loop Self Protection effort.
- Continued preparations for the completion of the EUT effort by planning a field demonstration of the full capabilities of the integrated personal communications, situational awareness, and gunfire detection system including the Monocular Display with a super video graphics adapter (SVGA) resolution of 800x600 pixels.
- Continued developing technologies to support the Intelligent Video Surveillance project which includes integration of object recognition and tracking algorithms, machine vision, and multiple networked video streams into different classes of EO/IR sensors. (Transferred from PE 0602131M in FY 2007.)
- Continued performance evaluation of a Counter Torpedo Detection, Classification and Localization (CTDCL) prototype torpedo protection system capable of countering two torpedoes launched in rapid succession. Transferred from PE 0603747N.

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- Transferred the Shipboard EO/IR Closed Loop Self-Protection effort to PE 0603271N.
- Transferred development work on improving imaging technologies (EO/IR/Laser) supporting Integrated Radar Optical Sighting & Surveillance (IROSS) Shipboard Protection System (SPS) Spiral for IROSS to PE 0602131M.
- Completed laboratory demonstration of the common jam code countermeasure jamming capability by demonstrating a 95% jamming effectiveness for all Tier 1 and 2 IR threats (EO/IR Laser Jammer for TACAIR).
- Completed flight tests against single and multiple, simultaneous threats employing the complete system capabilities, including new towline capable of continuous operation at temperatures exceeding 1800 degrees Fahrenheit, 80W output continuous wave RF decoy, and Electronic Countermeasure (ECM) techniques (IDECM P3I effort).

Underwater Platform Self-Defense -
- Continued development of technologies to support the Underwater Threat Neutralization project which include a scalable low frequency continuous wave acoustic weapon for use against underwater asymmetric threats.
- Completed closed loop in-water data collection experiments to collect ATT one-on-one (1x1) sensor data for improving operations in the wake.
- Completed closed loop in-water data collection efforts to evaluate the ATT two-on-two (2x2) salvo sonar technologies for improving operations outside the wake.
- Completed evaluation of NGCM mobility capabilities by in-tank tests.
- Completed open loop in-water demonstration of ATT one-on-one (1x1) engagement in the wake.
- Completed in-water demonstration of free swimming NGCM.
- Completed open loop in-water experiments to evaluate ATT salvo four-on-four (4x4) engagement technologies.
- Completed in-water tests evaluating the ability of ATTs to transmit and receive acoustic communication between vehicles.
- Initiated and completed demonstration of NGCM acoustic communication technologies and transition them to PMS415.
- Initiated and completed conduct of in-water demonstration of full duplex adaptive signal generation capability for NGCM.
- Initiated and completed in-tank experiments at Naval Undersea Warfare Center, Division Newport to evaluate NGCM group behavior technology.

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FY 2008 Plans:

Sensors & Associated Processing -
- Continue all efforts of FY 2007, less those noted as completed above.
- Complete the Integrated EO/IR Self Protect Suite for Rotary Wing Aircraft by conducting a field demonstration of the integrated Missile Warning Sensor (MWS) and multi-band fiber coupled laser jammer.
- Complete the Intelligent Video Surveillance project including integration of object recognition and tracking algorithms, machine vision, and multiple networked video streams into different classes of EO/IR sensors.
- Complete the IDECM P3I effort by conducting final flight testing of improved decoys and towlines.
- Complete performance evaluation of a CTDCL prototype torpedo protection system capable of countering two torpedoes launched in rapid succession.
- Initiate new FNC Enabling Capability (EC) Shipboard Force Protection in Port and Restricted Waters - Detection and Classification. This project will develop mission specific electro-optic/infrared sensors to detect, classify, and determine the intent of potential terrorist and special operations force threats to ships and craft in port and transiting restricted waters.

Underwater Platform Self-Defense -
- Continue all efforts of FY 2007, less those noted as completed above.
- Complete the Underwater Threat Neutralization project including demonstration of a scalable low frequency continuous wave acoustic system for use against underwater asymmetric threats in port.
- Initiate development of low-cost, light-weight swimmer detection and localization technologies.

FY 2009 Plans:

Sensors & Associated Processing -
- Continue all efforts of FY 2008, less those noted as completed above.
- Continue new FNC EC entitled Shipboard Force Protection in Port and Restricted Waters - Detection and Classification, initiated, in FY 2008. This effort develops mission specific electro-optic/infrared sensors to detect, classify, and determine the intent of potential terrorist and special operations force threats to ships and craft inport and transiting restricted waters. Sensor projects included in this FNC EC include Distributed Millimeter Wave (DmmW) Sensor, Active/Passive Dual Imaging IR (MW/SW) Sensor, and Situational Panoramic Infrared (SPIR) Sensor.
- Initiate the Countermeasures for Advanced Imaging Infrared (IIR) Guided Missiles FNC effort by

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commencing IIR threat surrogate hardware development.
- Initiate the Countermeasures for Millimeter Wave Guided Missiles FNC effort by initiating wide band gap monolithic microwave integrated circuit (MMIC) Ka-band development.
- Initiate the Multifunction Capabilities for Missile Warning Sensors FNC effort by commencing signal processor development.

Underwater Platform Self-Defense -
- Continue all efforts of FY 2008, less those noted as completed above.
- Initiate expanded development of autonomous, underway refueling for Unmanned Sea Surface Vehicle Technologies.
- Initiate advanced development of software encoded algorithms for the Anti-Torpedo Torpedo (ATT) sensor and controller that will enable ATT's to successfully engage torpedo salvoes of up to four attacking units.

	FY 2007	FY 2008	FY 2009
MISSILE DEFENSE (MD)	9,910	35,546	20,448

This activity describes Missile Defense Science and Technology (S&T) projects of the Sea Shield Future Naval Capability (FNC) program and an OSD-funded Joint Integrated Fire Control (JIFC) demonstration.
- Advanced Area Defense Interceptor (AADI) S&T planning and data analysis effort for Navy-Marine Corps Air-Directed Surface-to-Air Missile (ADSAM) live firing demonstration at White Sands Missile Range in FY 2008. The metric for AADI is execution of an ADSAM demonstration by the Navy and Marine Corps that establishes the basis for further development of an operational Naval Integrated Fire Control/Counter-Air (NIFC-CA) capability.
- Distributed Weapons Coordination (DWC) open architecture combat system algorithms for Theater Air and Missile Defense (TAMD) Automated Battle Management Aids (ABMA), including Common Threat Evaluation (CTE) and Preferred Shooter Recommendation (PSR) functions that will enable fleet units to defend against air and missile attacks with increased effectiveness and efficiency. Metrics for DWC include (a) increased effectiveness of combat resources through a theater-wide threat evaluation process; (b) increased efficiency of weapons resources through weapon assignment and preferred shooter recommendations considering Theater Ballistic Missile Defense (TBMD) and Area/Ship Defense capability operating simultaneously; and (c) reduced "free riders" (threats not fired at) due to ineffective use of resources (unengaged targets) by 50% (threshold) 80% (objective). Transition to acquisition in FY 2008.
- Distributed Sensor Coordination (DSC) algorithms for airborne sensor management in ADSAM and multi-threat air defense engagements. The metric for DSC is effective coordination of airborne sensor resources to

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support NIFC-CA capability, evaluated using laboratory Monte Carlo simulations within simulated stressing air defense environments. Transition to acquisition in FY 2008.

- Naval Interceptor Improvements (NII) technology upgrades for STANDARD Missile (SM) future TAMD missile. Metrics will be to achieve SM performance requirements in specified tactical rain environments and all specified electronic countermeasures environments. Transition anticipated in FY 2011.
- Extended Distributed Weapons Coordination (EDWC) algorithms to extend DWC ABMA functionality to include coordination of passive defense measures (emission control, use of decoys, maneuvering). Metrics will be improved probability of negation (Pneg) against advanced ballistic & cruise missile anti-ship threats that may be susceptible to decoys & jamming. Transition anticipated in FY 2011.
- Positive Control of Naval Weapons (PCNW) equipment and computer programs for an advanced multi-band weapon system/interceptor link to enable forward pass engagements and enhance link security in hostile environments. Metrics will be capabilities to receive in-flight update from TAMD systems including AEGIS combatants, airborne & land-based units, and ability to transmit status and target data to controlling unit and/or other interceptor missiles. Transition anticipated in FY 2011.
- Advanced technologies that support delivery of Technology Oversight Group (TOG)-approved FNC enabling capabilities (EC) structured to close operational capability gaps in missile defense.
- Joint Integrated Fire Control (JIFC) S&T planning and preparations, non-FNC expansion of the AADI ADSAM demonstration, to support participation of Army, Air Force and coalition sensor and weapon test assets. The metric for this expanded participation is a series of demonstrations in FY08-09 that show a technology basis for effective interoperability with Navy and Marine Corps participating systems. These additional demonstrations are designed to show the viability of a multi-Service/coalition JIFC capability to defend expeditionary forces from air and missile attacks.

Funding increase from FY 2007 to FY 2008 results from JIFC demonstration S&T efforts and initiation of EDWC and PCNW projects. Funding decrease in FY 2009 reflects near completion of AADI and completion of DWC and DSC projects.

FY 2007 Accomplishments:

- Continued AADI ADSAM demonstration planning and coordination efforts.
- Continued development of DSC algorithms and operational concept for TAMD sensor management.
- Continued testing and demonstration of DWC combat system algorithms developed under PE 0602123N.
- Continued AADI planning and coordination for FY 2008 Navy ADSAM live-fire demonstration.

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FY 2008 Plans:

- Continue all efforts of FY 2007.
- Complete testing and demonstration of DWC and DSC algorithms.
- Initiate EDWC, NII and PCNW project efforts.
- Initiate JIFC demonstration S&T planning and preparations.

FY 2009 Plans:

- Continue all efforts of FY 2008, less those noted as complete above.
- Complete AADI project and JIFC effort.

	FY 2007	FY 2008	FY 2009
HIGH SPEED CRAFT TECHNOLOGY	2,973	0	0

X-Craft is envisioned as an S&T platform designed for Littoral Combat Ship (LCS) risk reduction and mission module demonstration. A high-speed, all-aluminum catamaran, it displaces 1400 tons at full load. Performance requirements are 50 knots at combat load (about 1200 tons), 40 knots in sea state 4, and a 4000 nautical miles range without replenishment. It will be capable of landing two helicopters up to the size of SH-60R, transporting and operating autonomous vehicles, and carrying several reconfigurable mission modules in standard Twenty-foot Equivalent Unit (TEU) boxes. The crew will be minimal and the vessel will be built to commercial American Bureau of Shipping (ABS) standards.

FY 2007 Accomplishments:

- Completed development of drag reduction and lifting body technology and lifting body hull forms.

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PROGRAM ELEMENT: 0603123N PROGRAM ELEMENT TITLE: FORCE PROTECTION ADVANCED TECHNOLOGY
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C. OTHER PROGRAM FUNDING SUMMARY - NAVY RELATED RDT&E::
PE 0204152N E-2 Squadrons
PE 0205601N HARM Improvement
PE 0206313M Marine Corps Communications Systems
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 0602271N RF Systems Applied Research
PE 0603235N Common Picture Advanced Technology
PE 0603271N RF Systems Advanced Technology
PE 0603502N Surface and Shallow Water Mine Countermeasures
PE 0603561N Advanced Submarine System Development
PE 0603563N Ship Concept Advanced Design
PE 0603564N Ship Preliminary Design & Feasibility Studies
PE 0603609N Conventional Munitions
PE 0603640M USMC Advanced Technology Demonstration (ATD)
PE 0604307N Surface Combatant Combat System Engineering
PE 0604518N Combat Information Center Conversion
PE 0604558N New Design SSN

OTHER PROGRAM FUNDING SUMMARY - NON-NAVY RELATED RDT&E::
Not applicable.

D. ACQUISITION STRATEGY:
Not applicable.

FY 2009 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2008
Exhibit R-2a

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603123N PROGRAM ELEMENT TITLE: FORCE PROTECTION ADVANCED TECHNOLOGY
PROJECT NUMBER: 3049 PROJECT TITLE: FORCE PROTECTION

Project Number & Title	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
3049 FORCE PROTECTION	2,602	2,079	2,236	2,377	2,524	2,572	2,625

A. MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: The efforts in this project shifted focus to protection of Naval Installations starting in FY 2006. Other efforts (water-mist and volume sensor work) moved to Project 2912 in FY 2006. Advanced technologies developed, critical to protecting naval installations, will provide seamless full spectrum protection against asymmetric terrorist attack by improving the ability to: sense developing and immediate threats; shape our responses through improved situational awareness and decision making; shield personnel, mission critical facilities, infrastructure, and operating fleet assets; maintain essential functions; and sustain and restore critical services in the aftermath of an incident. Technologies developed will also seek to reduce the required manpower and skill levels devoted to the force protection mission.

B. ACCOMPLISHMENTS/PLANNED PROGRAM:

	FY 2007	FY 2008	FY 2009
EMERGING THREATS	2,602	2,079	2,236

This activity includes: Advanced technologies developed, critical to protecting naval installations, will provide seamless full spectrum protection against asymmetric terrorist attack by improving the ability to: sense developing and immediate threats; shape our responses through improved situational awareness and decision making; shield personnel, mission critical facilities, infrastructure, and operating fleet assets; maintain essential functions; and sustain and restore critical services in the aftermath of an incident. Technologies developed will also seek to reduce the required manpower and skill levels devoted to the force protection mission.

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603123N PROGRAM ELEMENT TITLE: FORCE PROTECTION ADVANCED TECHNOLOGY
PROJECT NUMBER: 3049 PROJECT TITLE: FORCE PROTECTION

FY 2007 Accomplishments:

- Continued development of lower cost/higher performance Force Protection sensors and automated detection algorithms, and decision support tools.
- Initiated interim demonstration of prototype Force Protection sensors.
- Initiated development of intrusion/incident response countermeasures for Force Protection.

FY 2008 Plans:

- Continue all efforts of FY 2007.
- Initiate full scale demo of swimmer defense system including sensors and response countermeasures.
- Initiate interim demonstration of force protection detection and response system with automated detection and self learning algorithms.

FY 2009 Plans:

- Continue all efforts of FY 2008.
- Initiate research to reduce force protection manpower and equipment costs through automation and predictive learning algorithms.
- Initiate threat characterization research and perception experiments for sensor performance optimization and model development and validation.

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603123N PROGRAM ELEMENT TITLE: FORCE PROTECTION ADVANCED TECHNOLOGY
PROJECT NUMBER: 3049 PROJECT TITLE: FORCE PROTECTION

C. OTHER PROGRAM FUNDING SUMMARY - NAVY RELATED RDT&E:
PE 0204152N E-2 Squadrons
PE 0205601N HARM Improvement
PE 0206313M Marine Corps Communications Systems
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 0602271N RF Systems Applied Research
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PE 0603502N Surface and Shallow Water Mine Countermeasures
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PE 0603564N Ship Preliminary Design & Feasibility Studies
PE 0603609N Conventional Munitions
PE 0603640M USMC Advanced Technology Demonstration (ATD)
PE 0604307N Surface Combatant Combat System Engineering
PE 0604518N Combat Information Center Conversion
PE 0604558N New Design SSN

OTHER PROGRAM FUNDING SUMMARY - NON-NAVY RELATED RDT&E:
Not applicable.

D. ACQUISITION STRATEGY:
Not applicable.

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603123N PROGRAM ELEMENT TITLE: FORCE PROTECTION ADVANCED TECHNOLOGY
PROJECT NUMBER: 9999 PROJECT TITLE: CONGRESSIONAL PLUS-UPS

CONGRESSIONAL PLUS-UPS:

	FY 2007	FY 2008
ACCELERATED DEVELOPMENT OF MOBILE ACOUSTIC COUNTERMEASURE FOR FORCE PROTECTION FNC	971	0

FY 2007 Accomplishments: Initiated Mobile Acoustic Countermeasure efforts.

	FY 2007	FY 2008
ACCELERATING FUEL CELLS MANUFACTURABILITY AND THEIR APPLICATION IN THE ARMED FORCES	0	2,750

FY 2008 Plans: Establish a cooperative industry/academic fuel cell test, development and demonstration center, and conduct the research required to advance and demonstrate fuel cell manufacturing feasibility and readiness for field testing for a wide range of applications, initially including surface ships, unmanned underwater vehicles, ground vehicles and mobile equipment such as light carts and fork lifts, stationary and mobile power generation, unmanned aerial vehicles and ground support.

	FY 2007	FY 2008
ADVANCED LOGISTICS FUEL REFORMER FOR FUEL CELLS	0	2,400

FY 2008 Plans: Develop fuel cell technology and deploy next-generation systems, by conducting a rigorous, targeted research, development and field trial demonstration program for use with fuel cell systems and components

	FY 2007	FY 2008
ADVANCED VOLUME SENSOR SYSTEM	0	1,588

FY 2008 Plans: This effort supports the advanced volume sensor system.

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PROJECT NUMBER: 9999 PROJECT TITLE: CONGRESSIONAL PLUS-UPS

	FY 2007	FY 2008
AFFORDABLE DISTRIBUTED APERTURE IRCM FOR HELICOPTERS AND REGIONAL JETS	3,885	0

FY 2007 Accomplishments: Integrated a large format mid-wave infrared (MWIR) two-color focal plane array (FPA)-based sensor and a miniature laser beam director for Distributed Aperture Infrared Countermeasures (DAIRCM). Incorporated a laser warning sensor; developed a real-time processor capable of handling the higher data rate of the large format FPA; and produced a fiber-optic MWIR transmission line with reduced core diameter to improve the output of the beam director.

	FY 2007	FY 2008
AGILE PORT AND HIGH SPEED SHIP TECHNOLOGY	2,331	2,384

FY 2007 Accomplishments: Initiated efforts to support an agile port concept concentrating on the inland port concept and enabling ship technologies including high power waterjets.

FY 2008 Plans: This effort supports agile port and high speed ship technology.

	FY 2007	FY 2008
AVIATION GROUND ADVANCED TECHNOLOGY	2,138	0

FY 2007 Accomplishments: Continued effort that focused on research, development, test, and evaluation of the Aviation Ground Navigation System (AGNAS) full-scale prototype system configuration, including demonstrations of automated aircraft docking and towing operations at the local municipal airport.

	FY 2007	FY 2008
CENTER FOR APPLIED RESEARCH FOR AUTONOMOUS SYSTEMS	1,417	0

FY 2007 Accomplishments: Developed innovative approaches & concepts in intelligent autonomy and advanced control. These autonomous technologies developments were in the areas of dynamic control, obstacle detection and management, group behavior and planning of multiple heterogeneous vehicles, control in rough sea

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conditions, and supervisory control.

	FY 2007	FY 2008
COMPLETION OF ADVANCED SHIP SERVICE FUEL CELL POWER PLANT	971	0

FY 2007 Accomplishments: Completed factory testing and additional performance characterization for the 625 kiloWatt Molten Carbonate Fuel Cell system at the manufacturer's test site and continued development of an advanced DC/DC converter that can be used in a fuel cell system.

	FY 2007	FY 2008
CRYOGENIC POWER SYSTEM FOR UNMANNED UNDERWATER VEHICLES	1,262	994

FY 2007 Accomplishments: Initiated development, fabrication and demonstration of a multifunctional cryogenic power system consisting of a PEM (Proton Exchange Membrane) fuel cell and liquid hydrogen and oxygen storage for a 21" unmanned undersea vehicles (UUVs).

FY 2008 Plans: This effort supports the Unmanned Underwater Vehicle Cryogenic Power system.

	FY 2007	FY 2008
DAMAGE CONTROL WIRELESS COMMUNICATIONS AND EXPERIMENTATION (DCWC&E)	2,137	0

FY 2007 Accomplishments: Continued research to enhance a multi-path reconfigurable Damage Control (DC) communications capability. This project built on the FY 2005 Congressional Future Naval Capabilities-Crew Modeling and Simulation (FNC-CMS) effort by developing complementary capabilities through the addition of components ruggedized for shipboard use. This effort explored technologies and equipment to add imagery and personnel location capability to the current prototype capability and develops a prototype communications capability suitable for operational full scale testing onboard Ex-USS Shadwell at the Navy Safety and Survivability/Damage Control Laboratory in Mobile, Alabama.

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	FY 2007	FY 2008
DETECTING IMPROVISED EXPLOSIVE DEVICES (IEDS)	971	994

FY 2007 Accomplishments: Initiated development of EO/IR technology for the detection of IEDs in a stand-off mode. This effort would enhance signature detection of certain types of IEDs.

FY 2008 Plans: This effort supports detecting improvised explosive devices.

	FY 2007	FY 2008
DEVELOPMENT OF HIGH PERFORMANCE SANDWICH PANEL CONSTRUCTION	1,749	0

FY 2007 Accomplishments: Continued testing and qualification of low cost, lightweight steel sandwich structures for surface ship applications.

	FY 2007	FY 2008
DIRECT MOTOR DRIVEN WATERJET	0	1,588

FY 2008 Plans: This effort supports the direct motor driven waterjet.

	FY 2007	FY 2008
ELECTROCHEMICAL FIELD-DEPLOYABLE SYSTEM FOR POTABLE WATER GENERATION	0	2,384

FY 2008 Plans: This effort supports the electromechanical field-deployable system for potable water generation.

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	FY 2007	FY 2008
FORMABLE TEXTILE FOR COMPLEX SHAPED AEROSPACE COMPOSITES	0	1,588

FY 2008 Plans: Initiate the development of infrastructure necessary to provide a stable, consistent environment to support an aircraft manufacturing program utilizing materials which hold promise for reducing manufacturing costs of aerospace-grade, complex curved structural composite parts by enabling, via the materials, improved formability, greater utilization of automated manufacturing technologies as opposed to the current labor intensive hand lay-up methods.

	FY 2007	FY 2008
FUTURE FUEL NON-TACTICAL VEHICLE INITIATIVE	0	1,588

FY 2008 Plans: This effort supports the future fuel non-tactical vehicle initiative.

	FY 2007	FY 2008
HIGH POWER DENSITY MOTOR DRIVE	1,311	0

FY 2007 Accomplishments: Continued efforts to design, build, test and demonstrate a high performance motor drive capable of simultaneously meeting the Navy's requirement for high power density, low distortion, low acoustic noise, and high efficiency for demanding naval ship propulsion applications.

	FY 2007	FY 2008
HIGH SPEED POWER NODE SWITCHING AND CONTROL CENTER	2,331	1,588

FY 2007 Accomplishments: Expanded development of the concept of microsecond fault detection and circuit interruption, and determined its applicability to Navy shipboard electrical power systems.

FY 2008 Plans: This effort supports high speed power node switching and control center.

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	FY 2007	FY 2008
HIGH TEMPERATURE SUPERCONDUCTING (HTS) GENERATOR	2,184	0

FY 2007 Accomplishments: Continued conceptual design of 10.6 MegaWatt High Temperature Superconducting (HTS) Generator, risk assessments, and mitigation plans for seven key components for 36.5 MegaWatt Class HTS Generator technology.

	FY 2007	FY 2008
HTS AC SYNCHRONOUS NAVY PROPULSION MOTOR	2,914	0

FY 2007 Accomplishments: Construction of the propulsion motor completed by American Superconductor at the Philadelphia Naval Business District, Building 16. Completed IEEE testing of the motor and it was delivered to NAVSEA (PMS-500) for full power testing.

	FY 2007	FY 2008
INNOVATIVE METHODS FOR SHIP-BUILDING AFFORDABILITY	0	1,588

FY 2008 Plans: Support design development testing and qualification of low cost, light weight steel sandwich structures for U.S. Navy ships including CVN-78/79, DDG-1000 and LCS.

	FY 2007	FY 2008
INTEGRATED ADVANCED COMMUNICATIONS TERMINAL (IACT)	0	994

FY 2008 Plans: This effort supports development of the Integrated Advanced Communications Terminal (IACT).

	FY 2007	FY 2008
LARGE UNMANNED UNDERSEA VEHICLE (LUUV) TEST BED	1,262	0

FY 2007 Accomplishments: Continued design modifications to the existing Large Unmanned Undersea Vehicle (UUV) Test Bed that will facilitate advanced UUV systems and scaled advanced submarine propulsion systems demonstrations.

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	FY 2007	FY 2008
LASER PERIMETER AWARENESS SYSTEM	0	1,488

FY 2008 Plans: Initiate the installation and integration of the Laser Perimeter Awareness System (LPAS) with the Electronic Harbor Security System, Command, Control, Communications and Display. Conduct system testing and evaluation of the LPAS at the Naval Facility at San Diego for waterside applications to validate range and detection operations. If successful this system will provide additional coverage with its laser based sensor to detect surface swimmers, small boats, and other waterborne threats at Naval installations to protect personnel, equipment, facilities, infrastructure, and US Navy ships.

	FY 2007	FY 2008
LIGHTWEIGHT, RUGGEDIZED RECONNAISSANCE ROBOT	975	0

FY 2007 Accomplishments: Developed, in conjunction with the National Center for Defense Robotics (NCDR) technology collaborative, a working, functional prototype of a small, lightweight, multi-link manipulator arm for a lightweight, ruggedized reconnaissance robot ground vehicle. Additionally, identified, adapted, and demonstrated available advanced robotic technology in support of the Marines' route clearance and related missions.

	FY 2007	FY 2008
M65 BISMALEIMIDE CARBON FIBER PREPREG	0	2,384

FY 2008 Plans: Qualify a new controlled-flow resin technology in the manufacture of composite aircraft parts, resulting in 60% manufacturing cost savings over older methods. Supports the F-22, F-35, Long Range Strike, UAVs and other future programs.

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	FY 2007	FY 2008
MANUFACTURING AND REPAIR CELL	3,157	3,971

FY 2007 Accomplishments: Demonstrated the fabrication of new and replacement parts and components. In addition, the direct metal deposition and friction stir processing technologies were integrated into a manufacturing system and evaluated for ability to be field deployed.

FY 2008 Plans: This effort supports manufacturing and repair cell.

	FY 2007	FY 2008
MARITIME MOBILE FORCE PROTECTION PROGRAM	0	1,588

FY 2008 Plans: This effort supports the maritime mobile force protection program.

	FY 2007	FY 2008
MISSILE WARNING SENSOR	2,719	0

FY 2007 Accomplishments: Developed a large format (400 by 400 pixels) mid-wave infrared (MWIR) two-color focal plane array (FPA) to be used in a higher accuracy missile warning sensor. Developed methods to reduce the number of bad pixels that can be detrimental to missile location accuracy.

	FY 2007	FY 2008
MULTI-FUEL COMBUSTOR FOR SHIPBOARD FUEL CELLS	0	1,588

FY 2008 Plans: Naval Sea Systems Command and Naval Surface Warfare Center to evaluate a delivered scaled up Multi-Fuel Combustor capable of integration into a shipboard fuel cell system.

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	FY 2007	FY 2008
MULTIPOLAR MOTOR	1,068	0

FY 2007 Accomplishments: Continued very small scale prototypes for an innovative permanent magnet multipolar motor, and developed a detail design for a 1,000 to 5,000 horsepower prototype motor.

	FY 2007	FY 2008
PHASE II VIRENT-NASEA ANTIFREEZE HYDROGEN PROJECT	971	0

FY 2007 Accomplishments: Continued to develop fuel cell systems and reforming technologies focused on using waste ethylene glycol and other novel fuels that are part of the existing logistics chain. Continued the program that was initiated in the FY06 MULTI-FUEL PORTABLE FUEL CELL POWER PROJECT Congressional Plus-Up.

	FY 2007	FY 2008
POROUS SILICON-BASED DIRECT METHANOL FUEL CELL	1,311	0

FY 2007 Accomplishments: Continued development and demonstration of an air-independent porous silicon fuel cell.

	FY 2007	FY 2008
PURE HYDROGEN SUPPLY FROM LOGISTICS FUEL	1,164	2,384

FY 2007 Accomplishments: Continued development of pure hydrogen supply extraction system. This effort was focused on the design, construction and demonstration of a large-scale, innovative hydrogen membrane separator system that is sulfur tolerant to concentrations greater than 100 parts per million.

FY 2008 Plans: This efforts supports pure hydrogen supply from logistics fuel.

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	FY 2007	FY 2008
REMOTE CONTINUOUS ENERGETIC MATERIAL MANUFACTURING FOR PYROTECHNIC IR DECOYS	1,075	0

FY 2007 Accomplishments: Continued the development of improved twin-screw extruder processing technologies (from a safety & reliability standpoint) for remote energetic material used in pyrotechnic systems (e.g. infrared flare decoys).

	FY 2007	FY 2008
SEA FIGHTER	14,566	0

FY 2007 Accomplishments: Completed development of specifications for a ship alteration package to improve SEA FIGHTER capabilities. These modifications include necessary improvements to aviation equipment, damage control, crew facilities, communications and topside survivability improvements. A shipyard availability will occur in FY 2008 to implement these improvements.

	FY 2007	FY 2008
SECURE INFRASTRUCTURE TECHNOLOGY LABORATORY (SINTEL)	6,215	3,178

FY 2007 Accomplishments: Developed and evaluated diver and small boat technologies for Anti-Terrorism/Force Protection at the Secure Infrastructure Technology Laboratory (SINTEL).

FY 2008 Plans: This effort supports secure infrastructure technology laboratory.

	FY 2007	FY 2008
SINGLE GENERATOR OPERATIONS LITHIUM ION BATTERY	3,206	4,966

FY 2007 Accomplishments: Initiated development of lithium ion battery technology for use with shipboard fuel cell systems.

FY 2008 Plans: This effort supports single generator operations lithium ion battery.

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	FY 2007	FY 2008
SMART MICRO-SENSOR ARRAYS	971	0

FY 2007 Accomplishments: Initiated efforts to develop and demonstrate a smart micro sensor array for damage control and toxic industrial chemical detection. A portable, hand-held detector unit is under development to assist damage control personnel to detect and identify hazards.

	FY 2007	FY 2008
SOLID OXIDE FUEL CELLS (SOFCs)	971	0

FY 2007 Accomplishments: Continued to design, construct, install, and demonstrate a 100 kiloWatt planar Solid Oxide Fuel Cell cluster. The cluster will consist of four discrete and clustered 25 kiloWatt fuel cell modules that will initially run on natural gas and then on DoD logistics fuel.

	FY 2007	FY 2008
SOLID STATE DC PROTECTION SYSTEM (SSDCP)	971	397

FY 2007 Accomplishments: Initiated development of a universal solid-state circuit breaker (USSB) for medium voltage Navy power distribution systems. This effort focused on developing programmable thresholds for electrical fault trip points with increased interruption speed within a hybrid USSB that is designed to operate in Navy medium voltage applications.

FY 2008 Plans: This effort supports the Solid State DC Protection System.

	FY 2007	FY 2008
STABILIZED LASER DESIGNATION CAPABILITY	971	0

FY 2007 Accomplishments: Developed system design requirements and target tracking algorithms for an enhanced, medium altitude laser designation capability for medium altitude aircraft operations that can address moving

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targets, as well as targets in a Global Positioning System (GPS)-jammed environment.

	FY 2007	FY 2008
STRATEGIC MOBILITY 21 DEPLOYMENT TECHNOLOGY	2,719	0

FY 2007 Accomplishments: Continued projects that deal with the application of transportation technologies for Joint Force deployment and sustainment support through the development of a prototype Agile Port System (APS) that can be duplicated, adapted and integrated on a national basis and deployed intra-theater to include future Sea Basing operational requirements. Continued mobility projects for Joint Force deployment and sustainment through APS efforts.

	FY 2007	FY 2008
SUPERCONDUCTING DC HOMOPOLAR MOTOR FOR ELECTRIC DRIVE SHIPS	2,526	0

FY 2007 Accomplishments: Continued superconducting DC homopolar main propulsion motor efforts. The superconducting DC homopolar main propulsion motor is currently in the detailed design phase by General Atomics and is expected to be delivered to the Navy in FY 2011.

	FY 2007	FY 2008
TACTICAL COMPACT OPTICAL INTERROGATOR	0	1,588

FY 2008 Plans: This effort supports the tactical compact optical interrogator.

	FY 2007	FY 2008
TRANSPARENT ARMOR	486	0

FY 2007 Accomplishments: Continued efforts to establish a research and development program to explore new materials and strategies for fabrication of transparent materials with the mechanical properties needed for providing armor protection.

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603123N PROGRAM ELEMENT TITLE: FORCE PROTECTION ADVANCED TECHNOLOGY
PROJECT NUMBER: 9999 PROJECT TITLE: CONGRESSIONAL PLUS-UPS

	FY 2007	FY 2008
UNDERGROUND COORDINATION OF MANAGED MESH-NETWORKS	0	795

FY 2008 Plans: This effort supports the underground coordination of managed mesh-networks.

	FY 2007	FY 2008
UNMANNED SYSTEMS TECHNOLOGIES FOR EXPLOSIVE ORDNANCE DISPOSAL	975	0

FY 2007 Accomplishments: Continued developing unmanned ground system technologies for explosive ordnance disposal (EOD). Specifically, integrated low-cost, sensor and software technology on a lightweight, expendable Unmanned Aerial System (UAV), to produce an "eye-in-the-sky" capability that operates autonomously and synchronously with a unmanned ground vehicle (UGV), providing enhanced situational awareness and increased security in support of EOD operations and missions. Also integrated onto a UGV, a low-cost, colorized ranging system that generates a real-time, virtualized, three dimensional, off-robot view of the UGV maneuvering in its physical environment. This effort has the future potential to completely replace the need for live video feedback in order to tele-operate UGVs, thereby enabling the use of very low-band communications and greatly expanding the range over which they can operate.

	FY 2007	FY 2008
WAVE POWER ELECTRIC POWER GENERATING SYSTEM FOR HAWAII NAVAL BASE	971	0

FY 2007 Accomplishments: Initiated analysis of performance data for the three direct drive power conversion methods (hydraulic, rack and pinion, and permanent magnet systems).

	FY 2007	FY 2008
WIDE-AREA SENSOR FOR FORCE PROTECTION TARGETING	2,526	1,588

FY 2007 Accomplishments: Initiated wide-area sensor for force protection targeting efforts by developing an integrated EO/IR sensor prototype for demonstration.

FY 2008 Plans: This effort supports wide-area sensor for force protection targeting.

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603123N PROGRAM ELEMENT TITLE: FORCE PROTECTION ADVANCED TECHNOLOGY
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	FY 2007	FY 2008
WIDE-BAND GAP SEMICONDUCTOR MATERIALS	5,050	1,588

FY 2007 Accomplishments: Continued development of manufacturing processes for silicon carbide semiconductor crystals capable of higher power levels and greater temperature ranges than currently employed silicon-based materials. Crystal diameter capability was successfully increased from three to four inches. Issues associated with high thermal gradients in growth systems which affect silicon carbide crystal quality, were realized and investigations initiated.

FY 2008 Plans: This effort supports development in wide-band gap semiconductor materials.

	FY 2007	FY 2008
WIRELESS CONDITION-BASED MAINTENANCE MONITORING FOR NAVAL SHIPYARD EQUIPMENT AND FACILITIES	1,603	0

FY 2007 Accomplishments: Continued development of a wireless condition-based maintenance monitoring system of naval shipyard equipment and facilities for efforts to reduce maintenance costs and operational time. The focus of these efforts were on such equipment as mobile and overhead cranes, drydock pumps, compressors and other equipment that paces ship production and repair.

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

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603235N
PROGRAM ELEMENT TITLE: COMMON PICTURE ADVANCED TECHNOLOGY

COST: (Dollars in Thousands)

Project Number & Title	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
Total PE	63,076	92,401	104,578	60,722	66,710	57,357	41,110
2919 COMMUNICATIONS SECURITY	55,058	89,817	104,578	60,722	66,710	57,357	41,110
9999 CONGRESSIONAL PLUS-UPS	8,018	2,584	0	0	0	0	0

A. MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: The efforts described in this Program Element (PE) are based on investment directions as defined in the Naval S&T Strategic Plan approved by the S&T Corporate Board (Jan 2007). This strategy is based on needs and capabilities from Navy and Marine Corps guidance and input from the Naval Research Enterprise (NRE) stakeholders (including the Naval enterprises, the combatant commands, the Chief of Naval Operations (CNO), and Headquarters Marine Corps). It provides the vision and key objectives for the essential science and technology efforts that will enable the continued supremacy of U.S. Naval forces in the 21st century. The Strategy focuses and aligns Naval S&T with Naval missions and future capability needs that address the complex challenges presented by both rising peer competitors and irregular/asymmetric warfare.

Activities and efforts in this program address the advanced technology development, test, and evaluation of a dynamic distributed common picture based on emergent technologies that will improve situational awareness across command echelons. The promise of net-centricity and potential for persistent and pervasive sensing creates greater demand for automated fusion of large volumes of multi-sensor data, techniques to coordinate deployment of multiple diverse sensors, and tailored dissemination of information to support network centric operations. The focus of this program is to refine technologies that exploit information and networking technology to ensure mission success in unpredictable warfighting environments. These missions include the Global War on Terrorism (GWOT), urban operations, and asymmetric warfare. To ensure Maritime Domain Awareness, we must be able to collect, fuse, and disseminate enormous quantities of data drawn from US joint

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603235N
PROGRAM ELEMENT TITLE: COMMON PICTURE ADVANCED TECHNOLOGY

forces and government agencies, international coalition partners and forces, and commercial entities. To further network centric capabilities, this project demonstrates technologies that support seamless information services afloat and ashore; collaborative decision-making among geographically dispersed warfighters; a common, consistent view of the battlespace geared to user requirements; system interoperability with coalition forces; real-time information access with quality of service guarantees; and information assurance. Technologies of interest provide access to, and automated processing of, information necessary to make decisions that lead to rapid, accurate decision-making and result in decisive, precise, and desired engagement outcomes. The payoff is access to tailored information in near real time with corresponding increases in speed of command, improved decision-making, and reduction in manpower.

The Common Picture Program supports FORCEnet, Sea Shield and Sea Strike pillars and contains investments in the following Enabling Capabilities (ECs): Secure Collaboration; Advanced Communication for FORCEnet; GIG Compliant Networking; Dynamic Target Engagement and Enhanced Sensor Capability; Next Generation Command, Control and Decision Support Services; Combatant Commander (COCOM) to Marine Combat ID; Combat ID Information Management of Coordinated Electronic Surveillance; Combat ID in the Maritime Domain to Reveal Contact Intent; Automated Control of Large Sensor Networks; and Hostile Fire Detection and Response Spiral 1.

In the context of the Naval Transformation Roadmap construct, this investment will achieve capabilities required by FORCEnet (Persistent Intelligence, Surveillance, and Reconnaissance; Time Sensitive Strike; and Sea Based Information Operations), Sea Strike (Ship-to-Objective Maneuver), and Sea Shield (Theater Air and Missile Defense).

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

FY2007 funding total includes $ 2.0 M received in GWOT supplemental.

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603235N
PROGRAM ELEMENT TITLE: COMMON PICTURE ADVANCED TECHNOLOGY

B. PROGRAM CHANGE SUMMARY:

	FY 2007	FY 2008	FY 2009
FY 2008/FY 2009 President's Budget Submission	65,686	40,782	22,755
Congressional Action	0	52,600	0
Congressional Undistributed Reductions/Rescissions	0	-650	0
Execution Adjustments	-1,481	0	0
Program Adjustments	-58	0	81,803
Rate Adjustments	0	0	20
SBIR Assessment	-1,071	-331	0
FY 2009 President's Budget Submission	63,076	92,401	104,578

PROGRAM CHANGE SUMMARY EXPLANATION:
Technical: Not applicable.

Schedule: Not applicable.

C. OTHER PROGRAM FUNDING SUMMARY:
Not applicable.

D. ACQUISITION STRATEGY:
Not applicable.

E. PERFORMANCE METRICS:
Performance metrics are discussed within the project (R2a).

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603235N PROGRAM ELEMENT TITLE: COMMON PICTURE ADVANCED TECHNOLOGY
PROJECT NUMBER: 2919 PROJECT TITLE: COMMUNICATIONS SECURITY

COST: (Dollars in Thousands)

Project Number & Title	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
2919 COMMUNICATIONS SECURITY	55,058	89,817	104,578	60,722	66,710	57,357	41,110

A. MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: Activities and efforts in this project address the advanced technology development, test, and evaluation of a dynamic distributed common picture based on emergent technologies that will improve situational awareness across command echelons. The promise of net-centricity and potential for persistent and pervasive sensing creates greater demand for automated fusion of large volumes of multi-sensor data, techniques to coordinate deployment of multiple diverse sensors, and tailored dissemination of information to support network centric operations. The focus of this program is to refine technologies that exploit information and networking technology to ensure mission success in unpredictable warfighting environments. These missions include the GWOT, urban operations, and asymmetric warfare. To ensure Maritime Domain Awareness, we must be able to collect, fuse, and disseminate enormous quantities of data drawn from US joint forces and government agencies, international coalition partners and forces, and commercial entities. To further network centric capabilities, this project demonstrates technologies that support seamless information services afloat and ashore; collaborative decision-making among geographically dispersed warfighters; a common, consistent view of the battlespace geared to user requirements; system interoperability with coalition forces; real-time information access with quality of service guarantees; and information assurance. Technologies of interest provide access to, and automated processing of, information necessary to make decisions that lead to rapid, accurate decision-making and result in decisive, precise, and desired engagement outcomes. The payoff is access to tailored information in near real time with corresponding increases in speed of command, improved decision-making, and reduction in manpower.

The Communications Security project supports FORCEnet, Sea Shield and Sea Strike pillars and contains investments in the following Enabling Capabilities (ECs): Secure Collaboration; Advanced Communication for FORCEnet; GIG Compliant Networking; Dynamic Target Engagement and Enhanced Sensor Capability; Next Generation Command, Control and Decision Support Services; COCOM to Marine Combat ID; Combat ID Information Management of Coordinated Electronic Surveillance; Combat ID in the Maritime Domain to Reveal Contact Intent; Automated Control of Large Sensor Networks; and Hostile Fire Detection and Response Spiral 1.

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603235N PROGRAM ELEMENT TITLE: COMMON PICTURE ADVANCED TECHNOLOGY
PROJECT NUMBER: 2919 PROJECT TITLE: COMMUNICATIONS SECURITY

In the context of the Naval Transformation Roadmap construct, this investment will achieve capabilities required by FORCEnet (Persistent Intelligence, Surveillance, and Reconnaissance (ISR); Time Sensitive Strike; and Sea Based Information Operations), Sea Strike (Ship-to-Objective Maneuver), and Sea Shield (Theater Air and Missile Defense).

B. ACCOMPLISHMENTS/PLANNED PROGRAM:

	FY 2007	FY 2008	FY 2009
HIGH-INTEGRITY GLOBAL POSITIONING SYSTEM (HIGPS)	0	49,682	61,200

The High-Integrity Global Positioning System (HIGPS) activity is focused on developing the technology required to demonstrate the capability of using the existing Iridium satellite constellation to enhance current GPS navigation and timing capabilities. Enhancements include improved anti-jam performance, improved accuracy of navigation and positioning, increased availability of satellite navigation signals, improved accuracy in time stability transfer, and faster acquisition times.

This activity focuses on integrating a HIGPS Enabling Technology Development (ETD) prototype. This effort is planned to transition to a HIGPS Technology Concept Demonstration (TCD) program under Navy program management at Office of Naval Research.

The increase from FY 2007 to FY 2008 is due to a Congressionally directed realignment of program from Air Force to the Navy.

The increase from FY 2008 to FY 2009 is required for procurement of prototype user equipment and completion of HIGPS technology demonstrations in FY 2009.

FY 2008 Plans:

• Initiate and complete the HIGPS Enabling Technology Development (ETD) prototype development which includes development of a HIGPS user receiver (UR) prototype design, development and implementation of prototype HIGPS base station equipment, demonstrations of long baseline precision time transfer, and Iridium ephemeris store and broadcast, and completion of various trade studies required to determine the optimum way forward in implementing the system concept demonstration.

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• Initiate the HIGPS Technology Concept Demonstration (TCD) project. The HIGPS project will continue using the HI GPS ETD as a foundation to assemble a system that will demonstrate the GPS augmentation concept. In FY 2008 the activity is concerned with the system demonstration using Iridium ephemeris store and broadcast, precision time and differential GPS aiding from a base station, an enhanced narrowband Iridium signal, and brassboard user equipment.

FY 2009 Plans:

• Complete the HIGPS TCD project.

	FY 2007	FY 2008	FY 2009
INFORMATION SECURITY RESEARCH	1,870	1,901	1,940

This Activity seeks to protect the Navy and Joint information infrastructure from hostile exploitation and attack. This requires situational awareness of network assets and operations. This activity focuses, in part, on integrating successful proof-of-concept research prototypes developed under PE 0602235N. The goal is to develop tools, techniques and methodologies to: improve network resistance to denial of service attacks; improve indications and warnings of suspect activities; conduct traffic analysis; monitor and assess network status and health; identify new capabilities to analyze network vulnerabilities and attacks; measure the effectiveness of Information Assurance (IA) protective measures; and improve the quality and level of certification of IA software.

FY 2007 Accomplishments:

• Continued development of the security management tool that provides a common picture of the networked environment with respect to IA and security, with emphasis on visualization capabilities to support active computer network defense.
• Continued development of a tool for the development of agents that integrates unified modeling language (UML) and that provides a verifiable agent programming language, an inter-agent communication protocol, security agents for enforcing run-time properties, and property checkers.
• Completed the development and demonstrated a secure, survivable, and dynamic service-oriented enterprise architecture to support military missions, addressing grid computing, peer-to-peer computing, and the adaptation of security features to those technologies for military use.

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• Initiated development of integrated capabilities that support battle damage assessment and infrastructure and asset protection based on information provided by the common picture of the networked environment with respect to IA and security.

FY 2008 Plans:

• Continue all efforts of FY 2007 less those noted as completed above.
• Continue development of integrated capabilities that support battle damage assessment and infrastructure and asset protection based on information provided by the common picture of the networked environment with respect to IA and security. Evaluate and demonstrate the capabilities in an operationally representative environment and use the results to improve the capabilities.
• Initiate the development of a tool suite that will provide evidence of assurance for security products based on the foundations of formal methods. The tool will provide the automated analysis of the implementation based on the security policy, the architecture and/or the software security critical functions.
• Initiate the development of capabilities and an infrastructure that will support the management of high assurance devices/components used within Navy networks. Ensure the approach is supported by the Navy's network centric architecture.

FY 2009 Plans:

• Continue all efforts of FY 2008.
• Complete the development of integrated capabilities that support battle damage assessment and infrastructure and asset protection based on information provided by the common picture of the networked environment with respect to IA and security.

	FY 2007	FY 2008	FY 2009
GLOBAL POSITIONING SYSTEM (GPS) & NAVIGATION TECHNOLOGY	4,638	4,608	4,870

This activity enhances Global Positioning System anti-jam (GPS AJ) capabilities and develops other technologies to provide alternative navigation methods. In the GPS AJ area, Space-Time Adaptive Processing (STAP) is being pursued to remove the operational risks associated with enemy jamming of GPS functions. Also, the next generation GPS receiver will be programmed with M-code; therefore, both the next generation M-code and the existing C/Y-codes must be used at the same timeframe. Office of Naval Research initiated a transitional receiver which will accommodate both the C/Y- and M-codes. The alternative navigation methods

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investigated include GPS receivers with a tightly coupled Inertial Navigation System (INS); gravity gradiometer development, used in a terrain-following concept; and an electro-optic accelerometer developed as an improved element in INS. This activity also develops the atomic clock for inclusion in Naval Systems. The atomic clock efforts include small, low-cost Rubidium (Rb), and Coherent Population Trapping (CPT) atomic clock development. These areas will provide alternatives to GPS navigation and alternatives to the availability of precise GPS-provided time transfer.

FY 2007 Accomplishments:

- Continued the demonstration project of nonlinearly constrained adaptive beam forming for defeating Binary Phase-Shift-Keying (BPSK) jammers. Developed an algorithm to mitigate the loss of Signal-to-Noise Ratio (SNR) through a combination of adaptive space-time-frequency signal processing techniques.
- Continued the development of a small, lightweight Micro-Electro-Mechanical Systems (MEMS) Accelerometer for navigation systems; and fabricated an Electro-Optic Accelerometer.
- Continued the development of algorithms for distributed time scaling; developed architectures necessary to establish a Navy Global Coordinated Time Scale; tested the algorithms via both simulation and using actual clock data provided by the U.S. Naval Observatory (USNO).
- Continued the Integrated Optically Transduced Gyro Assembly (IOTA) project.
- Continued the Enhanced AJ GPS Receiver Technology (EAGRT) project.
- Continued the Advanced Anti-Spoofing Detection and Isolation for GPS Acquisition project.
- Continued the Scaleable Integrated Micro Optical Gyroscope (SIMOG) project.
- Continued the Navigation Grade Microfabricated Integrated Optical Gyro (MIOG) project.
- Continued the Navigation Grade Sub-Harmonic Lateral Mode Gyro (GSLMG) project.
- Continued the development of the Sonar Aided Inertial Navigation Technology (SAINT).
- Completed the development of Magnetic Passive Navigation (MPN).
- Initiated the 5-cc accelerometer with the Embedded GPS Inertial (EGI) System for aircraft avionics applications.
- Initiated the MEMS Gyro-cluster INS for Tactical Platforms project.
- Initiated the Precision Celestial Navigation System (PCNS) project.
- Initiated the Dead Reckoning Advanced Tight Coupling (DRATC) project.
- Initiated the Qualification of a Commercial-Off-the-Shelf (COTS) Miniature Atomic Clock project.

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FY 2008 Plans:

- Continue all efforts of FY 2007 less those noted as completed above.
- Complete the demonstration project of nonlinearly constrained adaptive beam forming for defeating Binary Phase-Shift-Keying (BPSK) jammers. Develop an algorithm to mitigate the loss of Signal-to-Noise Ratio (SNR) through a combination of adaptive space-time-frequency signal processing techniques.
- Complete the development of the Sonar Aided Inertial Navigation Technology (SAINT).
- Initiate the GPS anti-spoofer antenna electronics effort using Electronic Support Measures (ESM) and tracking/location-based system.
- Initiate the navigation grade Inertial Navigation System (INS) using fiber optic/Micro-Electronic Mechanical System (MEMS) gyros and electro-optic accelerometers.
- Initiate the Adaptive Temporal Suppression of GPS Structured Interference project.
- Initiate the Simultaneous Localization and Mapping (SLAM) Inertial Measurement Unit (IMU) non-GPS Navigator (SINGN) project.
- Initiate the GPS Synchronization of a Chip-scale Atomic Clock project.

FY 2009 Plans:

- Continue all efforts of FY 2008 less those noted as completed above.
- Complete the development of IOTA.
- Complete the development of EAGRT.
- Complete the Advanced Anti-Spoofing Detection and Isolation for GPS Acquisition project.
- Complete the development of SIMOG.
- Complete the development of MIOG.
- Complete the development of GSLMG.
- Complete the development of SAINT.
- Complete the SLAM IMU non-GPS Navigator (SINGN) project.
- Complete the GPS Synchronization of a Chip-scale Atomic Clock project.
- Complete the Qualification of a COTS Miniature Atomic Clock project.
- Initiate the development of the Sonar Aided Bathymetric Navigation Technology.
- Initiate the Optically Transduced MEMS Inertial Navigation System project.
- Initiate the Sub-harmonic Lateral Mode MEMS Inertial Navigation System project.
- Initiate the Two-Axis Gyro-compass Fiber Optic Inertial Navigation System project.

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	FY 2007	FY 2008	FY 2009
USCG VESSEL TRACKING	2,668	0	0

Details are of a higher classification.

All effort in this activity completed in FY 2007.

	FY 2007	FY 2008	FY 2009
MARINE MAMMALS	965	0	0

This initiative provides data and technology for making informed decisions regarding the interaction of naval activities with protected marine life and habitats to enable platform operation and force projection, and maximize use of Navy training ranges within environmental constraints. Ensure Navy compliance with national environmental laws, Executive Order 12114, and OPNAVINST 5090.1B while still maintaining full operational and training exercise capabilities.

All Marine Mammal efforts within this activity transfer to PE 0602435N effective FY 2008.

FY 2007 Accomplishments:

- Continued Temporary Threshold Shift (TTS) data collection to determine time, energy trade-off and recovery rates for long duration sound exposures and multiple pings typical of Navy operations and training.
- Continued to expand Marine Mammal Monitoring on Navy Ranges (M3R) capability for tracking beaked whales and develop classification software for identification of marine mammal species and populations.
- Continued M3R Atlantic Undersea Test Evaluation Center (AUTEC) on-site analysis and Pacific Missile Range Facility (PMRF) data collection with visual surveys.
- Continued TTS data collection to develop cumulative sound exposure model for seals and sea lions.
- Continued technology transition agreement (TTA) with CNO N45.
- Completed multiple ping TTS data collection for dolphins.
- Completed TTS Acoustic Safety Criteria Model for multiple sonar pings on dolphins and toothed whales.
- Initiated transition from behavioral to electrophysiological measurements of hearing/TTS in marine mammals.
- Initiated transition plan for demonstration and evaluation of M3R technology at other Navy ranges.

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- Initiated sound exposure study at AUTEC to develop effective M3R mitigation methodology for Navy ranges.

	FY 2007	FY 2008	FY 2009
KNOWLEDGE SUPERIORITY AND ASSURANCE (KSA)	38,647	32,626	36,568

This activity is aligned with the FORCEnet pillar and explores fundamental technologies that enhance the Navy's capability to exploit, manage and integrate complex, heterogeneous, multi-source information for the next generation common picture. Science and Technology (S&T) work is being focused on Navy and Marine Corps Warfighter Capability Gaps identified through analysis of operational and exercise lessons learned, as well as campaign analysis of capabilities required in the 2010-2024 time frame.

Warfighter Capability Gaps are being addressed by Enabling Capabilities (EC). Each EC delivers capability-level products to acquisition in a three to five-year effort, and allocates a sufficient investment to ensure a capability is provided. ECs addressed include: Secure Collaboration; Advanced Communication for FORCEnet; GIG Compliant Networking; Dynamic Target Engagement and Enhanced Sensor Capabilities; Next Generation Command, Control and Decision Support Services; COCOM to Marine Combat ID; Combat ID Information Management of Coordinated Electronic Surveillance; Combat ID in the Maritime Domain to Reveal Contact Intent; Automated Control of Large Sensor Networks; and Globally Netted Joint/Coalition Force Maritime Component Commander.

The decrease from FY 2007 to FY 2008 is due to the completion of efforts on Tactical Signal Intelligence (SIGINT) (SLY FOX) in connection with completion of the overall EC COCOM to Marine Combat ID in FY 2009.

The increase from FY 2008 to FY 2009 is due to initiation of the following ECs: Improved Maritime Common Operating Tactical Picture in a GIG-Enterprise Services (ES) Environment and Assured Information Exchange.

FY 2007 Accomplishments:

- Continued efforts on Joint Coordinated Real-Time Engagement (JCRE) Advance Concepts Technology Demonstration (ACTD) to provide Global Information Grid (GIG)-compliant core enterprise Services and Community of Interest (COI) Services which ensured warfighting COIs access to information required from any source for rapid situation awareness assessment.
- Completed effort on SIGINT (Sly Fox).
- Completed the Innovative Tactical Beyond Line of Sight (BLOS) Communications Relay (previously reported in PE 0603236N).

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- Completed Network Management Tools effort.
- Completed development of Integrated Autonomous Network Management (IANM) by transitioning to Automated Digital Network System (ADNS) Integrated Ship Network System (ISNS)/ADNS PMW-160. This enables central monitoring of as many as 15 distributed network management systems, tactical shore and ship, in a 1500 nm area. This network automatically assesses the environment and recommends changes to optimize network performance in real time (10s of seconds). As a result, there will be manpower savings, fewer personnel required to manage computers, and communication networks for big-deck ships.
- Initiated smart algorithms for tactical sensors.
- Initiated Combat ID in the Maritime Domain to Reveal Combat Intent.

FY 2008 Plans:

- Continue all efforts of FY 2007 less those noted as completed above.
- Complete development of Secure, Distributed Collaboration effort. Transition to the PEO for C4I and Space, for the PMW 160 program the Combined Enterprise Regional Information Exchange System (CENTRIXS) for secure collaboration across multiple coalition boundaries and security levels in the maritime environment. This enhances real-time collaboration among coalition partners and own forces and increases decision speed based on the integrated and shared tactical picture. It also enforces security policy providing increases in assurance level.
- Complete Ultra High Frequency (UHF)/L-Band phased array antennas for carriers (previously PE 0603271N).
- Complete the High Altitude Airborne Relay and Router Package to deliver relay/router packages for a high and medium altitude platforms across UHF/VHF and Ku-Bands (previously reported in PE 0603271N).
- Initiate development of technology to enable the coordinated Global Joint and Coalition Force Maritime Component Commander (J/CFMCC) capture and share information from sources and processes; with the intended result of managing at least 10,000 tracks per day in a consistent manner to support user awareness and control (current capability is approximately 200 tracks per day globally).

FY 2009 Plans:

- Continue all efforts of FY 2008 less those noted as completed above.
- Complete the Joint Coordinated Real-Time Engagement (JCRE) Advance Concepts Technology Demonstration (ACTD) to provide GIG-compliant core enterprise Services and COI Services which will ensure warfighting COIs access to information required from any source for rapid situation awareness assessment.
- Initiate development of advanced technologies that support delivery of Technology Oversight Group (TOG)

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approved FNC enabling capabilities structured to close operational capability gaps that involve the common picture.
• Initiate packaging of advanced common picture technologies into deliverable FNC products and ECs that can be integrated into acquisition programs within a five year period.
• Initiate effort to mature common picture technologies that support naval requirements identified within the FORCEnet naval capability pillar.
• Initiate effort to mature, demonstrate and apply emerging technologies that support dynamic and response management and control of net-centric enterprise theater and tactical ASW operations. This includes automation support for synchronized planning of resources and multi-mission execution, and access and shared awareness of data, activities and status among Maritime Operation Centers and tactical forces in a tactical netted service-oriented architecture (SOA) environment.
• Initiate effort to develop and apply emerging technologies that support self organizing networking and assured communications exchange in tactical communications networks.

	FY 2007	FY 2008	FY 2009
MULTI-SOURCE INTEGRATION (MSI) AND COMBAT IDENTIFICATION (CID)	6,270	1,000	0

This activity is aligned with the Sea Shield pillar. Multi-Source Integration (MSI), Advanced Sensor Netting Technology (ASNT), and Composite Combat Identification (CCID) technology address theater air and missile defense (TAMD) needs for data fusion, correlation of and reasoning over attributes leading to target Identification, and sensor fusion/management. The goal is to develop algorithms for use by air defense combat systems which will then be able to fuse, filter, and correlate on-board sensor and off-board battlespace information from all sources to achieve one common Combat Identification (CID) solution using Theater-wide information. This activity supports the Sea Shield Enabling Capability for Real Time Long Range Air Defense CID in Support of Early Engagements and related CID Science & Technology to be worked under FORCEnet.

Change in funding reflects the completion of efforts within this activity in FY 2008.

FY 2007 Accomplishments:

• Completed laboratory demonstrations of ASNT and CCID.
• Completed MSI project development and testing of algorithms to integrate real time and non-real time sensor data and correlate satellite communications (SATCOM) data in the E-2C mission computer.

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- Completed development of ASNT algorithms for integration of electronic warfare support (ES) data into the Open Architecture Track Manager in future combat systems and transmission of track ID attributes via real time sensor networks.
- Completed development of CCID algorithms to correlate and fuse real time tracks with intelligence, surveillance, and reconnaissance data in Ship Signal Exploitation Equipment (SSEE) equipped surface ships and common reasoning algorithms for CID capability to rapidly build high confidence identification of air tracks using all available ID attributes in theater.

FY 2008 Plans:

- Complete technology transition to the E-2C/D Program Management Office (PMA-231), Intelligence, Surveillance, Reconnaissance, and Information Operations Program Office (PMW-180), and PEO-IWS.

C. OTHER PROGRAM FUNDING SUMMARY - NAVY RELATED RDT&E:
PE 0204152N E-2 Squadrons
PE 0205601N HARM Improvement
PE 0206313M Marine Corps Communications Systems
PE 0303140N Information Systems Security Program
PE 0308601N Modeling and Simulation Support
PE 0601153N Defense Research Sciences
PE 0602114N Power Projection Applied Research
PE 0602123N Force Protection Applied Research
PE 0602131M Marine Corps Landing Force Technology
PE 0602235N Common Picture Applied Research
PE 0602236N Warfighter Sustainment Applied Research
PE 0602271N RF Systems Applied Research
PE 0603114N Power Projection Advanced Technology
PE 0603123N Force Protection Advanced Technology
PE 0603236N Warfighter Sustainment Advanced Technology
PE 0603271N RF Systems Advanced Technology
PE 0603609N Conventional Munitions
PE 0603640M USMC Advanced Technology Demonstration (ATD)
PE 0603658N Cooperative Engagement
PE 0604307N Surface Combatant Combat System Engineering

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603235N PROGRAM ELEMENT TITLE: COMMON PICTURE ADVANCED TECHNOLOGY
PROJECT NUMBER: 2919 PROJECT TITLE: COMMUNICATIONS SECURITY

PE 0604518N Combat Information Center Conversion

OTHER PROGRAM FUNDING SUMMARY - NON-NAVY RELATED RDT&E:
PE 0603750D8Z Advanced Concept Technology Demonstrations

D. ACQUISITION STRATEGY:
Not applicable.

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603235N PROGRAM ELEMENT TITLE: COMMON PICTURE ADVANCED TECHNOLOGY
PROJECT NUMBER: 9999 PROJECT TITLE: CONGRESSIONAL PLUS-UPS

CONGRESSIONAL PLUS-UPS:

	FY 2007	FY 2008
4D DATA FUSION VISUALIZATION	1,554	0

This effort developed new display techniques to present and integrate 4- dimensional information over time, as well as developing techniques for visualizing the time latency of information content.

	FY 2007	FY 2008
COMPUTER FORENSICS FOR ENHANCED MARITIME DOMAIN AWARENESS	0	994

This project will develop software and methods to analyze existing and new software applications residing on military networks to discover vulnerabilities and exploitations.

	FY 2007	FY 2008
IMPROVED SHIPBOARD COMBAT INFORMATION	1,311	0

This project developed techniques that enabled Combat Information Center watchstanders to better receive, comprehend, and respond to incoming data during combat operations (enhancing combat operations) while also reducing the number of required Combat Information Centers (CICs).

	FY 2007	FY 2008
MARITIME IDENTIFICATION SURVEILLANCE TECHNOLOGY (MIST)	971	1,590

FY 2007 - MIST developed technologies to provide continuous surveillance, identification and tracking of all surface ships around naval platforms at sea, or in coastal waters and harbors.

FY 2008 - This effort will develop and test a low cost multifunction X-Band radar sub-array.

FY 2009 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2008
Exhibit R-2a

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603235N PROGRAM ELEMENT TITLE: COMMON PICTURE ADVANCED TECHNOLOGY
PROJECT NUMBER: 9999 PROJECT TITLE: CONGRESSIONAL PLUS-UPS

	FY 2007	FY 2008
RAIL SENSOR TESTBED	1,262	0

This project developed technologies to support the real-time detection, identification, and assessment of chemical, biological, radiological, and nuclear threats to the United States.

	FY 2007	FY 2008
SITUATIONAL AWARENESS IMPROVEMENTS AT FORWARD OPERATING BASES IN IRAQ	1,949	0

This project developed learning algorithms to incorporate multiple sensor signature recognition and integration for alerting an operator to anomalous or suspect activity. The automation of certain processes reduces manual target feature processing by operators.

	FY 2007	FY 2008
URBAN DATA DELIVERY IN THE VIRTUAL BATTLE LAB	971	0

This project developed techniques to extend net-enabled urban geographical information system capabilities to lower-echelon tactical warfighters.

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

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603236N
PROGRAM ELEMENT TITLE: WARFIGHTER SUSTAINMENT ADVANCED TECHNOLOGY

COST: (Dollars in Thousands)

Project Number & Title	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
Total PE	92,732	101,007	112,520	101,051	117,968	82,961	48,332
2915 WARFIGHTER SUSTAINMENT ADVANCED TECHNOLOGY	61,822	90,375	112,520	101,051	117,968	82,961	48,332
9999 CONGRESSIONAL PLUS-UPS	30,910	10,632	0	0	0	0	0

A. MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: The efforts described in this Program Element (PE) are based on investment directions as defined in the Naval Science and Technology (S&T) Strategic Plan approved by the S&T Corporate Board (Jan 2007). This strategy is based on needs and capabilities from Navy and Marine Corps guidance and input from the Naval Research Enterprise (NRE) stakeholders (including the Naval enterprises, the combatant commands, the Chief of Naval Operations (CNO), and Headquarters Marine Corps). It provides the vision and key objectives for the essential S&T efforts that will enable the continued supremacy of U.S. Naval forces in the 21st century. The Strategy focuses and aligns Naval S&T with Naval missions and future capability needs that address the complex challenges presented by both rising peer competitors and irregular/asymmetric warfare.

Warfighter Sustainment Advanced Technology supports: Manpower and Personnel, Training, and Readiness; and the Future Joint Warfighting Capabilities identified by the Joint Chiefs of Staff. It supports Future Naval Capabilities (FNC) Programs in Airframe/Ship Corrosion; Turbine Engine Technologies; Littoral Combat; Sea Base Planning, Operations and Logistics; and Sea Base Mobility and Interfaces. It develops technologies that enable the Navy to better recruit, select, classify, assign, and manage its people; to train effectively and affordably in classroom settings, in simulated and actual environments, and while deployed; and to effect human systems integration into weapon systems. Other technologies enable reduced operating costs through life-extension of legacy systems and increased efficiency of future propulsion systems and improved diagnostic tools.

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603236N
PROGRAM ELEMENT TITLE: WARFIGHTER SUSTAINMENT ADVANCED TECHNOLOGY

Within the Naval Transformation Roadmap, this investment supports the achievement of all the transformational capabilities of Sea Warrior and the transformational capabilities of: Ship to Objective Maneuver and Time Sensitive Strike required by Sea Strike; Littoral Sea Control and Anti-Sub Warfare required by Sea Shield; Compressed Deployment and Employment Times and Enhanced Sea-Borne Positioning of Assets required by Sea Basing; and Battlespace Integration required by FORCEnet. FY 2008 reflects the reinitiation of Human Systems Integration efforts to develop automation, human interface, and decision support technologies (funded in FY 2005 and prior).

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

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603236N
PROGRAM ELEMENT TITLE: WARFIGHTER SUSTAINMENT ADVANCED TECHNOLOGY

B. PROGRAM CHANGE SUMMARY:

	FY 2007	FY 2008	FY 2009
FY 2008/FY 2009 President's Budget Submission	98,758	102,124	110,384
Congressional Action	-2,000	700	0
Congressional Undistributed Reductions/Rescissions	0	-657	0
Execution Adjustments	-1,994	0	0
Program Adjustments	0	0	2,198
Rate Adjustments	0	0	-62
SBIR Assessment	-2,032	-1,160	0
FY 2009 President's Budget Submission	92,732	101,007	112,520

PROGRAM CHANGE SUMMARY EXPLANATION:
Technical: The impact of the $10 million dollar Congressional reduction in FY 2008 to this PE impacts the Sea Base Mobility and Interfaces activity. The Small-to-Large Vessel At-Sea (STLVAST) FNC program reductions have eliminated the program's ability to contract with multiple performers for FY 2008. Program risk has increased because single source performer contracts increase the technical and schedule risk if the lone performer fails to meet STLVAST Program contract phase one requirements.

Schedule: The impact of the $10 million dollar Congressional reduction in FY 2008 to this PE impacts the Turbine Engine Technology activity. The initiation of design and fabrication of Versatile Affordable Advanced Turbine Engines (VAATE) Phase II demonstrator engines with General Electric (GE)/Liberty Works (LW) has been delayed until FY 2009.

C. OTHER PROGRAM FUNDING SUMMARY:
Not applicable.

D. ACQUISITION STRATEGY:
Not applicable.

E. PERFORMANCE METRICS:

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603236N
PROGRAM ELEMENT TITLE: WARFIGHTER SUSTAINMENT ADVANCED TECHNOLOGY

Efforts within this PE support the FNC program and are monitored at two levels. At the lowest level, each is measured against technical and financial milestones on a monthly basis. Annually, each FNC project is reviewed in depth for technical and transition performance by The Chief of Naval Research against requirements approved by the Navy's senior flag level Technical Oversight Group. Routine site visits to performing organizations are conducted to assess programmatic and technical progress. Most are reviewed annually or bi-annually by an independent board of visitors who assess the level and quality of the Science and Technology basis for the project.

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603236N PROGRAM ELEMENT TITLE: WARFIGHTER SUSTAINMENT ADVANCED TECHNOLOGY
PROJECT NUMBER: 2915 PROJECT TITLE: WARFIGHTER SUSTAINMENT ADVANCED TECHNOLOGY

COST: (Dollars in Thousands)

Project Number & Title	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
2915 WARFIGHTER SUSTAINMENT ADVANCED TECHNOLOGY	61,822	90,375	112,520	101,051	117,968	82,961	48,332

A. MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: Warfighter Sustainment Advanced Technology supports Manpower and Personnel, Training, and Readiness; and the Future Joint Warfighting Capabilities identified by the Joint Chiefs of Staff. This project supports FNC Programs in Airframe/Ship Corrosion; Turbine Engine Technologies; Littoral Combat; Sea Base Planning, Operations and Logistics; and Sea Base Mobility and Interfaces. This project develops technologies that enable the Navy to better recruit, select, classify, assign, and manage its people; to train effectively and affordably in classroom settings, in simulated and actual environments, and while deployed; and to effect human systems integration into weapon systems. Other technologies enable reduced operating costs through life-extension of legacy systems, increased efficiency of future propulsion systems and improved diagnostic tools. Within the Naval Transformation Roadmap, this investment supports the achievement of all the transformational capabilities of Sea Warrior and the transformational capabilities of Ship to Objective Maneuver and Time Sensitive Strike required by Sea Strike; Littoral Sea Control and Anti-Submarine Warfare (ASW) required by Sea Shield; Compressed Deployment and Employment Times and Enhanced Sea-Borne Positioning of Assets required by Sea Basing; and Battlespace Integration required by FORCEnet.

B. ACCOMPLISHMENTS/PLANNED PROGRAM:

	FY 2007	FY 2008	FY 2009
SEA BASE PLANNING, OPERATIONS AND LOGISTICS	10,873	18,721	15,328

This activity includes support for Sea Base Collaborative Command and Control; Sea Base Integrated Operations; Surface Connector Vehicle Transfer; Automated Weapons Assembly; and Sense and Respond Logistics. Sea Basing will require more robust afloat command and control for sustainment activities. Logistics must integrate with the joint task force common operating picture, and provide awareness of mission supportability and readiness at an operational and tactical level. This activity will produce techniques and systems to support automated

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603236N PROGRAM ELEMENT TITLE: WARFIGHTER SUSTAINMENT ADVANCED TECHNOLOGY
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transfer of cargo from shipboard unload/onload point to stowage spaces. This activity further supports the Seabasing mission of marshalling troops, equipment, and materials. It will improve current replenishment capabilities for transfer of cargo between Sea Base/Logistics vessels (large ship-to-ship) during high sea states, while maintaining safety of operations. Technologies include high-strength composites, ship-motion compensation for force control-based systems, intelligent systems, and robotics.

FY 2007 - FY 2009 funding profile reflects planned project transitions through land-based and at-sea demonstrations and also the effects of the realignment of FNC Program investments into Enabling Capabilities (ECs). Funding growth was required for FY 2008 to initiate new FNC efforts in Automated Weapons Assembly and Sense and Respond Logistics. The decrease in FY 2009 represents completion of Intra-Connector Material Handling and Large-to-Large Vessel Interface – Lift On/Lift Off efforts.

FY 2007 Accomplishments:

- Continued efforts on the Large to Large Vessel Lift on/Lift off capability
- Completed the efforts of Compact Agile Material Movement including the human amplification technologies via an at-sea demonstration of the technologies.
- Completed efforts of software development for the afloat component of naval sustainment Command and Control (C2).
- Initiated efforts in the development of Interface Ramp Technologies for seabasing.
- Initiated efforts in the development of Intra-Connector Material Handling cargo securing technologies.

FY 2008 Plans:

- Continue all efforts of FY 2007.
- Initiate efforts for the development of technologies supporting automated shipboard assembly of air-delivered weapons.
- Initiate the development of advanced technologies to provide a Sense and Respond Logistics capability.

FY 2009 Plans:

- Continue all efforts of FY 2008 less those noted as completed above.
- Complete efforts for Intra-Connector Material Handling cargo securing technology development via an at-sea demonstration of the technology.

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603236N PROGRAM ELEMENT TITLE: WARFIGHTER SUSTAINMENT ADVANCED TECHNOLOGY
PROJECT NUMBER: 2915 PROJECT TITLE: WARFIGHTER SUSTAINMENT ADVANCED TECHNOLOGY

- Complete efforts on Large to Large Vessel Lift on/Lift off capability via an at-sea demonstration of the technologies.

	FY 2007	FY 2008	FY 2009
SEA BASE MOBILITY AND INTERFACES	12,293	22,180	29,292

This activity includes support for Sea Base Mobility and Interfaces and Force Closure. This activity improves the capability for transfer of cargo between Sea Base/Logistics vessels and employment of combat ready forces over unimproved beaches during high sea states. Capabilities being developed include propulsion technologies, cargo stabilization technologies, and advanced hull technologies needed for sustained operations at high speed in high sea states. This activity further supports the Seabasing mission of transporting troops, equipment, and materials from the seabase to shore, and providing support to seaborne forces via surface distribution interfaces.

FY 2007 - FY 2009 fluctuations result from the planned initiation of projects to support the Navy's developing seabasing concept of operations, to support planned product transitions to new ship programs through land-based and at-sea demonstrations, and to reflect the realignment of FNC Program investments into ECs. The FY 2008 increase from the FY 2007 budget is per the documented Business Plan developed and approved within the FNCs Program. FY 2008 Congressional reduction impacts the Small-to-Large Vessel At-Sea (STLVAST) FNC program by eliminating the program's ability to contract with multiple performers. Program risk has increased because single source performer contracts increase the technical and schedule risk if the lone performer fails to meet STLVAST Program contract phase one requirements. Funding increases between FY 2008 and FY 2009 support several programs that are at the stage where the actual full prototype systems are being manufactured and/or undergoing shipboard integration for major At-Sea Demonstrations that are scheduled to occur in FY 2009. Additionally funding growth is required for fabrication of large scale test articles, such as a waterjet prototype, to support FY 2009 at-sea and land-based technology demonstrations.

FY 2007 Accomplishments:

- Continued work for a beachable high speed craft as a Sea Base mobility interface.
- Continued efforts on the Large to Large Vessel Lift on/Lift off capability.
- Continued technology exploration in hydrodynamic impacts and design space trade studies.
- Continued efforts on the High Speed Sea Base to Shore Connector technology development.
- Continued efforts to develop technologies for Small to Large At-Sea Vessel Interfaces.

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603236N PROGRAM ELEMENT TITLE: WARFIGHTER SUSTAINMENT ADVANCED TECHNOLOGY
PROJECT NUMBER: 2915 PROJECT TITLE: WARFIGHTER SUSTAINMENT ADVANCED TECHNOLOGY

- Continued the development of concepts for High Rate Horizontal and Vertical Material Movement within the Sea Base.
- Continued efforts to develop a large scale Axial Flow Waterjet technology.
- Initiated efforts to develop blade control technology for the heavy lift vertical air replacement platform.

FY 2008 Plans:

- Continue all efforts of FY 2007 (Impact of Congressional reduction: Small-to-Large Vessel At-Sea (STLVAST) FNC program reductions have eliminated the program's ability to contract with multiple performers. Program risk has increased because single source performer contracts increase the technical and schedule risk if the lone performer fails to meet STLVAST Program contract phase one requirements.).

FY 2009 Plans:

- Continue all efforts of FY 2008.
- Complete efforts on the High Speed Sea Base to Shore Connector technology development through at-sea demonstrations of the technologies.
- Complete efforts in Small to Large At-Sea Vessel Interfaces through at-sea demonstrations of the technologies.
- Complete efforts in the Axial Flow Waterjet program through an at-sea demonstration of the technology.
- Complete efforts in the High Rate Horizontal and Vertical Material Movement within the Sea Base.
- Initiate efforts to develop large ship fuel savings technologies for high speed materiel transport ships and follow on efforts initiated under Friction Drag Reduction.

	FY 2007	FY 2008	FY 2009
FRICTION DRAG REDUCTION	0	2,453	1,250

This activity is a collaborative effort with the Defense Advanced Research Agency (DARPA) and the Program Executive Officer for Ships (PEO Ships). The objective is to unambiguously demonstrate the performance of large-scale predictive models that incorporate sufficient physics from first-principles models on a large or full-scale ship test vehicle.

FY 2008 - 2009 funding profile reflects the phased completion of the Friction Drag Reduction program at the end of FY 2009.

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603236N PROGRAM ELEMENT TITLE: WARFIGHTER SUSTAINMENT ADVANCED TECHNOLOGY
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FY 2008 Plans:

- Initiate design of large-scale demonstrator; modify demonstrator to install drag reduction equipment and sensors.
- Initiate at-sea large-scale demonstrator test.
- Initiate design of an optimal implementation of additive-based drag reduction technology using large-scale predictive models.

FY 2009 Plans:

- Complete large-scale flat-plate test and data reduction.

	FY 2007	FY 2008	FY 2009
SEA BASING	6,618	13,559	26,221

This activity includes advancement of technologies to support the design and development of Sea Base Enabler Innovative Naval Prototypes (INP's). Areas include design and development of various Sea Basing prototypes in the areas of high speed, shallow draft and beachable connectors; and vessel to vessel interfaces.

The Sea Base Enabler INP effort was initiated in FY 2006. The INP program spans from conceptual design through prototype fabrication and testing. The increasing budget between FY 2007 and FY 2009 represents changes in complexity and cost going from preliminary design and model development through prototype fabrication. In FY 2008 and FY 2009 this INP plan includes the completion of the development and at-sea testing of the Rapid Deployable Seabasing Stable Transfer Platform demonstrator; the continuation of several land based and tow-tank based model construction and testing for the Sea Base to "Over-the-Shore" Connector Transformational Craft (T-CRAFT) Prototype; and the full scale component-level development, evaluation, and testing of critical T-CRAFT technologies. In addition, technology components of the Expeditionary Craft (E-CRAFT) program are pursued in this activity

FY 2007 Accomplishments:

- Continued multiple INP contracts for preliminary designs in the area of a T-CRAFT and a Rapidly Deployable Seabasing Stable Transfer Platform.

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PROGRAM ELEMENT: 0603236N PROGRAM ELEMENT TITLE: WARFIGHTER SUSTAINMENT ADVANCED TECHNOLOGY
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- Completed the preliminary design phase of the T-CRAFT demonstrator.
- Initiated the down-selection of T-CRAFT designs for further development and model construction and testing.
- Initiated T-CRAFT model construction and testing.
- Initiated the construction of a scaled model of a Rapidly Deployable Stable Transfer Platform demonstrator
- Initiated a second evaluation of potential new Seabasing INP efforts.

FY 2008 Plans:

- Continue all efforts of FY 2007 less those noted as completed above.
- Complete the development of the Rapidly Deployable Seabasing Stable Transfer Platform demonstrator.
- Initiate planning of T-CRAFT prototype and component development.

FY 2009 Plans:

- Continue all efforts of FY 2008 less those noted as completed above.
- Complete T-CRAFT model testing and evaluation.
- Initiate the down-selection of T-CRAFT designs for prototype and component development and fabrication.
- Initiate testing and evaluation of E-CRAFT demonstrator hydrodynamic and structural characteristics.

	FY 2007	FY 2008	FY 2009
MANPOWER AND PERSONNEL DEVELOPMENT	5,199	5,040	5,435

This activity provides Navy personnel system managers with the ability to attract and retain the right people and to place them in jobs that best use their skills, training, and experience. Application of modeling and simulation, mathematical optimization, advanced testing, statistical forecasting, information visualization, data warehousing, data cleansing, web-based knowledge management, and human performance measurement technologies enhances Fleet readiness and reduces personnel costs.

FY 2007 Accomplishments:

- Completed Web Based Marketplace for Sailors and Jobs, the computational operating environment in which the command, broker, and Sailor cognitive agents will interface to distribute and assign military personnel.
- Completed advanced development of Cultures and Values Selection for integration with other selection and classification measures.

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603236N PROGRAM ELEMENT TITLE: WARFIGHTER SUSTAINMENT ADVANCED TECHNOLOGY
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- Completed Integrated Whole Person Assessment, which integrates Attrition Reduction Technologies, Non-Cognitive Measures, and Rating Identification Engine (RIDE)/Job and Occupational Interest in the Navy (JOIN).
- Completed Integrated Sailor/Marine Career Management System, which integrates Career Case Manager Technologies Distribution Incentive System.
- Completed development of advancement and retention analytical tools for Comprehensive Optimal Manpower & Personnel Analytical Support System (COMPASS), formerly titled Integrated Personnel Situational Monitoring, Analysis, and Response Technologies.

FY 2008 Plans:

- Initiate development and demonstration of decision support tools linked with Sea Warrior.
- Initiate advanced selection, classification and assessment metrics to facilitate optimal labor substitution.
- Initiate integration and multi-faceted decision support tools to evaluate manpower alternatives.
- Initiate development and demonstration of behaviorally-based predictive models.

FY 2009 Plans:

- Continue all efforts of FY 2008.
- Initiate experiments and demonstration of independent dynamic supply and demand models for Navy skill sets.
- Initiate development of a prototype assessment measure of team adaptive performance.

	FY 2007	FY 2008	FY 2009
TRAINING SYSTEMS	10,442	10,181	10,865

This activity improves mission effectiveness and safety by applying both simulation and instructional technology to the design of affordable education and training methods and systems. Improved training efficiency and cost-effectiveness is achieved by applying operations research, modeling and simulation, and instructional, cognitive, and computer sciences to the logistics, development, delivery, evaluation, and execution of training.

FY 2007 Accomplishments:

- Completed advanced technologies for Interactive Electronic Technical Manuals.
- Completed Virtual Technologies and Environments (VIRTE) Demonstration III.

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603236N PROGRAM ELEMENT TITLE: WARFIGHTER SUSTAINMENT ADVANCED TECHNOLOGY
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- Completed advanced technologies for collaborative network-centric visualization systems.

FY 2008 Plans:

- Initiate research and assessment of advanced gaming technology for enhanced training.
- Initiate development and demonstration of technology for enhanced human performance in networked environments.
- Initiate developments for enabling better warfighter understanding of languages and cultures to enhance their regional expertise.

FY 2009 Plans:

- Continue all efforts of FY 2008.
- Initiate advanced technology development demonstrations of game based training for better warfighter understanding of languages and cultures to enhance their regional expertise.
- Initiate experiments to validate automated performance assessment and after action reviews.
- Initiate development of an Adaptive Expert System to automatically and rapidly analyze aircrew performance (1M+ flight hours annually) to detect human factors related mishap leading indicators using a new technique with anomaly and corroboration.

	FY 2007	FY 2008	FY 2009
HUMAN SYSTEMS INTEGRATION	0	3,705	4,295

This effort supports the warfighter by providing enhanced capabilities by designing affordable user-centered systems that are efficient, easy to use, and provide required mission capabilities at lowest lifecycle costs. Such systems will be optimally designed for the right number and types of personnel, requiring minimum training while providing high skills retention.

The increase from FY 2007 to FY 2008 is due to reinitiating work in this field of research, so important to the reduction in complex naval systems design, acquisition, operation, and maintenance costs and improvements in the effectiveness of operations. This effort was funded from FY 2002 through FY 2005; budget priorities led to the gap in funding in FY 2006 and FY 2007. Congressional, DoD, and Navy policies and instructions require Navy and Marine Corps Program Managers to have a comprehensive plan for Human Systems Integration (HSI) in the acquisition process to optimize total system performance, minimize total ownership costs, and ensure the

BUDGET ACTIVITY: 03
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system is built to accommodate the characteristics of the user population that will operate, maintain, and support the systems. A strong HSI effort is required to meet these goals. The funding increase from FY 2008 to FY 2009 supports research in commanding officer/crew decision making and studies for control and monitoring multiple unmanned vehicles.

FY 2008 Plans:

- Initiate research to develop and demonstrate automation and human interface technologies to support collaborative decision-making in which multiple unmanned system operators manage groups of vehicles with optimal manning.
- Initiate research to develop and demonstrate advanced tactical decision making technologies to integrate spatially disparate displays and reduce the reliance of crew support to achieve superior ship commanding officer and crew decision making.
- Initiate HSI interface display research to improve ships personnel's ability to efficiently and effectively detect, recognize, and identify noisy targets in ambiguous and uncertain dynamic environments.
- Initiate HSI tool research, development, and application to engineering efforts to develop robust standardized set of human systems integrated specific modeling and simulation tools to assess the interaction between operators performance by system design by manning levels.

FY 2009 Plans:

- Continue all efforts of FY 2008.
- Initiate experiments to study design issues related to simultaneous control and monitoring of a multiple unmanned surface and air vehicles. Of particular importance are issues monitoring and control of multiple vehicles, planning and re-planning as environmental findings from sensors are interpreted, and safety and collision avoidance.

	FY 2007	FY 2008	FY 2009
TURBINE ENGINE TECHNOLOGY	10,725	7,850	10,800

This activity provides integration and experimental engine testing of advanced gas turbine engine technologies to reduce their technical risk and demonstrate their readiness for transition. These technologies will enable advanced capabilities for Navy weapon systems at reduced total ownership costs. Versatile Affordable Advanced

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603236N PROGRAM ELEMENT TITLE: WARFIGHTER SUSTAINMENT ADVANCED TECHNOLOGY
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Turbine Engines (VAATE) is a DoD/DOE/NASA/Industry program to develop and demonstrate versatile, affordable, advanced engine technologies enabling for increased systems capabilities and reduced total ownership costs. The VAATE goal is 10X improvement in propulsion system affordability (capability/cost) by 2017, with interim goals of 4X by 2009 and 6X by 2013. The elements of the capability-to-cost index are increased thrust to weight; decreased specific fuel consumption; and reduced development, production, and maintenance costs for the entire integrated propulsion system. To achieve these goals, VAATE is organized into multiple product areas. Specifically for the Navy, the focus, as part of the Enterprise and Platform Enablers FNC, is on turbine engine capability enhancements for future and emerging systems. Technologies critical to Navy fighter jets are being worked, including low pressure turbine technologies for short takeoff and landing; high pressure turbine technologies for higher temperature, longer life; fan and compressor technologies for greater engine robustness and durability, and instrumentation and control technologies for greater engine state awareness and less unscheduled maintenance. Technologies being demonstrated include advanced aerodynamic, material, and structural concepts and emerging active control, prognostic health management, thermal management, aircraft subsystem integration, and information technologies.

The decrease in funding from FY 2007 to FY 2008 is due to Congressional reductions against this PE. As a result of the reduction the initiation of the design and fabrication of VAATE Phase II demonstrator engines with GE/LW has been delayed until FY 2009. The increase in funding from FY 2008 to FY 2009 is due to the completion of the testing of the VAATE Phase I demonstrator engine and the hardware fabrication and assembly of the VAATE demonstrator engine.

FY 2007 Accomplishments:

- Continued VAATE Phase I: Design, component development, integration and fabrication of Phase I demonstrator engines.
- Initiated assembly, instrumentation, and testing of VAATE Phase I demonstrator engines with General Electric (GE)/Liberty Works (LW) and Pratt & Whitney (P&W).

FY 2008 Plans:

- Continue all efforts of FY 2007.
- Complete initial testing of VAATE Phase I demonstrator and core engines with GE/LW and P&W.
- Initiate development of shipboard compact power conversion technologies for multi-function motor drives, bi-directional power conversion modules, and power management controllers.

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603236N PROGRAM ELEMENT TITLE: WARFIGHTER SUSTAINMENT ADVANCED TECHNOLOGY
PROJECT NUMBER: 2915 PROJECT TITLE: WARFIGHTER SUSTAINMENT ADVANCED TECHNOLOGY

- Initiate design and fabrication of VAATE Phase II demonstrator engines with GE/LW and P&W. (Impact of Congressional reduction: Design and fabrication of VAATE Phase II demonstrator engines with GE/LW has been delayed until FY 2009.)

FY 2009 Plans:

- Continue all efforts of FY 2008 less those noted as completed above.
- Complete hardware fabrication and assembly of the VAATE demonstrator engine with P&W.
- Complete reporting shipboard compact power conversion project under this Program Element (PE). These efforts transition to PE 0603123N Force Protection Advanced Technology, R2 Activity Surface Ship & Submarine Hull Mechanical and Electrical (HM&E) in FY 2009
- Complete testing of VAATE Phase I demonstrator engines with GE/LW and P&W.
- Initiate design and fabrication of VAATE Phase II demonstrator engine with GE/LW.

	FY 2007	FY 2008	FY 2009
AIRFRAME/SHIP CORROSION	3,783	2,271	2,639

This activity includes an integrated approach for the control of the effects of external and internal corrosion in Naval weapon systems. The work develops advanced, cost effective prevention and lifecycle management technologies. This is particularly significant to life extension for the aging fleet.

The funding profile from FY 2007 to FY 2009 reflects the reorganization of the FNC Program investments into EC's.

FY 2007 Accomplishments:

- Continued Nondestructive Inspection (NDI) technology for heat damage detection on composite materials.
- Completed development of road test method for Marine Corps vehicles.
- Completed the development of NDI Technology for aircraft metal and composite structures to detect cracks and defects.
- Completed the development of single coat systems for Collection-Holding-Transfer (CHT) ship tanks.

FY 2008 Plans:

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603236N PROGRAM ELEMENT TITLE: WARFIGHTER SUSTAINMENT ADVANCED TECHNOLOGY
PROJECT NUMBER: 2915 PROJECT TITLE: WARFIGHTER SUSTAINMENT ADVANCED TECHNOLOGY

- Continue all efforts of FY 2007 less those noted as completed above.
- Initiate development on improved non-skid coatings.
- Initiate development on improved ship rudder coatings
- Initiate development on high performance topside coatings
- Initiate development on high performance airfield pavements.

FY 2009 Plans:

- Continue all efforts of FY 2008.
- Initiate evaluation of advanced material coatings for erosion control on helicopter main rotor blade leading edges.

	FY 2007	FY 2008	FY 2009
LITTORAL COMBAT	1,889	4,415	6,395

The goal of Littoral Combat is the application of technologies to enhance the ability of the Navy/Marine Corps team to execute the Naval portion of a joint campaign in the littorals. This activity considers all the critical functions of warfighting: command, control, communications, computers, intelligence, surveillance, and reconnaissance (C4ISR), fires, maneuver, sustainment, force protection, and training. The activity includes support to the following FNC ECs; Battlefield Power, Reduced Support Costs 1, Advanced Naval Fires Technology Spiral 1, Combatant Commander (COCOM) to Marine Combat Identification (ID), Global Information Grid (GIG)-Compliant Networking, Hostile Fire Detection and Response Spiral 2, Position-Location-Information, Reduced Cost of Operations 1, Sea Base Collaborative Command and Control, Sea Base Mobility and Interfaces, and Sea Base Integrated Operations.

The growth in FY 2007 to FY 2008 reflects the Battlefield Power refined funding profile from initiation. The FY 2008 to FY 2009 growth reflects Technology Oversight Group (TOG) approval of a new EC to develop enhanced individual protective systems for the Warfighter. The FNC program provides the best technology solutions to stated OPNAV requirements by bundling discrete but interrelated Science & Technology products that deliver a distinctly measurable improvement within a five-year time frame.

FY 2007 Accomplishments:

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603236N PROGRAM ELEMENT TITLE: WARFIGHTER SUSTAINMENT ADVANCED TECHNOLOGY
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- Initiated development of battlefield power generation technologies lunchbox sized 500 – 1000W portable JP-8 fueled generator.

FY 2008 Plans:

- Continue all efforts of FY 2007.

FY 2009 Plans:

- Continue all efforts of FY 2008.
- Initiate development of advanced lighter weight modular individual protective system that will provide increased flexibility and protection for the warfighter. (Concurrent effort funded by PE 0602131M and PE 0603640M).

C. OTHER PROGRAM FUNDING SUMMARY - NAVY RELATED RDT&E:
PE 0206624M Marine Corps Combat Services Support
PE 0601103N University Research Initiatives
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 0602236N Warfighter Sustainment Applied Research
PE 0603512N Carrier Systems Development
PE 0603640M USMC Advanced Technology Demonstration (ATD)
PE 0604703N Personnel, Training, Simulation, and Human Factors
PE 0605013M Information Technology Development
PE 0605152N Studies and Analysis Support - Navy

OTHER PROGRAM FUNDING SUMMARY - NON-NAVY RELATED RDT&E:
PE 0601102A Defense Research Sciences
PE 0602211A Aviation Technology
PE 0603003A Aviation Advanced Technology
PE 0603007A Manpower, Personnel and Training Advanced Technology

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603236N PROGRAM ELEMENT TITLE: WARFIGHTER SUSTAINMENT ADVANCED TECHNOLOGY
PROJECT NUMBER: 2915 PROJECT TITLE: WARFIGHTER SUSTAINMENT ADVANCED TECHNOLOGY

PE 0601102F Defense Research Sciences
PE 0602203F Aerospace Propulsion
PE 0603216F Aerospace Propulsion and Power Technology

D. ACQUISITION STRATEGY:
Not applicable.

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603236N PROGRAM ELEMENT TITLE: WARFIGHTER SUSTAINMENT ADVANCED TECHNOLOGY
PROJECT NUMBER: 9999 PROJECT TITLE: CONGRESSIONAL PLUS-UPS

CONGRESSIONAL PLUS-UPS:

	FY 2007	FY 2008
ADAPTIVE IED TACTICAL SYSTEM	1,408	0

This effort provided analysis of existing processes by which Scenario-Based Training (SBT) content is generated, used, modified/improved, and/or discarded. It used current information to generate SBT components that can be easily modified by the instructor to intensify specific training objective. It evaluated and reported on an SBT tool during two separate Explosive Ordnance Disposal training exercises.

	FY 2007	FY 2008
ADVANCED COMPOSITE MATERIALS RESEARCH	3,157	0

The Composite Vehicle Research Consortium (CVRC) reviewed vehicle survivability and occupant safety and developed standardized testing techniques for burst, blast, and fire. It researched composite joining, identified multi-functional composite materials, and initiated experimental verification of material, morphological, & processing parameters. The CVRC evaluated the approach to non-destructive inspection and identified candidate techniques that will provide structural health monitoring of heavy-duty vehicles. The fatigue life of composites was reviewed and assessed along with the experimental techniques to evaluate strain regimes. A model to predict fatigue life and durability of composites was conceptually developed. The CVRC researched and identified designs in nature that also possess the attributes similar to composites. Lastly, the design and manufacturability of composites was reviewed and an instrumented tool for verification of process simulation models was designed and fabricated.

	FY 2007	FY 2008
AUTONOMOUS SUSTAINMENT CARGO CONTAINER (ASCC) DELIVERY SYSTEM	1,942	0

This effort conducted a preliminary design phase for strap-on propulsion and navigation modules on International Organization of Standardization (ISO) containers for autonomous transfer of cargo from ship to shore. Recent deliverables included a design concept overview, a mission requirements and scenario description, and a discussion of key performance parameters.

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603236N PROGRAM ELEMENT TITLE: WARFIGHTER SUSTAINMENT ADVANCED TECHNOLOGY
PROJECT NUMBER: 9999 PROJECT TITLE: CONGRESSIONAL PLUS-UPS

	FY 2007	FY 2008
CURVE PLATE TECHNOLOGY	971	0

This effort supported curve plate technology research. Designed, fabricated and constructed full-scale stainless steel curved bulkheads, keel and longerons using curved plate precision welding and fabrication for assemblies for hybrid scaled down slamming load facility (with installed composite material panels which included pressure gauges and strain sensors), to measure slamming load characteristics vs. sea states. Additionally, this effort refined and delivered computer aided manufacturing models and the developmental weld distortion models for thin section steel welding and fabrication technology.

	FY 2007	FY 2008
DEFENSE SYSTEMS MODERNIZATION AND SUSTAINMENT INITIATIVE	1,456	0

The project was concerned with legacy sea ground and air vehicles. It developed (a) advanced low cost wireless sensors to aid in extending Asset Health Monitoring system capability and (b) analysis and design methodologies to insure safe and uninterrupted operation of critical systems subject to internal failures, external disturbance, or targeted attack. It integrated materials aging and prognostics, material restoration and repair, and system remanufacturing research to advance the science of determining military components wear and fatigue processes. Besides monthly and final reports to ONR program describing technologies and tools developed to aid in platform design and maintenance, deliverables included an innovative maintenance system for ONR's new E-Craft vessel and input to the Marine Corps' EPLS contract for the Light Armored Vehicle.

	FY 2007	FY 2008
ENVIRONMENTALLY-SEALED RUGGEDIZED AVIONICS DISPLAYS	0	1,591

This project will develop a production representative display system, perform qualification testing, conduct platform integration tasks, perform certification testing to include thermal, vibration, pressure, and destructive test regimes that qualify the prototype for military use and establish an assembly/integration facility. This project could reduce the manpower currently required for maintenance and cleaning of filters in vertical lift helicopters and unmanned aerial vehicles as a result of harsh combat operational environments.

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603236N PROGRAM ELEMENT TITLE: WARFIGHTER SUSTAINMENT ADVANCED TECHNOLOGY
PROJECT NUMBER: 9999 PROJECT TITLE: CONGRESSIONAL PLUS-UPS

	FY 2007	FY 2008
HEET	3,108	0

This project developed and tested advanced fuel cell systems using hardware in the loop (HIL) methods to evaluate performance and durability and evaluated the potential for using hydrates as a fuel for undersea fuel cell applications. This effort leveraged industrial, government laboratory, and international collaboration to conduct field and laboratory work in fuel cells and methane hydrates, conducted an International Workshop on Methane Hydrates, and reported the results.

	FY 2007	FY 2008
INTELLIGENT WORK MANAGEMENT	1,410	0

This effort expanded the Intelligent Work Management (IWM) scheduling capabilities, including the addition of temporal and resource constraints as well as disjunctive tasking (more than one way to satisfy a tasking requirement being competitively scheduled). Additionally, it expanded the applications scheduler using IWM, including areas such as Watch Bill and Long Range Training Plan scheduling. It delivered a scheduling system suitable for application in shipboard maintenance.

	FY 2007	FY 2008
LITTORAL COMBAT SHIP (LCS) NETWORKED TACTICAL TRAINING SYSTEM (NTTS)	973	994

FY 2007 Accomplishments - This effort designed and developed a complementary LCS training system to support trainee throughput using low cost, high fidelity mission modules, bridge/navigation, damage control, and maintenance simulator-based training technology. It developed high fidelity acoustic propagation/loss models to support ASW and Mine Warfare (MIW) mission module training. It developed combat system graphical user interface and communication system emulators necessary for LCS crew members to conduct individual, team, and integrated team training. It delivered a simulation-based training capability for the LCS which includes both mission package and sea frame crew training modules.

FY 2008 Plan - This effort supports the littoral combat ship (LCS) networked tactical training system.

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603236N PROGRAM ELEMENT TITLE: WARFIGHTER SUSTAINMENT ADVANCED TECHNOLOGY
PROJECT NUMBER: 9999 PROJECT TITLE: CONGRESSIONAL PLUS-UPS

	FY 2007	FY 2008
MISSION READINESS ADVANCEMENTS FOR VERTICAL LIFT AIRCRAFT	1,417	0

This effort focused on developing better tools and depot processes to ensure worker safety. It also developed next-generation depot manufacturing processes that are more cost effective, as well as developing the capability to provide aircraft spare parts on demand.

	FY 2007	FY 2008
NADEP CHERRY POINT CENTER FOR VERTICAL LIFT - INSTITUTE FOR MAINTENANCE SCIENCE AND TECHNOLOGY	1,319	2,384

FY 2007 Accomplishments - This effort facilitated science and technology insertion into a dedicated activity to identify, demonstrate, validate, and assist in implementing improved maintenance products, procedures, and processes into depot operations. The payoff of these technology advancements increased readiness by improving maintenance operations and decreasing maintenance cycle times for rotary wing aircraft.

FY 2008 Plan - This project will address the sustainment needs of the military and its commercial military contractors by infusing new technology, methodologies, materials and training into maintenance and rework operations. It will develop educational programs to train a new generation of hi-tech workers in the latest advances in maintenance technology. It will support increased readiness and total cost of ownership reduction through implementation of more efficient and rapid procedures while improving maintenance cycle times in addition to providing increased workforce efficiency through implementation of effective training curricula.

	FY 2007	FY 2008
NATIONAL CENTER FOR RESEARCH ON EVALUATION, STANDARDS, AND STUDENT TESTING (CRREST) SKILL SET ANALYSIS	5,050	2,384

FY 2007 Accomplishments - This effort provided technical support to Surface Warfare Officer's School (SWOS) curriculum development by designing and building Subject Matter Expert (SME)/instructor user friendly assessment and authoring tools for simulation based instruction. The assessment tools provided the capability of SWOS instructors to design/build performance based tests that are reliable and predictive of on the job performance of officers in operational environments. Final reports documenting and describing the results of the proof-of concept demonstrations and the research performed were provided.

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603236N PROGRAM ELEMENT TITLE: WARFIGHTER SUSTAINMENT ADVANCED TECHNOLOGY
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FY 2008 Plan - This effort will conduct research addressing factors contributing to effective verbal simulation-based training with an application focus of ship handling training in the Surface Warfare Officer's School (SWOS) Conning Officer's Virtual Environment (COVE). Additionally research will be conducted on effectiveness of instructional design and assessment. Three instructional lessons are to be developed; one on cognition and the cognitive architecture, the second on instructional method and strategies, and the third on assessment.

	FY 2007	FY 2008
ON-DEMAND DISTRIBUTED TRAINING FOR THE WARFIGHTER (ODTW)	2,192	0

This effort built and demonstrated a prototype onboard mission rehearsal system (software) for damage control for the Littoral Combat Ship (LCS).

	FY 2007	FY 2008
PHOTONIC MACHINING OF ELECTRONIC MATERIALS	971	0

This effort involved non-traditional machining process development for electro-optic materials such as conformal domes. For this purpose, femtosecond and superpulse laser machining, reactive-atom plasma technology and magnetorheological finishing were utilized. In addition, material specifications and metrology systems were developed and delivered.

	FY 2007	FY 2008
PROTECTIVE APPAREL TECHNOLOGY SYSTEMS	1,942	795

FY 2007 Accomplishments - This effort expanded and diversified the Institute for Protective Apparel Research and Technology (IPART) faculty, students, scientists and other institutions. Developed near term design concepts and demonstrations with today's materials via appropriate performance tests, simulations, and data integration techniques. Integrated new comfort, fit and thermal management data sources into design process. Established thermal and moisture environmental performance databases with both fabric and garment data. Identified and tested promising flexible and composite ballistic materials. Integrated human surrogate test data into protective apparel near term design solutions and advanced design concepts design process.

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Implemented dynamic apparel performance databases.

FY 2008 Plan - This effort supports protective apparel technology systems.

	FY 2007	FY 2008
SHIPBOARD PERSONAL LOCATOR BEACON	1,262	0

This effort developed a Shipboard Personal Locator Beacon capability for application on ships. An empirical evaluation of the prototype was used to establish real life loading models for the network. These models were then used to determine if an entire crew's location can be monitored full time and how much condition data can be monitored. It delivered a wearable Shipboard Personal Locator beacon suitable for application aboard Navy, Coast Guard, and commercial ships.

	FY 2007	FY 2008
TRAINING TRANSFORMATION FOR THE PACIFIC	2,332	0

This effort enhanced and installed ASW helicopter (SH-60B and SH-60F) mission rehearsal tactical team trainers (MRT3) at Kaneohe Bay, HI, for use by Pacific Fleet aviators to maintain ASW mission readiness and to participate in Fleet Synthetic Training (FST) exercises. It designed and developed the Toolkit for Medical Modeling (TOMM) to support MARFORPAC and PACOM pandemic modeling requirements. It transitioned and integrated modeling and simulation (M&S) technologies from Joint Forces Command (JFCOM) and service M&S proponents to augment existing Pacific Command (PACOM) training capabilities and to stand-up the Pacific Warfighting Center (PWC). It delivered MRT3 trainers to USMC Air Station, Kaneohe Bay, to maintain ASW mission readiness among SH-60 aircrews, and also a TOMM modeling capability (software) to support mission planning and readiness in the face of wide-spread disease among military personnel.

	FY 2007	FY 2008
VALIDATION OF PROGNOSTIC OF HEALTH MANAGEMENT SYSTEMS	0	2,484

This project will utilize an existing test facility to measure dynamic characteristics of rolling element bearings. It will validate new prognostics and health management software and extend as necessary to account for new data. This validation will create fleet management tools to be developed and released for

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PROJECT NUMBER: 9999 PROJECT TITLE: CONGRESSIONAL PLUS-UPS

implementation. This software could be used to validate critical joint Strike Fighter engine dynamic characteristics to determine life remaining and damage to engines in the fleet.

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

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603271N
PROGRAM ELEMENT TITLE: RF SYSTEMS ADVANCED TECHNOLOGY

COST: (Dollars in Thousands)

Project Number & Title	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
Total PE	94,652	41,204	37,058	59,356	70,747	87,384	92,171
2913 RF SYSTEMS ADVANCED TECHNOLOGY	42,908	22,325	37,058	59,356	70,747	87,384	92,171
9999 CONGRESSIONAL PLUS-UPS	51,744	18,879	0	0	0	0	0

A. MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: The efforts described in this Program Element (PE) are based on investment directions as defined in the Naval S&T Strategic Plan approved by the S&T Corporate Board (Jan 2007). This strategy is based on needs and capabilities from Navy and Marine Corps guidance and input from the Naval Research Enterprise (NRE) stakeholders (including the Naval enterprises, the combatant commands, the Chief of Naval Operations (CNO), and Headquarters Marine Corps). It provides the vision and key objectives for the essential science and technology efforts that will enable the continued supremacy of U.S. Naval forces in the 21st century. The Strategy focuses and aligns Naval S&T with Naval missions and future capability needs that address the complex challenges presented by both rising peer competitors and irregular/asymmetric warfare.

Activities and efforts in this PE address technologies critical to enabling the transformation of discrete functions to network centric warfare capabilities which simultaneously perform Radar, Electronic Warfare (EW), and Communications and Network functions across platforms through multiple, simultaneous and continuous communications/data links. The Radio Frequency (RF) Systems Advanced Technology program addresses RF technology for Surface and Aerospace Surveillance sensors and systems, EW sensors and systems, RF Communication Systems, and Multi-Function sensor systems. The Program emphasizes near to mid-term transition opportunities by developing and demonstrating technologies supporting the Future Naval Capabilities (FNC) Program Enabling Capabilities (ECs) for Multi-Source Intelligence, Surveillance, and Reconnaissance (ISR) for the Warfighter, Long Range Detection and Tracking, Advanced Electronic Sensor Systems for Missile Defense,

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Marine and all types/forms of Unmanned Vehicles (UxV) Tactical ISR, Next Generation Airborne Electronic Attack, Advanced Communication for FORCEnet, GIG-Compliant Networking, Low Cost Over the Horizon Communication, Satellite Communication (SATCOM) and Line of Sight (LOS) Apertures, and Affordable Electronically Scanned Array Technology for Next Generation Naval Platforms. Within the Naval Transformational Roadmap, this investment offers affordable options for the transformational capabilities required by the Sea Shield (Theater Air and Missile Defense), Sea Strike (Persistent Intelligence, Surveillance, and Reconnaissance), and ForceNet (Communications and Networking) SeaPower 21 Naval Warfighting Pillars.

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

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603271N
PROGRAM ELEMENT TITLE: RF SYSTEMS ADVANCED TECHNOLOGY

B. PROGRAM CHANGE SUMMARY:

	FY 2007	FY 2008	FY 2009
FY 2008/FY 2009 President's Budget Submission	98,065	22,676	29,566
Congressional Action	0	19,000	0
Congressional Undistributed Reductions/Rescissions	0	-290	0
Execution Adjustments	-1,286	0	0
Federal Technology Transfer	-20	0	0
Program Adjustments	-85	0	7,613
Rate Adjustments	0	0	-121
SBIR Assessment	-2,022	-182	0
FY 2009 President's Budget Submission	94,652	41,204	37,058

PROGRAM CHANGE SUMMARY EXPLANATION:
Technical: Not applicable.

Schedule: Not applicable.

C. OTHER PROGRAM FUNDING SUMMARY:
Not applicable.

D. ACQUISITION STRATEGY:
Not applicable.

E. PERFORMANCE METRICS:
Advanced Electronic Sensor Systems for Missile Defense and Long Range Detection and Tracking ECs are aligned to the Navy's Advanced Cruiser (CG(X)) plans and closely coordinated with Naval Sea Systems Command Integrated Warfare Systems (PEO IWS 2.0). Multi-Source ISR to the Warfighter supports the Navy's Advanced Destroyer (DD(X)) Electronic Surveillance requirements and is closely coordinated with PEO IWS 2.0. Marine and UxV Tactical ISR supports Program Manager Aviation (PMA) 263 Broad Area Maritime Surveillance (BAMS) acquisition strategy. Advanced Communications for ForceNet is aligned with a number of acquisition programs ranging from

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undersea warfare to carriers. Other performance metrics are discussed within the R-2a.

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603271N PROGRAM ELEMENT TITLE: RF SYSTEMS ADVANCED TECHNOLOGY
PROJECT NUMBER: 2913 PROJECT TITLE: RF SYSTEMS ADVANCED TECHNOLOGY

COST: (Dollars in Thousands)

Project Number & Title	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
2913 RF SYSTEMS ADVANCED TECHNOLOGY	42,908	22,325	37,058	59,356	70,747	87,384	92,171

A. MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: The RF Systems Advanced Technology Thrust addresses technologies critical to enabling the affordable transformation of discrete functions to network centric warfare, utilizing multiple, simultaneous, and continuous communications/data links between platforms while simultaneously performing the functions of Radar and EW. Work in this thrust addresses cost-effective RF technology for Surface and Aerospace Surveillance sensors and systems, EW sensors and systems, RF Communication Systems, and Multi-Function sensor systems. The thrust emphasizes near to mid-term transition opportunities by developing and demonstrating technologies which enable affordable options for transformational capabilities required by the Sea Shield, Sea Strike, and ForceNet pillars.

B. ACCOMPLISHMENTS/PLANNED PROGRAM:

	FY 2007	FY 2008	FY 2009
ADVANCED MULTI-FUNCTION RF TECHNOLOGY	42,908	22,325	37,058

This effort develops, demonstrates, and transitions affordable wideband, high performance Advanced Multifunction Radio Frequency (AMRF) apertures capable of transmitting and receiving multiple, simultaneous, independent RF beams while providing reduced signature and numbers of apertures. Program activity goals include development and demonstration of multi functional RF technologies applicable to systems development for Advanced Destroyers (DD(X)), Advanced Cruisers (CG(X)), Aircraft Carriers (CVNs), and other ship classes. These technologies will provide reduced recurring costs for total system functionality; reduced number of topside antennas and support systems; reduced ship radar cross section; reduced number of unique spares and lower ship manning requirements; ability to upgrade systems and capabilities with reduced cost, time, and complexity while mitigating the risk of obsolescence; and ability to rapidly exploit technological innovation through open systems concepts. This activity also includes Multifunction Systems Technology developments that directly support the Department of Defense Joint Warfighter Science and Technology Plan and the Defense

BUDGET ACTIVITY: 03
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Technology Area Plans.

Major objectives include:

Affordable, open architecture Digital Array Radar for CG(X). Development, testing, and technology demonstration of communications, electronic attack, electronic surveillance, and radar functions in multi-function apertures. Development of a Multi Function Electronic Warfare/Electronic Surveillance (MFEW/ES) Advanced Development Model (ADM) architecture demonstrating key ES capabilities for several simultaneous ES functions and capable of supporting additional RF functions. Conducting MFEW/ES ADM testing that satisfies DD(X) acquisition program Technology Development (TD) phase requirements to enable a smooth transition of AMRF technology to the DD(X) System Development and Demonstration (SDD) Acquisition Phase with minimal changes in system architecture. Electronic Attack (EA) Techniques maintain effective countermeasures in the face of increasingly sophisticated naval threats.

Budget decrease from FY 2007 to FY 2008 is due to completion of the following efforts:
-MFEW/ES FNC effort.
-Digital Array Radar Prototype Components FNC effort.
-EA Techniques to Counter Advanced Threats FNC effort.

The increase from FY 2008 to FY 2009 is due to Future Naval Capability (FNC) zero-sum program of record update and initiation of Integrated Digital Apertures and Array Radar System (IDAARS) Innovative Naval Prototype effort.

FY 2007 Accomplishments:

- Continued operation of the wideband multi-function Communications and EW testbed in support of multi-function system development and multi-function technology insertion and demonstration for the AMRF-C effort.
- Continued Shipboard Electro-Optical/Infra-Red (EO/IR) Closed Loop Self-Protection effort.
- Continued development of a High Band array antenna capable of simultaneously supporting multiple Electronic Support Measures (ESM) surveillance functions for the MFEW/ES ADM, providing 4 high gain high sensitivity Electronics Support Measures beams.
- Continued development of a Mid Band array antenna capable of simultaneously supporting multiple ESM functions for the MFEW/ES ADM.
- Continued development of back-end analog receiver equipment supporting MFEW/ES ADM.

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- Continued systems integration, risk reduction, and Navy critical subsystem development effort leading to demonstration of MFEW/ES ADM in a relevant environment and support MFEW/ES hardware/component testing within the AMRF-C testbed.
- Completed the MFEW/ES Program Technology Development Phase, demonstrating complete systems integration, risk reduction, and Navy critical subsystem development leading to demonstration of MFEW/ES ADM in a relevant environment, and continued to support MFEW/ES hardware/component testing within the AMRF-C testbed.
- Completed development of S-band Digital Array Radar prototype components development.
- Completed the EA Techniques to Counter Advanced Threats effort by conducting field testing of the Coherent EA Advanced Techniques Generator (ATG) and Digital Radio Frequency Memory (DRFM) Hardware containing a field programmable gate array (FPGA) development board that is capable of operating at 200 MHz.
- Initiated Shipboard EW Improvement and EA Transmitter projects to develop Electronic Warfare/Electronic Attack capability for rapid technology insertion into DD(X) and other ship classes utilizing MFEW/ES ADM components and architecture and AMRF-C testbed technology. Demonstrated capability to support 4 beams/band transmit functions.
- Initiated final at-sea demonstration of the Shipboard Integrated Electro-optic Defense System (SHIELDS) hardware.

FY 2008 Plans:

- Continue all efforts of FY 2007, less those noted as completed above.
- Complete the Shipboard EO/IR Closed Loop Self-Protection effort by final at-sea demonstration of the Shipboard Integrated Electro-optic Defense System (SHIELDS) hardware which includes a Mid-Wave IR (MWIR) camera operating in the 2-5 um wavelength spectral band.
- Initiate FNC EC Long Range Detection and Tracking. Capture and extend the prototype development that occurred under Advanced Electronic Sensor Systems for Missile Defense, this project delivers an affordable, open-architecture Digital Array Radar (DAR) single face Advanced Development Model.
- Initiate the Next Generation Airborne Electronic Attack effort by performing a threat assessment study.
- Initiate FNC EC Affordable Electronically Scanned Array Technology for Next Generation Naval Platforms. Develop Partial Array consisting of high efficiency non-commercial off-the-shelf (COTS) transmitter element chains using wide band-gap semiconductors, mixed signal digital, RF, microwave, millimeter wave and associated passive components, exploiting Development & Implementation (D&I) advances in high power, high efficiency digital S- and X-band microwave amplifiers to reduce cooling and prime power needs, enabling affordable radar and EA solutions for CG(X) and DD(X). Develop and demonstrate the technology for extending the digital domain further into the transmitter RF hardware, i.e., bringing the digital domain closer to the radiating element,

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enabling Navy systems to continue to exploit advancements in COTS computing capacity for signal generation and processing, and require the activity to only develop the combined RF/digital hardware. Target cost reductions to enable ubiquitous deployment of advanced radiating systems with affordable development and procurement costs. This EC will take the lead for development of efficient, high power RF digital-microwave transmitter technology by exploiting new technologies such as Wide Band Gap (WBG) semiconductors for substantial savings of prime power requirements and topside weight and moment. This will provide a potential for smaller ships and reduced acquisition and life cycle costs.

- Initiate H-60 Tactical Commercial Data Link (TCDL) project.
- Initiate Low cost SATCOM-on-the Move array for Marine Corps.
- Initiate nested, coplanar array/ Modular Integrated Link Electronics System (MILES) design and integration.

FY 2009 Plans:

- Continue all efforts of FY 2008, less those noted as completed above.
- Complete FNC EC: Long Range Detection and Tracking, S-Band Digital Array Radar Advanced Development Model.
- Initiate Integrated Digital Apertures and Array Radar System (IDAARS), a multi-function RF topside aperture prototype covering approximately 200MHz to 22 GHz and provide the appropriate control and synergy of the functionality such that the RF functions automatically support one another providing improved operational capability. Additionally, demonstrate reductions in size, weight, and power as well as cost (both acquisition and life cycle) by reducing the number of topside apertures needed for communication, electronic warfare, and some radar functions. A critical tenet of the prototype will be the demonstration of an open architecture so that not only can different companies supply the major components such as a given receive or transmit aperture, but even down to the subarray and lower component level throughout the life cycle to ensure continuing competition for maintenance and replacement parts.
- Initiate the Enhanced Nulka Payload FNC effort by starting system architecture design.
- Initiate the Enhanced Surface Electronic Warfare Improvement Program (SEWIP) Transmitter FNC effort by starting system architecture design and Low Voltage Gallium Arsenide (GaAs) High Power Amplifier (HPA) Monolithic Microwave Integrated Circuit (MMIC) purchases.

C. OTHER PROGRAM FUNDING SUMMARY - NAVY RELATED RDT&E:
PE 0204152N E-2 Squadrons
PE 0601153N Defense Research Sciences
PE 0602123N Force Protection Applied Research

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603271N PROGRAM ELEMENT TITLE: RF SYSTEMS ADVANCED TECHNOLOGY
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PE 0602131M Marine Corps Landing Force Technology
PE 0602235N Common Picture Applied Research
PE 0602271N RF Systems Applied Research
PE 0603123N Force Protection Advanced Technology
PE 0603235N Common Picture Advanced Technology
PE 0603640M USMC Advanced Technology Demonstration (ATD)
PE 0604307N Surface Combatant Combat System Engineering

OTHER PROGRAM FUNDING SUMMARY - NON-NAVY RELATED RDT&E:
Not applicable.

D. ACQUISITION STRATEGY:
Not applicable.

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603271N PROGRAM ELEMENT TITLE: RF SYSTEMS ADVANCED TECHNOLOGY
PROJECT NUMBER: 9999 PROJECT TITLE: CONGRESSIONAL PLUS-UPS

CONGRESSIONAL PLUS-UPS:

	FY 2007	FY 2008
ADVANCED LOW COST RADAR MODULE COOLING SYSTEM	1,311	0

ONR sponsored research to perform risk reduction on affordable methods to cool microwave power amplifiers. This technology will provide cost savings and performance enhancement to large phased array radars.

	FY 2007	FY 2008
ADVANCED WIDEBAND OPEN ARCHITECTURE RADAR SYSTEM	11,654	0

ONR sponsored the development of architecture and components for a wideband radar compatible with airborne platforms. The effort addressed the Navy's requirement for a future long range Airborne Electronic Warning radar that includes the capability to classify targets, conduct feature aided tracking, operate with jamming and restricted frequency spectrums.

	FY 2007	FY 2008
APY-6 REAL TIME PRECISION TARGETING RADAR	1,942	0

Deliverables included flight testing, mode development and integration support.

	FY 2007	FY 2008
C-BAND ACTIVE ARRAY RADAR (CBAAR)	15,993	3,973

FY 2007: The deliverable was the C-BAAR System Design Studies.

FY 2008: The deliverable will be the C-BAAR System Design and the Phased Array Technology Demo Study.

	FY 2007	FY 2008
COMMAND AND CONTROL ON THE MOVE NETWORK DIGITAL OVER THE HORIZON	6,376	0

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603271N PROGRAM ELEMENT TITLE: RF SYSTEMS ADVANCED TECHNOLOGY
PROJECT NUMBER: 9999 PROJECT TITLE: CONGRESSIONAL PLUS-UPS

	FY 2007	FY 2008
RELAY (CONDOR)		

ONR sponsored research of a mobile Command and Control over the horizon system.

	FY 2007	FY 2008
COMMON AFFORDABLE RADAR PROCESSOR	2,816	0

Deliverables included 12 channel data distribution module and end to end system test.

	FY 2007	FY 2008
COMMON RADAR SIGNAL PROCESSOR	6,603	0

ONR sponsored research to develop a Common Radar Signal Processor. This technology will allow cost savings and performance enhancements to large phased array radars.

	FY 2007	FY 2008
HORIZON EXTENSION SURVEILLANCE SYSTEMS (HESS)	1,456	0

Deliverables included Miniature Microwave Integrated Circuit (MMIC) with integrated transmit/receive switch.

	FY 2007	FY 2008
JOINT ELECTRONIC ATTACK UNMANNED VEHICLES	971	0

Deliverables included an electronic attack (EA) payload installed in a pod that is certified for flight onboard Predator-class unmanned aircraft such as Predator A and B, Improved-Gnat (iGnat) and Warrior; and a ground station which includes all software and communications equipment necessary to monitor and control the payload.

	FY 2007	FY 2008
OPEN ARCHITECTURE COMPUTER TEST BED	1,554	0

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603271N PROGRAM ELEMENT TITLE: RF SYSTEMS ADVANCED TECHNOLOGY
PROJECT NUMBER: 9999 PROJECT TITLE: CONGRESSIONAL PLUS-UPS

ONR sponsored research in Open Architecture fusion and display technologies in support of Netcentric operations.

	FY 2007	FY 2008
PACIFIC AIRBORNE SURVEILLANCE AND TESTING	0	14,906

ONR will sponsor the development of component prototypes to enable multi-band/ multi-function capabilities compatible with airborne platforms.

	FY 2007	FY 2008
POLYMIDE MACRO ELECTROMECHANICAL SYSTEMS	1,068	0

Deliverables included K-Band receive array for wideband global satellite data.

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

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603640M
PROGRAM ELEMENT TITLE: USMC ADVANCED TECHNOLOGY DEMONSTRATION (ATD)

COST: (Dollars in Thousands)

Project Number & Title	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
Total PE	82,521	77,760	100,787	107,461	118,729	128,909	134,331
2223 MARINE CORPS ATD	24,462	36,242	64,345	70,339	79,809	86,209	88,798
2297 MARINE CORPS WARFIGHTING LAB - CORE	34,579	33,768	36,442	37,122	38,920	42,700	45,533
9999 CONGRESSIONAL PLUS-UPS	23,480	7,750	0	0	0	0	0

A. MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: The efforts described in this Program Element (PE) are based on investment directions as defined in the Naval Science and Technology (S&T) Strategic Plan approved by the S&T Corporate Board (Jan 2007). This strategy is based on needs and capabilities from Navy and Marine Corps guidance and input from the Naval Research Enterprise (NRE) stakeholders (including the Naval enterprises, the combatant commands, the Chief of Naval Operations (CNO), and Headquarters Marine Corps). It provides the vision and key objectives for the essential S&T efforts that will enable the continued supremacy of U.S. Naval forces in the 21st century. The Strategy focuses and aligns Naval S&T with Naval missions and future capability needs that address the complex challenges presented by both rising peer competitors and irregular/asymmetric warfare.

As a key component of naval expeditionary forces, the Marine Corps has unique and technologically stressing requirements because of its expeditionary mission and intensive operational tempo, Marine Air-Ground Task Force (MAGTF) structure, and conduct of maneuver warfare. Critical requirements in this program element (PE) are: Command, Control, Communications, Computers, Intelligence, and Reconnaissance (C4ISR); maneuver techniques and means; force protection; logistic sustainment; human performance, training and education; and firepower. There are ongoing actions to develop and demonstrate advanced technologies and concepts in operational environments. Joint service efforts are aligned with Defense Technology Objectives and Joint

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603640M
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Warfighting Capability Objectives. In addition, there is funding for experimentation in warfighting concepts as well as operational assessment of emerging technologies, to include technical support of operating forces to assess military utility of selected technologies. This PE specifically supports: continued development of Distributed Operations (DO) through field experiments with Marine infantry battalions; rapid response to low-, mid-, and high-intensity conflicts in the Global War on Terrorism (GWOT); methods for countering irregular threats; and expansion of seabasing and naval force packaging capabilities. The investment directly assists in fulfilling the forward presence requirements of Sea Shield and the transformational capabilities prescribed by Sea Strike. The Future Naval Capability (FNC) process is supported and funds are programmed accordingly. This PE is largely focused on demonstration of products and capabilities from the knowledge base and Discovery and Invention (D&I) phases of Naval Science and Technology (S&T). As Naval partners, the Navy and Marine Corps S&T Team strive to transition technologies that will implement objectives outlined in the Naval Operations Concept. This PE also funds technical solutions designed to increase Naval force capability, such as the Naval Expeditionary Combat Command. Investments in S&T provide the opportunities for future capabilities and will prevent technological surprise. The PE as a whole will advance the amphibious and expeditionary capabilities for the Combatant Commanders helping to meet their emerging challenges by enhancing Naval S&T contributions to the long commitment to the GWOT.

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

FY2008 funding totals do not include $13.0M in pending request for current FY2008 GWOT requirements.

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603640M
PROGRAM ELEMENT TITLE: USMC ADVANCED TECHNOLOGY DEMONSTRATION (ATD)

B. PROGRAM CHANGE SUMMARY:

	FY 2007	FY 2008	FY 2009
FY 2008/FY 2009 President's Budget Submission	83,376	70,968	68,564
Congressional Action	0	7,800	0
Congressional Undistributed Reductions/Rescissions	0	-535	0
Execution Adjustments	1,070	0	0
Program Adjustments	-42	0	32,205
Rate Adjustments	0	0	18
SBIR Assessment	-1,883	-473	0
FY 2009 President's Budget Submission	82,521	77,760	100,787

PROGRAM CHANGE SUMMARY EXPLANATION:
Technical: FY 2009 reflects funding for a DoD directed integrated capability demonstration supporting the Protection of Ground Forces and Systems. DoD directed this initiative in response to the determination that its S&T investment is likely too small to meet the imposing security threats that challenge our Nation, and it may not be adequately postured to take advantage of key scientific and technological opportunities that offer breakthrough advantages to our warfighters. This broad, multi-year (through the FYDP) initiative will expand existing technology integration and increase/spur the application of more fundamental technologies to force and platform protection. The goal is multiple broad phased force protection applications and technologies, with off-ramps for fielding successes, therefore, funding associated with this DoD initiative is reflected throughout the PE.

Schedule: Project 2297, Worldwide contingency and combat operations (i.e. Operation Iraqi Freedom (OIF) campaigns, humanitarian efforts, and others) have increased the operations tempo of United States Operating Forces to the extent that their support of and participation in the Marine Corps Warfighting Laboratory (MCWL) Advanced Warfighting Experiments (AWEs) Sea Viking (SV) 2004, 2006, and 2008 was/remains substantially reduced. Events are rescheduled and adjusted so that operational assessments may be conducted by operational units preparing to deploy to Iraq and subsequently in Iraq in order to accommodate troop availability.

C. OTHER PROGRAM FUNDING SUMMARY:
Not applicable.

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603640M
PROGRAM ELEMENT TITLE: USMC ADVANCED TECHNOLOGY DEMONSTRATION (ATD)

D. ACQUISITION STRATEGY:
Not applicable.

E. PERFORMANCE METRICS:
The primary objective of this PE is the development of technologies to meet unique Marine Corps needs in conducting Expeditionary Maneuver Warfare. The program consists of a collection of projects categorized by critical warfighting function. Individual project metrics reflect the technical goals of each specific project. Typical metrics include the advancement of related Technology Readiness Levels, the degree to which project investments are leveraged with other performers, reduction in life cycle cost upon application of the technology, and the identification of opportunities to transition technology to higher categories of development.

FY 2009 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2008
Exhibit R-2a

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603640M PROGRAM ELEMENT TITLE: USMC ADVANCED TECHNOLOGY DEMONSTRATION (ATD)
PROJECT NUMBER: 2223 PROJECT TITLE: MARINE CORPS ATD

COST: (Dollars in Thousands)

Project Number & Title	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
2223 MARINE CORPS ATD	24,462	36,242	64,345	70,339	79,809	86,209	88,798

A. MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: Critical Marine Corps requirements/imperatives addressed in this Project are: Maneuver; Force Protection; Human Performance, Training and Education; Logistics; Command, Control, Communications and Computers (C4); Intelligence, Surveillance and Reconnaissance (ISR) and Firepower. These are ongoing efforts to develop and demonstrate advanced technologies and system concepts in an operational environment. Multiple transitions into the Sub-system/Component Advanced Development Phase are planned, as well as fieldable prototyped to reduce risk in System Concept Development and Demonstration. A tactically effective Mine Countermeasures (MCM) capability is vital to Force Protection and necessary if Maneuver on land is to become a functional component of Naval Expeditionary Maneuver Warfare. Maneuver, supported by MCM provides synchronization and speed of detection, breaching, clearance, proofing, and marking operations. This project supports: 1) engaging regional forces in decisive combat on a global basis; 2) responding to all other contingencies and missions in the full spectrum of combat operations (high, middle, and low intensity), in Military Operations in Urban Terrain (MOUT), and in Operations other than War (OOTW); 3) and warfighting experimentation. By providing the technologies to enable these capabilities, this project supports the goals and objectives of the Strike, Littoral Warfare and Surveillance Joint Mission Areas. These are ongoing efforts to develop and demonstrate advanced technologies and system concepts in an operational environment.

In addition, this project supports the goals and objectives of the Littoral Combat/Power Projection related Enabling Capability (EC)within the Future Naval Capabilities (FNC) portfolio. The focus of the EC within this PE in FY 2007 and beyond will be on technology related to Urban, Asymmetric, and Expeditionary Operations (UAEO). The UAEO Capability Gap is a science and technology developmental area that is of the highest importance to Marine Corps operations in Iraq and Afghanistan and is one of the highest ranked Capability Gaps prioritized by the Chief of Naval Operations and the Marine Corps Combat Development Command (MCCDC). The UAEO technology gap is being pursued as part of an overall effort that addresses the Sea Strike Capability Gap.

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603640M PROGRAM ELEMENT TITLE: USMC ADVANCED TECHNOLOGY DEMONSTRATION (ATD)
PROJECT NUMBER: 2223 PROJECT TITLE: MARINE CORPS ATD

B. ACCOMPLISHMENTS/PLANNED PROGRAM:

	FY 2007	FY 2008	FY 2009
MANEUVER	6,740	6,709	9,597

The Maneuver Thrust Technology Area focuses on the development, demonstration, and transition of technologies that will increase the warfighting capabilities and effectiveness of current and future Marine Corps maneuver systems. This Thrust aims at capturing emerging and "leap ahead" technologies in the areas of mobility, materials, propulsion, survivability, durability, signature reduction, modularity, and unmanned systems. Beginning in FY 2009, MCM efforts will be funded under the Force Protection activity. Presently, MCM supports and enhances the maneuver and force protection Marine landing forces with the development of technologies to enable detection, neutralization, breaching, and clearing of mines, Improvised Explosive Devices (IEDs), and unexploded ordnance from the beach exit to inland objectives. MAGTF MCM is a functional component of Naval Expeditionary Maneuver Warfare and includes Ship to Objective Maneuver (STOM), Expeditionary Operations from a Sea Base, sustained Operations Ashore, Urban and Asymmetric Operations, and OOTW.

FY 2009 reflects an increase for a DoD directed integrated capability demonstration supporting the Protection of Ground Forces and Systems. This capability demonstration has been directed to be wide ranging and encompass technologies for:
- Pre-detonation of IEDs,
- Personal protection materials,
- Personal power generation,
- Micro power sources, and
- Augmented reality

The Maneuver activity directly supports this integrated demonstration which will be a broad, multi-year thrust to both investigate technology integration as well as spur application of more fundamental technologies to force and platform protection. The goal is multiple broad phased force protection applications and technologies, with off-ramps for fielding successes.

FY 2007 Accomplishments:

- Continued Advanced Electronically Controlled Active Suspension System (ECASS) development in support of High Mobility Multi-Purpose Wheeled Vehicle (HMMWV), MAGTF Expeditionary Family of Fighting Vehicles (EFV) and

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603640M PROGRAM ELEMENT TITLE: USMC ADVANCED TECHNOLOGY DEMONSTRATION (ATD)
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other Light Armored Vehicles.
- Continued Electromagnetic Non-Explosive Reactive Armor (E-NERA) and Advanced Electromagnetic Armor technology development efforts.
- Continued development of scalable explosive neutralization technologies for MCM.
- Continued development of technologies to defeat side/top attack and advanced fuse mines through signature reduction and advanced signature duplication.
- Continued the development of technologies to locate and defeat IEDs.
- Continued S&T programs to address MAGTF Land MCM Master Plan capability gaps.
- Continued development of technologies to defeat advanced mine fuses (seismic, acoustic, and infrared).
- Continued the formation of blast consortia to foster the increased understanding of blast and fragmentation interaction with vehicles and biological effects.
- Completed the program to examine the feasibility of using lightweight mine clearance devices on USMC combat vehicles. (Effort transferred to MCWL).
- Initiated development of a Combat S&T vehicle prototype to enhance crew survivability and vehicle fuel efficiency.
- Initiated efforts to detect IEDs using radio frequency sources.
- Initiated studies to identify technology development plans to close identified force protection capability gaps.
- Initiated development of a test bed to demonstrate advanced survivability concepts.

FY 2008 Plans:

- Continue all efforts of FY 2007.
- Complete development of scalable explosive neutralization technologies for MCM.
- Complete Advanced ECASS development in support of HMMWV, MAGTF Expeditionary Family of Fighting Vehicles and other Light Armored Vehicles.
- Complete and transition continued development of technologies to locate and defeat IEDs into PEs associated with the FNC program.
- Complete E-NERA.
- Initiate technology development programs to address force protection capability gaps.
- Initiate development of fuel efficiency and battle field power systems for improved performance.

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603640M PROGRAM ELEMENT TITLE: USMC ADVANCED TECHNOLOGY DEMONSTRATION (ATD)
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FY 2009 Plans:

- Continue all efforts of FY 2008, less those noted as completed above.
- Initiate development of a Combat S&T Vehicle demonstrator to enhance crew survivability and vehicle fuel efficiency.
- Initiate survivability improvements and technologies to mitigate acceleration and traumatic brain injuries to occupants to enhance tactical mobility and survivability in support of Distributed Operations.
- Initiate advanced suspension systems development with ride height adjustment, ride quality adjustment, rollover prevention, and load equalizing systems for USMC tactical wheeled platforms to enhance tactical mobility in support of Distributed Operations.
- Initiate a Survivability/ Active Protection Systems Improvement effort to increase effectiveness of defeat (Pdefeat) of shoulder launched RPG type threats and ATGM threats on light platforms utilizing non-kinetic kill technologies.
- Initiate new mobility efforts for On-Board Vehicle Power to increase mobile exportable power for Diesel Electric Propulsion Concepts and a Fuels effort to investigate future fuel alternatives for internal combustion engines to include Fischer-Tropsch and coal gasification processes for use in military tactical wheeled vehicles.
- Initiate Maneuver Enabling Technologies such as Vehicle Stabilization to improve vehicle suspension and control technologies to stabilize the platforms themselves to improve ride quality, shoot on the move capability and human systems integration.
- Initiate a Vehicle Demonstrator program to design and fabricate an Integrated Power Demonstrator platform capable of producing the power needs for mobility and survivability concept demonstrations.

	FY 2007	FY 2008	FY 2009
FORCE PROTECTION	0	0	6,715

This activity supports the Force Protection Thrust’s Advanced Technology Demonstration efforts in the areas of individual Marine platforms, equipment and autonomous systems. This includes technologies to enable detection, neutralization, breaching, and clearing of mines, Improvised Explosive Devices (IEDs), and unexploded ordnance from the beach exit to inland objectives. Efforts supported under Force Protection also include the demonstration of technologies such as Counter Rocket and Mortar (CRAM) and Counter Sniper technologies in support of maneuver warfare, small unit distributed operations, and fixed installation protection and technologies for improved Personnel Protective Equipment for individual protection against blast and ballistic threats as well as in a chemical, radiological, and biological environment. Physical

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603640M PROGRAM ELEMENT TITLE: USMC ADVANCED TECHNOLOGY DEMONSTRATION (ATD)
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Security technologies to support expeditionary maneuver warfare, pier/port and base infrastructure are also addressed under this thrust. FY 2009 is the first reporting cycle where Force Protection Thrust efforts are separated from the Maneuver Thrust. Counter-IED and Counter-RPG Technologies remain high priority Marine Corps focal areas.

FY 2009 reflects additional funding ($3.4M) for a DoD directed integrated capability demonstration supporting the Protection of Ground Forces and Systems. This capability demonstration has been directed to be wide ranging and encompass technologies for:
- Pre-detonation of IEDs,
- Personal protection materials,
- Personal power generation,
- Micro power sources, and
- Augmented reality

The Force Protection activity is central to the integrated demonstration program, which will be a broad, multi-year thrust to both investigate technology integration as well as spur application of more fundamental technologies to force and platform protection. The goal is multiple broad phased force protection applications and technologies, with off-ramps for fielding successes.

FY 2009 Plans:

- Continue development of technologies to defeat side/top attack and advanced fuze mines through signature reduction and advanced signature duplication.
- Continue development of technologies to locate and defeat IEDs.
- Continue development of technologies to defeat advanced mine fuzes (seismic, acoustic, and infrared).
- Continue efforts to detect IEDs using radio frequency sources.
- Continue technology development programs to address force protection capability gaps.
- Complete studies to identify technology development plans and develop roadmaps to close identified force protection capability gaps.
- Complete design of a novel low passive inter-modulation wideband antenna for use against multiple classes of radio frequency triggered IEDs.
- Complete investigation of polarization diversity designs to counter specific placements and orientations of radio frequency triggered IEDs.
- Initiate new Explosive Hazard Defeat to address the Suicide-Bomber threat. This effort will combine multiple sensor modalities, analysis algorithms, and data fusion to demonstrate high Pd, low FAR detection of

BUDGET ACTIVITY: 03
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suicide bombers from standoff distances from multiple aspect angles.
- Initiate a new Anti-Tank Guided Missile (ATGM) effort to defeat ATGMs in complex urban environment.
- Initiate Warfighter modeling and simulation efforts for the Warfighter-as-a-System analysis approach and methodology combining survivability, mobility, and warfighter performance parameters.

	FY 2007	FY 2008	FY 2009
LITTORAL COMBAT/POWER PROJECTION (LC/PP)	3,806	16,165	16,675

This activity is aligned with the Sea Strike, Sea Shield, Sea Basing and FORCEnet pillars and provides the capability for the demonstration and transition of technologies developed through the related Marine Corps S&T programs directly to an acquisition program of record. Littoral Combat/Power Projection is the Enabling Capability (EC).

The funding profile from FY 2007 to FY 2009 reflects the reorganization of the FNC program investments into ECs. As a result of this reorganization, the funding for each EC has been realigned to a Budget Activity (BA) as appropriate. The focus of the ECs within this PE will be on technology related to Urban, Asymmetric, Littoral and Expeditionary Operations. The related science and technology development is of the highest importance to Marine Corps operations in Iraq, Afghanistan and the GWOT. Understandably, these Warfighter Capability Gaps are among those highest ranked of the prioritized Capability Gaps (prioritized by the OPNAV N-6/7 and the MCCDC). The technologies associated with these gaps are being pursued as part of an overall effort that addresses Sea Strike, Sea Shield, Sea Basing and FORCEnet Capability Gaps. Warfighter Capability Gaps are made up of ECs and supporting products. This activity includes support to the Urban, Asymmetric Operations-related to EC's for IED's, Modular Scalable Effects Weapons, Advanced Naval Fires Technology, Dynamic Target Engagement, Position Location Information, Transparent Urban Structures and Hostile Fire Detection and Response.

Increase from FY 2007 to FY 2008 and out reflects a net zero realignment of USMC S&T resources from BA 2 (PE0602131M) to BA 3. This was done to align the FNC products with the proper funding source. Additionally the FNC Program conducted a rephasing of funds ($320K), during execution, to support transitioning the GUNSLINGER hostile fire detection and counter fire system to the Naval Expeditionary Combat Command (NECC).

FY 2007 Accomplishments:

- Continued development of tools and technologies to support Marine Corps Intelligence, Surveillance and

BUDGET ACTIVITY: 03
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Reconnaissance (ISR) efforts Measurement and Signature Intelligence Tactical Remote Sensor System (MASINT/TRSS) in remote sensor integration within the Distributed Common Ground/Surface System (DCGS). (Realigned to PE 0603114N in FY 2007.)
- Continued design and development of advanced weapons materials for use in artillery and mortar systems to reduce weight while maintaining strength, and increasing operational life and capability. (Concurrent funding in PE 0602131M and 0602236N; realigned to PE 0603114N in FY 2007.)
- Continued development of improved lightweight computational fire control interface technology. (Concurrent funding from PE 0602131M, 0602236N, 0603236N and 0603782N; realigned to PE 0603114N in FY 2007.)
- Continued development of improved fire control systems technologies to Expeditionary Fire Support System artillery and mortar systems. (Realigned to PE 0603114N in FY 2007.)
- Continued effort to incorporate advanced target acquisition target hand-off technologies to reduce sensor to shooter loop and improve target location. (Previous and concurrent effort funded in PE 0602131M). (Realigned to PE 0603114N in FY 2007.)
- Continued development of ammunition packaging techniques to lower weight and have the packaging provide additional use on the battlefield. (Previous and concurrent funding provided by PE 0602131M). (Realigned to PE 0602114N and 0603114N in FY 2007.)
- Continued integration of hostile fire detection and counter-fire system (GUNSLINGER). (Concurrent funding in PE 0602131M and 0603782N; realigned to PEs 0602114N and 0603114N in FY 2007.)
- Continued development of innovative relay Beyond Line of Sight (BLOS) technology through integration and demonstration of secure wireless networks/secure wireless local area network (LAN) communication technologies. (Concurrent funding in PEs 0602131M, 0602236N, 0603236N and 0603782N; realigned to PE 0603235N in FY 2007.)
- Completed efforts to provide urban direction finding of RF emitters from moving platforms; provided algorithms to MARCORSYSCOM Program Manager INTEL.
- Completed development and begin transition of an obstacle detection system on the EFV. (Transitioned from 0602131M.)

FY 2008 Plans:

- Continue all efforts of FY 2007, less those noted as completed above.
- Complete development and transition of Asymmetric Threat Weapon technologies. (Transitioned from PE 0602131M and 0602123N)
- Complete development and transition unambiguous warning devices technologies. (Transitioned from PE 0602131M)
- Complete development and transition active RPG defense technologies. (Transitioned from PE 0602131M)

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603640M PROGRAM ELEMENT TITLE: USMC ADVANCED TECHNOLOGY DEMONSTRATION (ATD)
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- Complete development and transition improved imaging (Electro Optic/InfraRed/Laser) technologies. (Transitioned from PE 0602131M)
- Complete development and transition reconfigurable surveillance Unmanned Aerial Vehicles (UAVs) for Warfighter protection technologies. (Transitioned from PE 0602131M)
- Initiate development of transparent urban structures technologies. (Previous and concurrent funding from PE 0602131M)
- Initiate development of modular scalable effects prototype weapon. (Concurrent funding from PE 0602131M.)
- Initiate development of counter improvised explosive devices technologies. (Concurrent funding from PE 0602131M)
- Initiate development of tactical urban breaching technologies. (Concurrent funding from PE 0602131M)

FY 2009 Plans:

- Continue all efforts of FY 2008, less those noted as completed above.
- Initiate development of individual Warfighter protection technologies. (Concurrent funding in PE 0602131M; funding will also be provided by PE 0603236N in FY 2009).
- Initiate development of advanced survivability and mobility technologies for Marine Corps tactical and combat vehicles. (Concurrent funding in PE 0602131M; funding will also be provided by PE 0603236N in FY 2009).

	FY 2007	FY 2008	FY 2009
HUMAN PERFORMANCE, TRAINING & EDUCATION	3,551	3,563	8,227

This activity develops and demonstrates advanced training technology and technologies that enhance neural and cognitive aspects of human performance including tactical decision-making, modeling, simulation, range instrumentation, synthetic environment generation and training effectiveness evaluation.

FY 2009 reflects an increase for enhanced requirements in support of Distributed Operations and for a DoD directed integrated capability demonstration supporting the Protection of Ground Forces and Systems. This capability demonstration has been directed to be wide ranging and encompass technologies for:
- Pre-detonation of IEDs,
- Personal protection materials,
- Personal power generation,
- Micro power sources, and
- Augmented reality

BUDGET ACTIVITY: 03
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The Human Performance, Training and Education activity is key to the integrated demonstration program, which will be a broad, multi-year thrust to both investigate technology integration as well as spur application of more fundamental technologies to force and platform protection. The goal is multiple broad phased force protection applications and technologies, with off-ramps for fielding successes.

FY 2007 Accomplishments:

- Continued integration of cognitive performance improvement (augmented cognition) technology using operationally relevant systems and scenarios, and demonstrated improved human cognition via multiple sensory modalities.
- Continued the development of tools to capture metrics and lessons learned from a variety of simulation and training sources.
- Continued research into augmented reality training systems to enhance warfighter performance in urban combat.
- Continued development of immersive closed loop training system for MOUT.
- Continued MACHSI: physical protection of the head, neck and face. (Transitioned from the Firepower activity.)
- Completed the integration and evaluation of cognitive state detection technologies with instructor-based training scenario applications and demonstrated improved individual task performance.
- Initiated development of the Distributed Operations Training/Virtual Test Bed.
- Initiated research into environmental effects on cognitive and team performance.

FY 2008 Plans:

- Continue all efforts of FY 2007, less those noted as completed above.
- Complete research into augmented reality training systems to enhance warfighter performance in urban combat.
- Complete integration of cognitive performance improvement (augmented cognition) technology using operationally relevant systems and scenarios, and demonstrate improved human cognition via multiple sensory modalities.
- Complete development of immersive closed loop training system for MOUT.

FY 2009 Plans:

- Continue all efforts of FY 2008, less those noted as completed above.

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603640M PROGRAM ELEMENT TITLE: USMC ADVANCED TECHNOLOGY DEMONSTRATION (ATD)
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- Initiate development of adaptive experiential learning tools for Distributed Operations Training.
- Initiate in-depth analysis, state-of-the-art report, and testing on all USMC physical training regimens, their effectiveness and their injury incidence rates
- Initiate development of "Warfighter as a System" modeling tools
- Initiate development of automated behavioral and neurophysiological performance measurement technologies for Distributed Operations Warfighter assessment, classification and assignment to training.
- Initiate Human Performance and Training capabilities (Cognitive and physical enhancement, modeling and simulation, virtual reality squad level training) in support of Distributed Operations.
- Initiate demonstrations and field studies of mitigation/augmentation capabilities that enhance squad level communication in support of Distributed Operations.
- Initiate development of a Distributed Operations virtual reality simulation training system prototype that will be scalable across fire team, squad, and platoon.
- Initiate Lightening the Load efforts aimed at developing the software necessary to conduct trade off analysis on a physically and ergonomically accurate model of the United States Marine and its infantry equipment.
- Initiate new Experiential Learning Technologies to improve the Infantry Immersive Trainer to support the Squad Immersive Training Environment (SITE) Marine Corps Urgent Needs Statement. This includes developing tracking, Helmet Mounted Displays, and software technologies to enable Augmented Reality in unimproved locations.

	FY 2007	FY 2008	FY 2009
LOGISTICS	3,491	3,628	9,004

This activity supports Marine Corps Expeditionary Logistics which is the practical discipline and real world application of the deployment, sustainment, reconstitution, and re-deployment of forces engaged in expeditionary operations. Expeditionary Logistics replaces mass with assured knowledge and speed, is equally capable ashore or afloat in austere environments, and is fully scalable to meet uncertain requirements. Expeditionary Logistics logically divides into five pillars: deployment support, force closure, sustainment, reconstitution/redeployment, and command and control. These pillars are thoroughly integrated and perpetually related in execution.

FY 2009 reflects an increase for sustainability/logistics programs (includes fuel, water, ammunition, rations, and casualty care /MEDEVAC) in support of Distributed Operations; new USMC priorities in lightening the load of the individual Marine and enhancing the Marine Corps rifle squad's overall capabilities; and for a DoD

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directed integrated capability demonstration supporting the Protection of Ground Forces and Systems. This capability demonstration has been directed to be wide ranging and encompass technologies for:
- Pre-detonation of IEDs,
- Personal protection materials,
- Personal power generation,
- Micro power sources, and
- Augmented reality

The Logistics activity directly supports the integrated demonstration program, which will be a broad, multi-year thrust to both investigate technology integration as well as spur application of more fundamental technologies to force and platform protection. The goal is multiple broad phased force protection applications and technologies, with off-ramps for fielding successes.

FY 2007 Accomplishments:

- Continued exploring the development of portable fuel cell technologies capable of providing power in the 100 Watt to 500 Watt power range.
- Continued development of vehicle embarked & powered manipulator arm for next generation expeditionary vehicles.
- Completed research into developing a lightweight expeditionary bridging capability through assessment of bridge design, manufacturing, construction, and material solutions to include composites, extrusion, and forming techniques.
- Completed Marine Corps Seabasing Roadmap study.
- Completed development of lightweight high specific energy battery charger.
- Initiated efforts to develop a micro turbine generator capable of 100W average power.
- Initiated research into developing a replaceable electrode battery power source that consists of a metallic structure that is consumed during power generation and then easily replaced with a new metallic component that restores a full charge. (Realigned from PE 0602131M.)

FY 2008 Plans:

- Continue all efforts of FY 2007, less those noted as completed above.
- Complete development of vehicle embarked & powered manipulator arm for next generation expeditionary vehicles.
- Initiate analysis of material alternatives for automated vehicle health monitoring and reporting.

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- Initiate development of a tracking capability for major classes of supplies, forces & equipment.

FY 2009 Plans:

- Continue all efforts of FY 2008, less those noted as completed above.
- Initiate technology demonstration for responsive precision aerial logistic transport from Seabase to Distributed Operations Squad or Platoon.
- Initiate technology demonstration of an innovative bridge structure constructed from highly versatile modular composite components, thus expanding site-specific assembly options while simplifying logistic transport.
- Initiate development of a backpack that prevents oscillatory and transient peak loading forces from causing skeletal injury while enhancing human mobility with heavy loads.
- Initiate development of a man-portable capability to analyze captured fuel for adulterants and contaminants.
- Initiate development of a lightweight man-portable multi-fuel thermoelectric battery charger.

	FY 2007	FY 2008	FY 2009
COMMAND, CONTROL, COMMUNICATIONS, COMPUTERS, AND INTELLIGENCE, SURVEILLANCE AND RECONNAISSANCE (C4ISR)	3,756	2,971	0

This activity integrates and demonstrates enhanced communications and situational awareness in warfighting environments and communication and situational awareness technologies for near term USMC operations.

The decrease from FY 2007 to FY 2008 is due to FY 2007 including $750K for the Software Reconfigurable Payload (SRP) and Software Reprogrammable Payload Programs to address capability gaps and shortfalls in the areas of: converged services networks; intelligent network monitoring, maintenance and mobility; multilevel information security and information assurance. The SRP payload can provide dynamic allocation among users and provide an interference mitigation capability that is currently not available to the operating forces.

FY 2009 reflects both Command, Control, Communications, Computers (C4) and Intelligence, Surveillance and Reconnaissance (ISR) efforts and funding now being placed into separate activities within this PE.

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FY 2007 Accomplishments:

- Continued integration and demonstration of naval tactical warfighting applications and network connectivity.
- Continued development and demonstration of low-cost compact conformal antenna capability.
- Continued development and demonstration of urban communications capability.
- Continued efforts to reduce the risk in investing in the ability to see through urban structures in an effort to identify enemy personnel or other assets.
- Continued designing tools for mission specific tactical sensor fields capable of fulfilling specific mission objectives.
- Continued developing smart tactical sensors, platforms and algorithms capable of forwarding information/knowledge vice raw data.
- Continued creating a service oriented sensor network for expeditionary forces' current and future tactical sensors.
- Continued creating fusion tools capable of translating tactical sensor data into appropriate situational awareness for expeditionary forces in near real-time.
- Continued designing autonomous platforms and automatic sensor planning and management tools to ensure that the right data is collected by the right sensor in support of intelligence requirements.
-Continued developing tailored tactical Human to Machine Interfaces aligned to primary operational functions and non-intrusive within the battlespace.
- Continued creating services for the tactical network that are fully operable with DCGS and the DCGS Integration Backbone.
- Completed demonstration of advanced network mobility and network security capabilities.
- Initiated development and demonstration of measurement and signature intelligence data management and integration capability.
- Initiated demonstrations of tagging, tracking and locating various adversarial targets.
- Initiated development of adaptable enemy course of action engine (smart algorithms) development to interfere with or influence adversarial plans.

FY 2008 Plans:

- Continue all efforts of FY 2007, less those noted as completed above.
- Complete efforts to reduce the risk in investing in the ability to see through urban structures in an effort to identify enemy personnel or other assets.
- Initiate demonstrations of improved urban communications capabilities.

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- Initiate urban navigation with limited Global Positioning System availability demonstrations.
- Initiate development of advanced tactical sensor nets that will localize mobile detection of threats.

FY 2009 Plans:

C4 and ISR efforts have been realigned to separate activities within this PE.

	FY 2007	FY 2008	FY 2009
COMMAND, CONTROL, COMMUNICATIONS, COMPUTERS (C4)	0	0	4,163

This activity integrates and demonstrates enhanced communications and situational awareness in warfighting environments and communication and situational awareness technologies for near term USMC operations. The focus is on development and leveraging advanced C4 technologies to enable enhanced Distributed Operations, Irregular Warfare, and Marine Corps Expeditionary Warfare. Specifically, the C4 Thrust intends to demonstrate markedly improved capabilities in over-the-horizon (OTH), beyond line-of-sight, and restricted environment communications; mobile networking; tactical decision making; tactical situational awareness; and small unit position location and navigation. Advanced technology resources will be applied to complement commercial, other service, and defense agency investments to produce a technology base to address identified Marine Corps technology gaps.

*In FY 2007 and FY 2008, this effort was funded in the C4ISR activity within this PE.
FY 2009 reflects an increase for a DoD directed integrated capability demonstration supporting the Protection of Ground Forces and Systems. This capability demonstration has been directed to be wide ranging and encompass technologies for:
- Pre-detonation of IEDs,
- Personal protection materials,
- Personal power generation,
- Micro power sources, and
- Augmented reality

The C4 activity directly supports the integrated demonstration program, which will be a broad, multi-year thrust to both investigate technology integration as well as spur application of more fundamental technologies to force and platform protection. The goal is multiple broad phased force protection applications and technologies, with off-ramps for fielding successes.

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FY 2009 Plans:

- Continue urban navigation with limited Global Positioning System availability demonstrations. (Realigned from C4ISR Activity)
- Continue demonstrations of improved urban communications capabilities. (Realigned from C4ISR Activity)
- Continue creating a service oriented sensor network for expeditionary forces' current and future tactical sensors. (Realigned from C4ISR Activity)
- Continue developing tailored tactical Human to Machine Interfaces aligned to primary operational functions and non-intrusive within the battlespace. (Realigned from C4ISR Activity)
- Continue creating services for the tactical network that are fully operable with DCGS and the DCGS Integration Backbone. (Realigned from C4ISR Activity)
- Complete conformal antenna integration and demonstrations. (Realigned from C4ISR Activity)
- Initiate an Assured Connectivity effort to develop waveforms suited to maintaining low data rate links under extreme conditions.

	FY 2007	FY 2008	FY 2009
INTELLIGENCE, SURVEILLANCE, AND RECONNAISSANCE (ISR)	0	0	2,774

This activity supports the demonstration of technologies to enhance situational awareness and tactical decision making through automated analysis, fusion of data, rapid integration of information, and acquired knowledge resulting in actionable intelligence at the lower command levels. The activity includes the demonstration of ISR efforts involving enhanced reconnaissance and persistent surveillance, and sensors for unmanned ground and aerial vehicles. Advanced Technology demonstrations also include the collection of information [monitoring, sensing, and locating] in the 3D urban battlespace as well as exploiting information [identifying and classifying data] as part of the intelligence preparation of the battlespace in order to facilitate operational maneuver and distributed operations.

*In FY 2007 and FY 2008, this effort was funded in the C4ISR activity within this PE.
FY 2009 reflects an increase for a DoD directed integrated capability demonstration supporting the Protection of Ground Forces and Systems. This capability demonstration has been directed to be wide ranging and encompass technologies for:
- Pre-detonation of IEDs,
- Personal protection materials,
- Personal power generation,

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- Micro power sources, and
- Augmented reality

The C4 activity directly supports the integrated demonstration program, which will be a broad, multi-year thrust to both investigate technology integration as well as spur application of more fundamental technologies to force and platform protection. The goal is multiple broad phased force protection applications and technologies, with off-ramps for fielding successes.

FY 2009 Plans:

- Continue development of advanced tactical sensor nets that localize mobile detection of threats in a complex environment. (Realigned from C4ISR Activity)
- Continue development and demonstration of measurement and signature intelligence data management and integration capability. (Realigned from C4ISR Activity)
- Continue integration and demonstration of naval tactical warfighting applications and network connectivity.
- Continue tagging, tracking, and locating efforts to demonstrate the effectiveness of tactically relevant tag readers which support track classification algorithms. (Realigned from C4ISR Activity)
- Continue efforts to refine enemy course of action prediction software to adapt to stimuli. (Realigned from C4ISR Activity)
- Continue and initiate new Actionable Intelligence for Expeditionary and Irregular Warfare efforts which include Human Network Decision Modeling and the fusion across modeling approaches to increase prediction accuracy. (Realigned from C4ISR Activity)
- Initiate development of tactical sensor nets with organic unattended multi-level security processing and information dissemination.
- Initiate new Relevant and Situational Information on Demand such as Identity Dominance Enabled by an Integrated Biometric/Tag Track and Locate (TTL) Capability, providing human tracking algorithms based on models of biometric (face, voice and soft) and TTL (optical taggant) capabilities and modeling a biometric/optical taggant system relevant to human tracking across an urban 5 km x 2 km area.
- Initiate new Sensor Fields efforts such as Nanotechnology Enabled Witness Fields, development of sensors that provide near real time decision support to distributed operations by detecting specific interactions, and nanotechnology efforts which offer the potential to revolutionize tactical sensors. To enable this capability, nanomaterials that change state in the presence of another nanomaterial will be developed.

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	FY 2007	FY 2008	FY 2009
FIREPOWER	3,118	3,206	7,190

This activity develops technology for application on current and future expeditionary weapons and elements of the kill chain. It includes, but is not limited to, the following technologies: fuze, fire control, launch/propulsion, lethality, and accuracy.

FY 2009 reflects an increase for emerging priority requirements in lightening the load of the individual Marine while simultaneously enhancing the combat capabilities of the Marine Corps Rifle Squad and for a DoD directed integrated capability demonstration supporting the Protection of Ground Forces and Systems. This capability demonstration has been directed to be wide ranging and encompass technologies for:
- Pre-detonation of IEDs,
- Personal protection materials,
- Personal power generation,
- Micro power sources, and
- Augmented reality

The Firepower activity directly supports the integrated demonstration program, which will be a broad, multi-year thrust to both investigate technology integration as well as spur application of more fundamental technologies to force and platform protection. The goal is multiple broad phased force protection applications and technologies, with off-ramps for fielding successes.

FY 2007 Accomplishments:

- Continued scalable effects conventional warhead concept development.
- Continued shipboard submunition Microelectromechanical System (MEMS) fuze safety and reliability enhancement effort from PE 0602131M.
- Continued MACHSI advanced technology development. (Transitioned from FY 2005 PE 0602131M.)
- Continued development of caseless small caliber ammunition.
- Initiated enhanced lethality and extended range ammunition demonstrations.

FY 2008 Plans:

- Continue all efforts of FY 2007.
- Complete development of caseless small caliber ammunition.

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- Initiate improved mortar munition integration and demonstrations.
- Initiate development of targeting and engagement technologies for distributed operations collaborative fires integration and demonstrations.
- Initiate a Wind Sensing Program to provide technology that senses wind velocity & direction at firing point to apogee and supporting algorithms to compensate the computed/predicted wind effects on the ballistic flight of the 81mm mortar round in order to enhance weapon accuracy.

FY 2009 Plans:

- Continue all efforts of FY 2008, less those noted as completed above.
- Complete shipboard submunition MEMS fuze safety and reliability enhancement effort.
- Complete enhanced lethality and extended range ammunition demonstrations.
- Initiate an effort in Ballistic Flight Compensation Aiming in support of Distributed Operations Precision Engagement.
- Initiate design and prototyping of lightweight technologies that provide individual Marines enhanced capabilities to detect and identify man-size targets out to at least the maximum effective range of their personal weapons during all conditions (daylight, limited visibility, & darkness) by integrating multiple capabilities into a single system.
- Initiate a Flight Control Kinematic Unit effort. Design & develop technology that provides guidance, navigation, and controls (GNC) to 81mm mortar rounds to enable trajectory shaping in urban environment to precisely & accurately strike specific targets.

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C. OTHER PROGRAM FUNDING SUMMARY - NAVY RELATED RDT&E::
PE 0204163N Fleet Telecommunications (Tactical)
PE 0206313M Marine Corps Communications Systems
PE 0206623M Marine Corps Ground Combat/Supporting Arms Systems
PE 0305204N Tactical Unmanned Aerial Vehicles
PE 0601152N In-House Laboratory Independent Research
PE 0601153N Defense Research Sciences
PE 0602131M Marine Corps Landing Force Technology
PE 0602236N Warfighter Sustainment Applied Research
PE 0602782N Mine and Expeditionary Warfare Applied Research
PE 0603235N Common Picture Advanced Technology
PE 0603236N Warfighter Sustainment Advanced Technology
PE 0603612M USMC Mine Countermeasures Systems - Adv Dev
PE 0603635M Marine Corps Ground Combat/Support System
PE 0603782N Mine and Expeditionary Warfare Advanced Technology

OTHER PROGRAM FUNDING SUMMARY - NON-NAVY RELATED RDT&E::
PE 0603004A Weapons and Munitions Advanced Technology
PE 0603005A Combat Vehicle and Automotive Advanced Technology
PE 0603606A Landmine Warfare and Barrier Advanced Technology
PE 0603607A Joint Service Small Arms Program
PE 0603619A Landmine Warfare and Barrier - Adv Dev
PE 0603772A Advanced Tactical Computer Science and Sensor Technology
PE 0604710A Night Vision Systems - SDD
PE 0604808A Landmine Warfare/Barrier - SDD
PE 0602702E Tactical Technology

D. ACQUISITION STRATEGY:
Not Applicable.

FY 2009 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2008
Exhibit R-2a

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PROGRAM ELEMENT: 0603640M PROGRAM ELEMENT TITLE: USMC ADVANCED TECHNOLOGY DEMONSTRATION (ATD)
PROJECT NUMBER: 2297 PROJECT TITLE: MARINE CORPS WARFIGHTING LAB - CORE

Project Number & Title	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
2297 MARINE CORPS WARFIGHTING LAB - CORE	34,579	33,768	36,442	37,122	38,920	42,700	45,533

A. MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: Marine Corps Warfighting Laboratory (MCWL) examines lessons learned from current operations, explores emerging threats and opportunities, and explores Joint and emerging service concepts through concept-based experimentation in order to enhance current and future warfighting capabilities. The use of modeling and simulation (M&S), both conducted within Service wargaming and virtual experiment venues (conducted in partnership with the Navy and Joint Forces Command (JFCOM)), will provide both a necessary Joint context for the Marine Corps Expeditionary Force Development System process as well as the opportunity to explore the implications of proposed future programs on seabased power projection capabilities.

"Live experimentation" permits exploration of prototype and surrogate technologies, as well as Tactics, Techniques, and Procedures (TTPs), in order to better refine equipment requirements and to identify Doctrine, Organization, Training, Materiel, Leadership, Personnel, and Facilities (DOTMLPF) initiatives needed to produce future capabilities. Experimentation encompasses inquiries into multiple warfighting areas, including: Command, Control, Communications, and Computers (C4); Intelligence, Surveillance, and Reconnaissance (ISR); Fires, Targeting, and Maneuver; Combat Service Support (CSS) and Force Protection; and Warfighting Excellence.

Using operational forces, MCWL conducts Advanced Warfighting Experiments (AWEs) supported by Limited Objective Experiments (LOEs), Limited Technical Assessments (LTAs), Wargames, and Studies. AWEs, LOEs, and LTAs examine discrete variables in as much isolation as can be achieved. Technologies assessed in LTAs are incorporated in LOEs while LOEs are building blocks from which resulting AWE-level campaigns are constructed. These campaigns (e.g., the Sea Viking (SV) experimentation series) are executed under the guidance of the Commandant of the Marine Corps (CMC) and in support of the Marine Corps Expeditionary Maneuver Warfare Enabling Capability List (ECL).

SV is a series of two-year campaigns that provide focus and synergy to MCWL concept-based experimentation.

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This approach allows integration of United States Marine Corps (USMC) service experiments with other services and with JFCOM experiments. SV experiments are currently focused on the implementation of the Distributed Operations (DO) Concept as an extension of maneuver warfare down to the small unit tactical level. DO is a concept characterized as the physical dispersion of network-enabled units, from squad to battalion size, over an extended battlespace.

- Sea Viking 2006 (SV06): (FY 2005 through FY 2006) SV06 was a series of related events that examined enhanced infantry training and tactics through several LOEs that culminated in the SV06 AWE which completed in first quarter FY 2007. The SV06 AWE was a live force experiment that examined the DO concept in the operational context provided by a deploying Marine Expeditionary Unit (MEU) in the Global War on Terrorism (GWOT). SV06 permitted development of prototype and surrogate technologies in order to better refine material and non-material capabilities needed by the Marine Corps to adapt to the shift toward irregular warfare.

- Sea Viking 2008 (SV08): (FY 2007 through FY 2008) SV08 continues exploration of DO in the irregular, nonlinear, battlespace emphasizing enhanced individual and small unit capabilities. SV08 expands the focus of DO beyond infantry training and tactics into logistics, command and control (C2), fires, and ISR. In keeping with the SV06 DO objective of empowering small unit leaders, SV08 seeks to identify decision support tools that will increase the individual Marine’s situational awareness through small unit access to tactical ISR assets and exploitation of actionable intelligence to better fight and win the GWOT.

- Sea Viking 2010 (SV10): (FY 2009 through FY 2010) SV10 shifts the focus of MCWL DO experimentation to exploring the use of computer based simulation systems to expand the training opportunities that will enable infantry units to gain and maintain the enhanced skill sets and tactical decision making expertise of small units as well as provide tools for mission planning and mission rehearsal. Experimentation with improved technologies in the areas of logistics, ISR, and C4 will continue during SV10 to complete the projects initiated during SV08.

B. ACCOMPLISHMENTS/PLANNED PROGRAM:

	FY 2007	FY 2008	FY 2009
COMMAND, CONTROL, COMMUNICATIONS, COMPUTERS (C4)	9,198	8,082	8,649

This activity encompasses all MCWL C4 related experimentation efforts. Although this category covers several small (less than $500K per FY) efforts being pursued by MCWL, most programs listed below are considered major

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(valued at $500K or more) or have near real-time operational impact.

Funds were realigned from other activities within this project to cover company and below requirements in FY 2008.

FY 2009 includes additional funding to support USMC major investments in the Lightening the Marine's Load & Enhancing the Rifle Squad; Operational Adaptation; Asymmetric/Irregular Warfare and Distributed Operations; and Counter Sniper Technologies.

FY 2007 Accomplishments:

- Continued C4 extended user assessments of selected prototype technologies in support of forces engaged in Operation Enduring Freedom and OIF.
- Continued experimentation of enhanced OTH communications Low Earth Orbit Satellite (LEOSAT)/Line of Sight (LOS) hybrid in support of SV08.
- Continued experimentation of coalition C4 interoperability concept demonstrator.
- Continued experimentation of concept demonstrators to support company and below alternative C2 architectures.
- Continued C4 related small unit enhancements against irregular forces, including urban terrain.
- Completed support for the SV06 experimentation campaign plan.
- Initiated C4 support for SV08 experiments.
- Initiated experimentation of enhanced communications concept demonstrators as part of SV08.

FY 2008 Plans:

- Continue all efforts of FY 2007, less those noted as completed above.
- Initiate USMC participation in Joint Forces Exercise Future Combat System (JFEX FCS) C4 spinout technology experiments.

FY 2009 Plans:

- Continue all efforts of FY 2008.
- Complete C4 support for SV08.
- Complete experimentation of OTH LEOSAT/LOS hybrid in support of SV08 and emerging DO architecture.

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- Initiate C4 support for SV10 experiments.
- Initiate experimentation of enhanced communications concept demonstrators as part of SV10.
- Initiate development and testing of an automated language translator concept demonstrator.
- Initiate efforts to assess/develop alternative communications (e.g., lasers, Ultraviolet) for use in an electronically challenged environment (i.e., electronic jamming against IEDs).

	FY 2007	FY 2008	FY 2009
INTELLIGENCE, SURVEILLANCE, AND RECONNAISSANCE (ISR)	6,910	7,112	7,611

This activity includes MCWL ISR related experimentation efforts involving enhanced reconnaissance; sensors (to include mine detection); and unmanned ground and aerial vehicles. Although this category covers several small (less than $500K per FY) efforts being pursued by MCWL, most programs listed below are considered major (valued at $500K or more) or have near real-time operational impact.

Funds were realigned from other activities within this project to cover increased requirements associated with the Small Unit Surveillance System (SUSS), Mobile Wearable Computer (MOWC), and Tier II in FY 2008.

FY 2009 includes additional funding to support USMC major investments in the Lightening the Marine's Load & Enhancing the Rifle Squad; Operational Adaptation; Asymmetric/Irregular Warfare and Distributed Operations; and Counter Sniper Technologies.

FY 2007 Accomplishments:

- Continued additional IED investigations into promising detect and neutralize technologies.
- Continued experimentation of Tier II Unmanned Aerial System (UAS) concept demonstrator to provide persistent ISR at regimental and battalion level.
- Continued development and experimentation of ISR technologies in preparation for SV08 planned experiments.
- Continued development and experimentation of the Wasp micro UAS, with the Defense Advanced Research Projects Agency (DARPA), in support of DO experimentation and OIF.
- Completed support for the SV06 experimentation campaign plan.
- Initiated efforts to develop the TTPs required for small infantry units to employ Unmanned Ground Vehicle (UGVs), Unmanned Aerial Vehicle (UAVs), and unattended ground sensors.
- Initiated ISR related small unit enhancements against irregular forces, including urban terrain.

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- Initiated experimentation with the Small Unit Surveillance System (SUSS) and the Mobile Wearable Computer (MOWC).
- Initiated experimentation of enhanced ISR concept demonstrators as part of SV08.

FY 2008 Plans:

- Continue all efforts of FY 2007, less those noted as completed above.
- Complete participation in DARPA's development and upgrade of the Wasp micro UAS and conduct extended operational assessment of Wasp Block II and Block III.
- Complete ISR related small unit enhancements against irregular forces, including urban terrain.

FY 2009 Plans:

- Continue all efforts of FY 2008, less those noted as completed above.
- Complete experimentation with SUSS and MOWC.
- Complete experimentation of enhanced ISR technologies and concept demonstrators as part of SV08.
- Initiate development and experimentation in small unit disposable sensors to enhance small unit force protection.
- Initiate assessment of technologies supporting company and below intelligence collection and integration – focused specifically on Stability and Support Operations (SASO) and GWOT applications.

	FY 2007	FY 2008	FY 2009
FIRES, TARGETING, AND MANEUVER	2,256	2,761	2,955

This activity includes MCWL experimentation efforts in the areas of fires, targeting, and maneuverability. Although this category covers several small (less than $500K per FY) efforts being pursued by MCWL, most programs listed below are considered major (valued at $500K or more) or have near real-time operational impact.

Funds were realigned from efforts associated with program management, XM-326, Heavy Machine Gun (HMG), 12 Gauge, and Electronic Control Active Suspension System (ECASS) in this activity to cover increased requirements in other activities within this project in FY 2008.

FY 2009 includes additional funding to support USMC major investments in the Lightening the Marine's Load &

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Enhancing the Rifle Squad; Operational Adaptation; Asymmetric/Irregular Warfare and Distributed Operations; and Counter Sniper Technologies.

FY 2007 Accomplishments:

- Continued evaluation of alternative counter shooter technologies.
- Continued development and testing of Heavy Machine gun Initiative (HMGI), an effort to design advanced mounts for USMC crew served weapons.
- Completed ECASS investigations/experimentation.
- Completed development of second XM326 120mm mortar system.
- Completed support for the SV06 experimentation campaign plan.

FY 2008 Plans:

- Continue all efforts of FY 2007, less those noted as completed above.
- Initiate development, testing and experimentation with UAS electronic warfare payload concept demonstrators.
- Initiate development, testing, and experimentation in technology intended to lighten the load of infantry.

FY 2009 Plans:

- Continue all efforts in FY 2008, less those noted as completed above.
- Complete development and testing of HMGI.
- Complete development, testing and experimentation with UAS electronic warfare payload concept demonstrators.
- Initiate development of concept demonstrators supporting SV10 simulation in small unit training.
- Initiate development, testing and experimentation with non-kinetic-effects systems.
- Initiate development, testing and experimentation in a new family of expeditionary counter-fire technologies.

	FY 2007	FY 2008	FY 2009
COMBAT SERVICE SUPPORT (CSS) AND FORCE PROTECTION	3,747	3,543	4,096

This activity includes MCWL experimentation efforts involving seabasing, logistics, CSS, urban combat, medical, force protection, as well as training and education. Although this category covers several small (less than $500K per FY) efforts being pursued by MCWL, most programs listed below are considered major

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(valued at $500K or more) or have near real-time operational impact.

Funds were realigned from High Speed Connector (HSC), medical, armor, and IED Detector Dogs efforts within this activity to other activities with this project in FY 2008.

FY 2009 includes additional funding to support USMC major investments in the Lightening the Marine's Load & Enhancing the Rifle Squad; Operational Adaptation; Asymmetric/Irregular Warfare and Distributed Operations; and Counter Sniper Technologies.

FY 2007 Accomplishments:

- Continued IED Detector Dog experiment that will merge specialized breeding, urban conditioning, and multi-disciplinary training techniques in support of small unit infantry operations. Effort supports OIF.
- Continued MCM/Counter IED efforts for mine and IED clearance, detection and neutralization.
- Continued to develop and experiment with bio-science (medical) technologies.
- Continued experimentation of simulation based training technologies to enhance small unit leader decision-making ability.
- Completed investigation of individual equipment to enhance survivability and combat effectiveness.
- Completed study of robotic Road-Side (RS) IED/Vehicle-Borne (VB) IED vehicle capability effort.
- Completed lightweight body armor materials investigation and human performance evaluation and modeling of extremity body armor systems.
- Completed and transition HSC experimentation efforts to Joint Program Office.
- Completed support for the SV06 experimentation campaign plan.
- Completed development and experimentation with Tactical Medical Coordination System.
- Completed lightweight body armor materials experimentation.
- Terminated development and testing of the LAV Self-extractor.
- Initiated experiment to develop training, organization and equipment allowance modifications for logistics units based on the requirement to support DO.
- Initiated development and experimentation with concept demonstrators that enable distribution of material from the seabase to small, widely dispersed, units ashore.
- Initiated development and experimentation of logistics related equipment and employment tactics tailored to the requirements of logistics units supporting DO.

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603640M PROGRAM ELEMENT TITLE: USMC ADVANCED TECHNOLOGY DEMONSTRATION (ATD)
PROJECT NUMBER: 2297 PROJECT TITLE: MARINE CORPS WARFIGHTING LAB - CORE

FY 2008 Plans:

- Continue all efforts of FY 2007, less those noted as completed above.
- Complete experiment to develop training, organization and equipment allowance modifications for logistics units based on the requirement to support DO.

FY 2009 Plans:

- Continue all efforts of FY 2008, less those noted as completed above.
- Complete IED Detector Dog experiment.
- Complete development and experimentation with logistics-related equipment tailored to requirements of DO.
- Complete development and experimentation with concept demonstrators that enable distribution of material from the seabase to small, widely dispersed, units ashore.
- Initiate development and testing of Modeling and Simulation (M&S) tools supporting training, logistics and force protection planning.

	FY 2007	FY 2008	FY 2009
MARINE CORPS WARFIGHTING LABORATORY (MCWL)OPERATIONS (SUPPORT)	8,142	7,597	8,130

MCWL Operations (Support) efforts include overall MCWL experimentation doctrine, planning, analysis, data collection, as well as technology transition tracking efforts. Although this category covers several small (less than $500K per FY) efforts being pursued by MCWL, most programs listed below are considered major (valued at $500K or more) or have near real-time operational impact.

Funds were realigned from other activities in this project to cover increased program management, analysis, and strategic planning requirements.

FY 2009 includes additional funding to support USMC major investments in the Lightening the Marine’s Load & Enhancing the Rifle Squad; Operational Adaptation; Asymmetric/Irregular Warfare and Distributed Operations; and Counter Sniper Technologies.

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603640M PROGRAM ELEMENT TITLE: USMC ADVANCED TECHNOLOGY DEMONSTRATION (ATD)
PROJECT NUMBER: 2297 PROJECT TITLE: MARINE CORPS WARFIGHTING LAB - CORE

FY 2007 Accomplishments:

- Continued to synthesize results and lessons learned into proposed DOTMLPF recommendations for the Marine Corps.
- Continued to provide technical, strategic, and managerial support to Marine Corps experimentation.
- Continued to provide overall analysis and reporting of experimentation efforts, analytical assistance during experiment design, and maintenance of an ad-hoc analysis capability.
- Completed support for the SV06 experimentation campaign plan.
- Initiated engineering, technical and data collection support for SV08.

FY 2008 Plans:

- Continue all efforts of FY 2007, less those noted as completed above.

FY 2009 Plans:

- Continue all efforts of FY 2008.
- Complete engineering, technical and data collection support for SV08.
- Initiate engineering, technical and data collection support for SV10.

	FY 2007	FY 2008	FY 2009
WARFIGHTING EXCELLENCE	4,326	4,673	5,001

This activity includes MCWL experimentation efforts in the areas of wargaming, the Center for Emerging Threats and Opportunities (CETO), and Joint experimentation. Although this category covers several small (less than $500K per FY) efforts being pursued by MCWL, most programs listed below are considered major (valued at $500K or more) or have near-real-time operational impact.

FY 2009 includes additional funding to support USMC major investments in the Lightening the Marine’s Load & Enhancing the Rifle Squad; Operational Adaptation; Asymmetric/Irregular Warfare and Distributed Operations; and Counter Sniper Technologies.

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603640M PROGRAM ELEMENT TITLE: USMC ADVANCED TECHNOLOGY DEMONSTRATION (ATD)
PROJECT NUMBER: 2297 PROJECT TITLE: MARINE CORPS WARFIGHTING LAB - CORE

FY 2007 Accomplishments:

- Continued executive agent responsibilities for Joint Title X programs, such as Unified Quest, Unified Course, and Unified Engagement. Title X war games generally address future capabilities in the context of Title X readiness responsibilities.
- Continued management and oversight of non-Title X Wargaming, including the highly visible Office of the Secretary of Defense Net Assessment Transformation War Game series and the Special Operations Command wargaming series.
- Continued to conduct quarterly Emerald Express seminars that resulted in collection and dissemination of insights and observations from the Operating Forces. Produced reports for the purpose of professional military education and advancing the lessons-learned process.
- Continued to support the CETO mission: 1) prevent operational and tactical surprises to senior Warfighting Commanders by assessing future security environments in light of emerging threats and potential conceptual and technological opportunities; 2) help focus science, technology, and experimental efforts by appraising promising concepts and technologies; 3) serve as a catalyst to stimulate thought and debate on issues of importance to the Marine Corps.
- Continued funding contributions to Joint Concept Technology Demonstrations and (JCTD) and Advanced Concept Technology Demonstrations (ACTD). Both JCTDs and ACTDs are intended to rapidly field needed capabilities by using emergent mature technologies matched with innovative operational concepts.
– Completed support for the SV06 experimentation campaign plan.
- Completed Marine Corps funding contribution to the Joint Force Projection ACTD to provide warfighters with a simple, timely, and comprehensive understanding of deployment and distribution of information. ACTDs are intended to rapidly field needed joint capabilities by using emergent mature technologies matched with innovative operational concepts.
- Initiated concept development and Modeling and Simulation support for SV08.
- Initiated technology assessment and operational evaluation of DARPA-developed robotic prototypes in support of DO experimentation.
- Initiated investigations/participation into promising ACTDs.

FY 2008 Plans:

- Continue all efforts of FY 2007, less those noted as completed above.
- Complete Joint Force Projection ACTD.

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603640M PROGRAM ELEMENT TITLE: USMC ADVANCED TECHNOLOGY DEMONSTRATION (ATD)
PROJECT NUMBER: 2297 PROJECT TITLE: MARINE CORPS WARFIGHTING LAB - CORE

FY 2009 Plans:

- Continue all efforts of FY 2008.
- Complete technology assessment and operational evaluation of DARPA-developed robotic prototypes in support of DO experimentation.
- Complete concept development and M&S support for SV08.
- Initiate participation in approved JCTDs and related Joint programs supporting Marine Corps combat development objectives.
- Initiate concept development and M&S support for SV10.

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603640M PROGRAM ELEMENT TITLE: USMC ADVANCED TECHNOLOGY DEMONSTRATION (ATD)
PROJECT NUMBER: 2297 PROJECT TITLE: MARINE CORPS WARFIGHTING LAB - CORE

C. OTHER PROGRAM FUNDING SUMMARY - NAVY RELATED RDT&E:
PE 0204163N Fleet Telecommunications (Tactical)
PE 0206313M Marine Corps Communications Systems
PE 0206623M Marine Corps Ground Combat/Supporting Arms Systems
PE 0305204N Tactical Unmanned Aerial Vehicles
PE 0601152N In-House Laboratory Independent Research
PE 0601153N Defense Research Sciences
PE 0602131M Marine Corps Landing Force Technology
PE 0602236N Warfighter Sustainment Applied Research
PE 0602782N Mine and Expeditionary Warfare Applied Research
PE 0603235N Common Picture Advanced Technology
PE 0603236N Warfighter Sustainment Advanced Technology
PE 0603612M USMC Mine Countermeasures Systems - Adv Dev
PE 0603635M Marine Corps Ground Combat/Support System
PE 0603782N Mine and Expeditionary Warfare Advanced Technology

OTHER PROGRAM FUNDING SUMMARY - NON-NAVY RELATED RDT&E:
PE 0603004A Weapons and Munitions Advanced Technology
PE 0603005A Combat Vehicle and Automotive Advanced Technology
PE 0603606A Landmine Warfare and Barrier Advanced Technology
PE 0603607A Joint Service Small Arms Program
PE 0603619A Landmine Warfare and Barrier - Adv Dev
PE 0603772A Advanced Tactical Computer Science and Sensor Technology
PE 0604710A Night Vision Systems - SDD
PE 0604808A Landmine Warfare/Barrier - SDD
PE 0602702E Tactical Technology

D. ACQUISITION STRATEGY:
Not Applicable.

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603640M PROGRAM ELEMENT TITLE: USMC ADVANCED TECHNOLOGY DEMONSTRATION (ATD)
PROJECT NUMBER: 9999 PROJECT TITLE: CONGRESSIONAL PLUS-UPS

CONGRESSIONAL PLUS-UPS:

	FY 2007	FY 2008
C3RP	3,108	0

This effort identified and supported relevant research and expertise at the California Central Coast Research Partnership, an interdisciplinary center of excellence in research relevant to national security and the Marine Corps on the central coast of California, by bringing together universities, government agencies (both federal and state) and the private sector creating a valuable national resource.

	FY 2007	FY 2008
CRAFT INTEGRATED ELECTRONIC SUITE (CIES)	1,603	2,384

In FY 2007, this effort distributed the data received from the Gunslinger sensors into the Common Operational Picture (COP) surveillance tool as well as integrated the COP into the Gunslinger graphical user interface. Gunslinger is a hostile fire detection and counter fire system that automatically detects, locates, identifies and engages hostile fire sources in constrained, dispersed and urban environments, in near real-time, with high precision.

In FY 2008, this effort will expand the efforts of FY 2007 to support the integration of an electronic control system to enhance the situational awareness of the crew of a small boat (Stilitto) to improve the understanding of ad hoc survivable networks delivering a boat with upgraded electronic control and C4ISR.

	FY 2007	FY 2008
DUAL STAGE ULTRA RELIABLE WATER FILTRATION TECHNOLOGY DEVELOPMENT	971	1,989

In FY 2007, this effort supported dual stage water filtration technology. The funding stimulated science to advance water purification technology and potentially reduced cost and energetics to desalinate or purify water.

In FY 2008, the effort will develop a compact individual water purification (IWP) device for use by Marine

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603640M PROGRAM ELEMENT TITLE: USMC ADVANCED TECHNOLOGY DEMONSTRATION (ATD)
PROJECT NUMBER: 9999 PROJECT TITLE: CONGRESSIONAL PLUS-UPS

warfighters that will provide emergency treatment of field drinking water that is based on dual-stage ultrafilters and size-efficient pump/filter technology.

	FY 2007	FY 2008
EXPEDITIONARY UNIT WATER PURIFICATION	3,157	0

This effort addressed the following areas: 1) Design specification/fabrication of an Engineering Prototype 300,000 Gallons Per Day (GPD) multi-pass high purity aircraft carrier reverse osmosis desalination plant demonstrator. 2) Design and fabrication of a ruggedized EUWP system that is capable of operation in the field. Advanced demonstrations of large capacity water systems, both ship board and land based, were conducted. These Expeditionary Water Purification Systems may lead to lower cost and more compact desalination systems that will allow Expeditionary Forces to desalinate seawater in high biofouling waters near the shore.

	FY 2007	FY 2008
INDIRECT FIRE MULTI-GRENADE LAUNCHER	996	0

This effort investigated the feasibility and suitability of a different underbarrel grenade launcher for the M16-series service rifle. This effort focused on technologies for a multi-shot capability and enhanced accuracy and lethality throughout the effective engagement range of the weapon.

	FY 2007	FY 2008
LASER INTEGRATED TARGET ENGAGEMENT SYSTEM (LITES)	4,710	0

This effort continued development of fiber-optic laser-based one man portable system for forward operating units to be used for precision target location/tracking, target identification, and laser designation. This effort also continued to provide improved power efficiency and performance, consolidation of functions and remote operation to improve safety/accuracy, lighten workloads, and open new operational scenarios for forward units. This effort also funded the completion of the LandSafe system which will provide enhanced situational awareness to helicopter pilots landing in reduced visibility conditions.

	FY 2007	FY 2008
MARINE AIR-GROUND TASK FORCE SITUATIONAL AWARENESS	971	993

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603640M PROGRAM ELEMENT TITLE: USMC ADVANCED TECHNOLOGY DEMONSTRATION (ATD)
PROJECT NUMBER: 9999 PROJECT TITLE: CONGRESSIONAL PLUS-UPS

In FY 2007, this effort distributed the data received from the Gunslinger sensors into the Common Operational Picture (COP) surveillance tool as well as integrated the COP into the Gunslinger graphical user interface. Gunslinger is a hostile fire detection and counter fire system that automatically detects, locates, identifies and engages hostile fire sources in constrained, dispersed and urban environments, in near real-time, with high precision.

In FY 2008, this effort will integrate data between the Common Operational Picture (COP) and Gunslinger interface.

	FY 2007	FY 2008
MEMS MICRODETONATOR PACKAGING TECHNOLOGY	0	2,384

This effort will develop batch hermetic packaging of microdetonator devices. The microdetonators needed by the Navy and the Marine Corps require hermetic packaging for long shelf life and reliable operation in harsh environments.

	FY 2007	FY 2008
ULTRA PROGRAM	2,914	0

This effort developed and demonstrated advanced survivability, mobility, and power generation technologies for future recon/scout vehicles. The operational impacts are increased crew survivability, improved mobility & safety and potentially reduced vehicle costs. The deliverables from the ULTRA program have helped define the future Marine Corps vehicle performance requirements.

	FY 2007	FY 2008
USMC ADVANCED TECH DEMO	5,050	0

This effort was devoted, almost exclusively, toward IED mitigation and detection, force protection, and counter sniper technologies. Efforts included IED Detector Dogs (off-leash, small unit support), barrier protection (adhesives that minimize blast effects on existing barrier structures), and technologies to detect, protect, and or provide an offensive capability against enemy combatants. In addition, this effort addressed

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603640M PROGRAM ELEMENT TITLE: USMC ADVANCED TECHNOLOGY DEMONSTRATION (ATD)
PROJECT NUMBER: 9999 PROJECT TITLE: CONGRESSIONAL PLUS-UPS

other critical enablers which include C4ISR capabilities that facilitate operations over widely dispersed areas, sustainment of the distributed force (to the tactical level), casualty treatment and evacuation on the distributed battlefield, and human performance (cognitive and physiological). This effort supported the war in Iraq and helped accelerate the transition of critical 6.3 efforts to the Marine Corps' acquisition command.

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

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603651M
PROGRAM ELEMENT TITLE: JOINT NON-LETHAL WEAPONS TECHNOLOGY DEVELOPMENT

COST: (Dollars in Thousands)

Project Number & Title	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
Total PE	1,400	10,736	11,020	11,167	11,384	11,628	11,956
3022 JOINT NON-LETHAL WEAPONS TECHNOLOGY DEVELOPMENT	1,400	10,736	11,020	11,167	11,384	11,628	11,956

A. MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: The DOD's Joint Non-Lethal Weapons Program (JNLWP) was established by the Secretary of Defense, who assigned centralized responsibility for DOD joint research and development of non-lethal technology to the Commandant of the Marine Corps as the Executive Agent. The Under Secretary of Defense for Acquisition, Technology and Logistics provides direct oversight of the JNLWP.

The efforts described in this Program Element (PE) reflect science and technology (S&T) investment decisions provided by the Joint NLW Integrated Product Team, a multi-service flag level corporate board that executes the JNLWP for the Commandant of the Marine Corps. This direction is based on the needs and capabilities of the Services, the Special Operations Command, and the Coast Guard, as identified in the DoD's Non-Lethal Weapons Joint Capabilities Document. This coordinated joint S&T development approach addresses mutual capability gaps and assures the best non-lethal technologies and equipment areprovided to the operating forces while eliminating duplicative service S&T investment.

This program funds the research and development of next-generation Non-Lethal Weapons (NLWs) and includes performing analysis, technical development efforts, and modeling and simulation necessary to ensure optimum weaponizing and use of these NLWs. Next-generation NLW systems focus on long-range localized Non-Lethal (NL) effects to identified threat individuals (or groups of individuals) and/or their threat weapons systems operating in complicated environments such as urban areas, crowds, buildings, vehicles, boats and also in close proximity to high-value civilian establishments. This program transitioned from Program Element (PE) 0603114N, Power Projection Advanced Technology by order of the Under Secretary of Defense for Acquisition, Technology, and Logistics to establish a separate PE for Joint Non-Lethal Weapons Technology Development and to establish the Marine Corps as the Executive Agent for DoD Joint Non-Lethal Weapons RDT&E.

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603651M
PROGRAM ELEMENT TITLE: JOINT NON-LETHAL WEAPONS TECHNOLOGY DEVELOPMENT

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

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603651M
PROGRAM ELEMENT TITLE: JOINT NON-LETHAL WEAPONS TECHNOLOGY DEVELOPMENT

B. PROGRAM CHANGE SUMMARY:

	FY 2007	FY 2008	FY 2009
FY 2008/FY 2009 President's Budget Submission	1,400	10,938	10,997
Congressional Undistributed Reductions/Rescissions	0	-69	0
Rate Adjustments	0	0	23
SBIR Assessment	0	-133	0
FY 2009 President's Budget Submission	1,400	10,736	11,020

PROGRAM CHANGE SUMMARY EXPLANATION:
Technical: Not applicable.

Schedule: Not applicable.

C. OTHER PROGRAM FUNDING SUMMARY:
Not applicable.

D. ACQUISITION STRATEGY:
Not applicable.

E. PERFORMANCE METRICS:
The primary objective of this Program Element is the development of technologies that lead to the next-generation of Non-Lethal Weapons. The program consists of a collection of projects that range from studies and analyses to the development and evaluation of feasibility demonstration models. Individual project metrics reflect the technical goals of each specific project. Typical metrics include both the effectiveness of the technology, human effects and effectiveness, and potential for compliance with policy and legislation. Overarching considerations include the advancement of related Technology Readiness Levels and Human Effects Readiness Levels, the degree to which project investments are leveraged with other performers, reduction in life cycle cost upon application of the technology, and the identification of opportunities to transition technology to higher categories of development.

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603651M PROGRAM ELEMENT TITLE: JOINT NON-LETHAL WEAPONS TECHNOLOGY DEVELOPMENT
PROJECT NUMBER: 3022 PROJECT TITLE: JOINT NON-LETHAL WEAPONS TECHNOLOGY DEVELOPMENT

COST: (Dollars in Thousands)

Project Number & Title	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
3022 JOINT NON-LETHAL WEAPONS TECHNOLOGY DEVELOPMENT	1,400	10,736	11,020	11,167	11,384	11,628	11,956

A. MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: This project funds the research and development of next-generation NLWs and includes performing analysis, technical development efforts, and modeling and simulation necessary to ensure optimum weaponizing and use of these NLWs. Investment areas include research and development of next-generation NLWs such as: non-lethal directed energy weapons (lasers, millimeter wave and high power microwave) for counter-personnel and counter-material missions; non-lethal acoustic and optical technologies; and advanced non-lethal materials (including materials for vehicle/vessel stopping and advanced anti-traction materials). Next-generation NLW systems focus on long-range localized NL effects to identified threat individuals (or groups of individuals) and/or their threat weapons systems operating in complicated environments such as urban areas, crowds, buildings, vehicles, boats and also in close proximity to high-value civilian establishments.

B. ACCOMPLISHMENTS/PLANNED PROGRAM:

	FY 2007	FY 2008	FY 2009
JOINT NON-LETHAL WEAPONS	1,400	10,736	11,020

Increase in FY 2008 funding reflects the initiation of several prototype developments and demonstration technologies involving vehicle/vessel stopping, Advanced Total Body Model, directed energy technologies for counter-personnel and counter-material application, multi-sensory stimuli candidate technologies, and technological advancements to miniaturize proven non-lethal weapon prototypes.

FY 2007 Accomplishments:

- Continued effort to assess the general utility, effect, and effectiveness of technologies for incapacitating personnel, clearing facilities, stopping vehicles and vessels, and denying enemy access to protected areas.

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603651M PROGRAM ELEMENT TITLE: JOINT NON-LETHAL WEAPONS TECHNOLOGY DEVELOPMENT
PROJECT NUMBER: 3022 PROJECT TITLE: JOINT NON-LETHAL WEAPONS TECHNOLOGY DEVELOPMENT

- Continued design of a man-transportable laser weapons system that can be used for non-lethal counter-personnel or non-lethal counter-material applications through ultra-high precision engagement of selected targets with minimal collateral damage.
- Continued research to define the optimum approaches, technologies and tactics necessary to clear a facility/building with and without entry.
- Continued characterization of bioeffects induced via acoustic non-lethal weapon concepts.
- Continued prototype demonstration of a muzzle-safe acoustic weapon for use in various counter-personnel/crowd control scenarios.
- Completed investigation into technology suitable for long-range, non-lethal vehicle or vessel stopping with reversible effects, and minimal collateral effects.
- Completed delivery of tabletop demonstrator.
- Initiated modeling/research to develop an understanding of the complex relationships between individual, group and crowd dynamics in order to predict the macro effects of NLWs. Specifically, investigate factors that cause crowds to move to violent behavior, and what non-lethal technologies will be effective in controlling or mitigating violent crowd behavior.
- Initiated effort to examine and optimize non-lethal effects and effectiveness of various non-lethal stimuli, to include light, acoustics, electrical, high power laser, high power microwave and active denial technology. Research includes human effects analysis with respect to existing non-lethal stimuli and other emerging system stimuli to characterize behaviors and their operational relevance.

FY 2008 Plans:

- Continue all efforts of FY 2007, less those noted as completed above.
- Initiate prototype development and demonstration of the most promising candidate technologies addressing the vehicle/vessel stopping capability gap.
- Initiate non-lethal effects characterization through modeling and effects testing using the Advanced Total Body Model.
- Initiate prototype development and demonstration of the most promising directed energy technologies under consideration for counter-personnel and counter-material applications.
- Initiate prototype development and demonstration of the most promising candidate technologies employing multi-sensory stimuli.
- Initiate investigations of technology advancements to miniaturize proven non-lethal weapon prototypes /demonstrators to enable their transition to tactically relevant, cost effective capabilities in the field.

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603651M PROGRAM ELEMENT TITLE: JOINT NON-LETHAL WEAPONS TECHNOLOGY DEVELOPMENT
PROJECT NUMBER: 3022 PROJECT TITLE: JOINT NON-LETHAL WEAPONS TECHNOLOGY DEVELOPMENT

FY 2009 Plans:

- Continue all efforts from FY 2008.
- Complete demonstration and transition of the most effective vehicle/vessel stopping technologies to acquisition programs.
- Complete demonstration and transition of the most effective directed energy technologies with counter-personnel and counter-material applications to higher categories of development/acquisition.
- Initiate prototype development of advanced payloads for candidate technological capabilities with applications relevant to emerging capability gaps.
- Initiate prototype development and demonstration of the most promising candidate technologies addressing the extended range/duration incapacitation capability gap.

C. OTHER PROGRAM FUNDING SUMMARY - NAVY RELATED RDT&E:
PE 0602651M Joint Non-Lethal Weapons Applied Research

OTHER PROGRAM FUNDING SUMMARY - NON-NAVY RELATED RDT&E:
Not applicable

D. ACQUISITION STRATEGY:
Not applicable.

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

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603729N
PROGRAM ELEMENT TITLE: WARFIGHTER PROTECTION ADVANCED TECHNOLOGY

COST: (Dollars in Thousands)

Project Number & Title	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
Total PE	55,532	49,418	12,129	12,641	12,810	12,914	13,022
2914 WARFIGHTER PROTECTION ADVANCED TECHNOLOGY	16,550	11,958	12,129	12,641	12,810	12,914	13,022
9999 CONGRESSIONAL PLUS-UPS	38,982	37,460	0	0	0	0	0

A. MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: The efforts described in this Program Element (PE) are based on investment directions as defined in the Naval S&T Strategic Plan approved by the S&T Corporate Board (Jan 2007). This strategy is based on needs and capabilities from Navy and Marine Corps guidance and input from the Naval Research Enterprise (NRE) stakeholders (including the Naval enterprises, the combatant commands, the Chief of Naval Operations (CNO), and Headquarters Marine Corps). It provides the vision and key objectives for the essential science and technology efforts that will enable the continued supremacy of U.S. Naval forces in the 21st century. The Strategy focuses and aligns Naval S&T with Naval missions and future capability needs that address the complex challenges presented by both rising peer competitors and irregular/asymmetric warfare.

This program supports the development and demonstration of field medical equipment, diagnostic capabilities and treatments; technologies to improve warfighter safety and to enhance personnel performance under adverse conditions; and systems to prevent occupational injury and disease in hazardous, deployment environments. Navy investment in these areas is essential because Navy/USMC mission needs are not adequately addressed by the civilian sector or other Federal agencies. For example, civilian emergency medicine does not address casualty stabilization during long transit times to definitive care. The National Institutes of Health (NIH) focuses on the basic science of disease processes and not product development. Programs are coordinated with other Services through the Armed Services Biomedical Research Evaluation Management (ASBREM) Committee to prevent duplication of effort. This project funds the Force Health Protection program a Future Naval

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603729N
PROGRAM ELEMENT TITLE: WARFIGHTER PROTECTION ADVANCED TECHNOLOGY

Capability (FNC) that will provide technology options for future Navy and Marine Corps capabilities and supports the "Sea Warrior" component of the Naval Transformation Roadmap, medical logistics aspects of "Sea Basing" and expeditionary force medical support associated with "Sea Strike".

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

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603729N
PROGRAM ELEMENT TITLE: WARFIGHTER PROTECTION ADVANCED TECHNOLOGY

B. PROGRAM CHANGE SUMMARY:

	FY 2007	FY 2008	FY 2009
FY 2008/FY 2009 President's Budget Submission	58,111	12,145	11,494
Congressional Action	-1,395	37,700	0
Congressional Undistributed Reductions/Rescissions	0	-322	0
Execution Adjustments	138	0	0
Program Adjustments	-66	0	650
Rate Adjustments	0	0	-15
SBIR Assessment	-1,256	-105	0
FY 2009 President's Budget Submission	55,532	49,418	12,129

PROGRAM CHANGE SUMMARY EXPLANATION:
Technical: Not applicable.

Schedule: Not applicable.

C. OTHER PROGRAM FUNDING SUMMARY:
Not applicable.

D. ACQUISITION STRATEGY:
Not applicable.

E. PERFORMANCE METRICS:
Efforts within this PE are measured at two levels. At the lower level, each is measured against technical and financial milestones on a monthly basis. Annually, each project is reviewed in depth for technical and transition performance by the Chief of Naval Research (CNR).

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603729N PROGRAM ELEMENT TITLE: WARFIGHTER PROTECTION ADVANCED TECHNOLOGY
PROJECT NUMBER: 2914 PROJECT TITLE: WARFIGHTER PROTECTION ADVANCED TECHNOLOGY

COST: (Dollars in Thousands)

Project Number & Title	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
2914 WARFIGHTER PROTECTION ADVANCED TECHNOLOGY	16,550	11,958	12,129	12,641	12,810	12,914	13,022

A. MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: This project supports the development and demonstration of field medical equipment, diagnostic capabilities and treatments; technologies to improve warfighter safety and to enhance personnel performance under adverse conditions; and systems to prevent occupational injury and disease in hazardous, deployment environments. Navy investment in these areas is essential because Navy/USMC mission needs are not adequately addressed by the civilian sector or other Federal agencies. For example, civilian emergency medicine does not address casualty stabilization during long transit times to definitive care. The NIH focuses on the basic science of disease processes and not product development. Programs are coordinated with other Services through the Armed Serivices Biomedical Research Evaluation and Management (ASBREM) Committee to prevent duplication of effort. This project funds the Force Health Protection program a Future Naval Capability (FNC)that will provide technology options for future Navy and Marine Corps capabilities and supports the "Sea Warrior" component of the Naval Transformation Roadmap, medical logistics aspects of "Sea Basing" and expeditionary force medical support associated with "Sea Strike".

The decrease in funds from FY 2007 to FY 2008 and out reflects the realignment of funds for 6.2 applied research in support of the Force Health Protection FNC.

B. ACCOMPLISHMENTS/PLANNED PROGRAM:

	FY 2007	FY 2008	FY 2009
CASUALTY CARE AND MANAGEMENT	8,114	5,775	6,598

The goal of Casualty Care and Management is to maximize the continuum of care with lifesaving interventions as close to the battlespace as possible. This is in an increasingly lethal battlespace, with reduced infrastructure and logistics.

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603729N PROGRAM ELEMENT TITLE: WARFIGHTER PROTECTION ADVANCED TECHNOLOGY
PROJECT NUMBER: 2914 PROJECT TITLE: WARFIGHTER PROTECTION ADVANCED TECHNOLOGY

The decrease in funds from FY 2007 to FY 2008 reflects the realignment of funds for 6.2 applied research in support of the Force Health Protection FNC. The increase from FY 2008 to FY 2009 is due to the transition of some efforts from the Healthy and Fit Force activity (this PE) into the Casualty Care and Management activity.

FY 2007 Accomplishments:

- Continued studies into the safety of hypotensive resuscitation to support development of resuscitation fluids that enhance cardiovascular function, tissue perfusion and oxygen delivery. Improved resuscitation fluids are needed to prevent casualty deaths from shock and associated tissue/organ damage.
- Continued identification of Food and Drug Administration (FDA) approved products as well as new development of novel therapeutics that protect against the induction of hemorrhagic shock. A reduced need for resuscitation fluids would significantly reduce the medical logistical burden for Naval forces.
- Continued development of casualty management tools and data. These tools and data are required by combat, material development, and medical planners to evaluate the effectiveness of personal protection systems and healthcare support services, and to project future material and training requirements.
- Continued development of an effective analgesic for controlling severe pain that does not have the adverse effects of morphine (cardiorespiratory depression, sedation) or the addiction potential. Naval casualties are expected to "stay in the fight" as long as possible and the use of morphine removes that capability.
- Continued efforts to develop prototype technology for closed-loop resuscitation for USMC en route care system.
- Continued preclinical study to evaluate use of vasopressin to manage traumatic brain injury (TBI).
- Completed development of drugs and devices for treatment of uncontrolled external/extremity hemorrhage in the far forward battlefield. Blood loss is the leading cause of preventable death in combat.
- Completed evaluation of novel antibiotics against multi-drug resistant bacteria.
- Completed study to determine time-to-occlusion of vascular shunts.
- Completed one project to enhance medical planning tools for combat developers.
- Completed market survey of Commercial off the Shelf (COTS) technologies related to blood transfusion safety.
- Initiated clinical trial evaluating safety of vasopressin for treatment of trauma patients.
- Initiated efforts to produce oxygen in situ for medical care, supporting USMC En Route Care System.
- Initiated efforts to develop a novel fibrinogen-like bandage using nanotechnology for hemorrhage control (internal and external).
- Terminated study to develop selective and specific biomarkers for detection of TBI.

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603729N PROGRAM ELEMENT TITLE: WARFIGHTER PROTECTION ADVANCED TECHNOLOGY
PROJECT NUMBER: 2914 PROJECT TITLE: WARFIGHTER PROTECTION ADVANCED TECHNOLOGY

FY 2008 Plans:

- Continue all efforts of FY 2007 less those noted as completed above.
- Complete efforts to develop prototype technology for closed-loop resuscitation for USMC En Route Care system.
- Complete remaining project to enhance medical planning tools for combat developers.
- Complete study to determine safety of hypotensive resuscitation in casualties in presence of hemorrhagic shock and hypothermia.
- Complete four studies on pharmacologic resuscitation; Down-select best agent for continued development.
- Initiate study to demonstrate selectivity/specificity of biomarkers for mild & moderate TBI in appropriate pre-clinical model.
- Initiate efforts to develop advanced technologies for First Responders.
- Initiate efforts to develop advanced technologies to support the Forward Resuscitative Surgery/Shipboard Surgical Systems.
- Initiate program to develop advanced technologies to support En Route Care of casualties.

FY 2009 Plans:

- Continue all efforts of FY 2008 less those noted as completed above.
- Continue program to examine comorbidity of traumatic brain injury and PTSD. (Realigned from Healthy and Fit Force activity of this PE after 2008.)
- Complete preclinical study to evaluate use of vasopressin to manage TBI.
- Initiate efforts to treat the psychological manifestations' of combat stress

	FY 2007	FY 2008	FY 2009
CASUALTY PREVENTION	6,863	4,875	5,531

Casualty Prevention includes protecting the warfighter from environmental, occupational and battlefield threats.

The decrease in funds from FY 2007 to FY 2008 reflects the realignment of funds for 6.2 applied research in support of the Force Health Protection FNC. In FY 2009 some efforts from the Healthy and Fit Force activity (in this PE) transition to Casualty Prevention.

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603729N PROGRAM ELEMENT TITLE: WARFIGHTER PROTECTION ADVANCED TECHNOLOGY
PROJECT NUMBER: 2914 PROJECT TITLE: WARFIGHTER PROTECTION ADVANCED TECHNOLOGY

FY 2007 Accomplishments:

- Continued development of improved hearing protection systems, educational tools, and pharmacological treatment paradigms to protect and restore hearing in Warfighters exposed to high noise environments.
- Continued research into understanding neurological and cognitive effects of blast injuries. There is an increasing amount of information related to the correlation of closed-head blast injury with cognitive and motor deficits as well as long term emotional problems such as Post-Traumatic Stress Disorder (PTSD).
- Completed development of protective personal gear and physiologic monitoring ensembles to reduce injury risk and enhance personnel safety in warm and cold water operations for Navy divers.
- Completed research on return-to-duty criteria for heat injury patients.
- Completed development of diagnostic tools for detecting and treating susceptibility to vestibular-related disorientation in aviators.

FY 2008 Plans:

- Complete development of improved hearing protection systems, educational tools, and pharmacological treatment paradigms to protect and restore hearing in Warfighters exposed to high-noise environments.
- Complete research into understanding neurological and cognitive effects of blast injuries.
- Initiate efforts to mitigate the effects of environmental and other threats to health.
- Initiate efforts to reduce operational injuries.

FY 2009 Plans:

- Continue all efforts of FY 2008 less those noted as completed above.
- Continue research to determine the safety and efficacy of perfluorocarbons in treating decompression sickness and arterial gas embolism. (Realigned from Healthy and Fit Force activity of this PE after 2008.)
- Initate development of tools to prevent psychological stress. (Similar effort funded in Healthy and Fit Force activity of this PE prior to FY 2009.)

	FY 2007	FY 2008	FY 2009
HEALTHY AND FIT FORCE	1,573	1,308	0

Healthy and Fit Force efforts preserve health and enhance fitness of ready forces against physical and psychological threats through the continuum of peace and war.

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603729N PROGRAM ELEMENT TITLE: WARFIGHTER PROTECTION ADVANCED TECHNOLOGY
PROJECT NUMBER: 2914 PROJECT TITLE: WARFIGHTER PROTECTION ADVANCED TECHNOLOGY

The decrease in funds from FY 2007 to FY 2008 and out reflects the realignment of funds for 6.2 applied research in support of the Force Health Protection FNC. This effort moves to Casualty Care and Management and Casualty Prevention activities in this PE in FY 2009.

FY 2007 Accomplishments:

- Continued evaluations of pharmacological compounds to combat motion-sickness in aviators without causing fatigue or cognitive deficit.
- Continued program for creating strategies to "inoculate" Warfighters against the effects of combat related stressors.
- Continued development of decision support tools for controlling disease and non-battle injuries on Navy vessels.
- Continued Virtual Reality Therapy Tools for acute PTSD.
- Completed identification of factors and causes of injury in shipboard and aviation scenarios, and development of exposure guidelines and engineering specifications for preventing mechanical shock-related injury. Musculoskeletal injury has a major impact on force readiness and warfighter health.

FY 2008 Plans:

- Complete evaluations of pharmacological compounds to combat motion-sickness in aviators without causing fatigue or cognitive deficit.
- Complete program for creating strategies to "inoculate" Warfighters against the effects of combat related stressors.
- Complete Virtual Reality Therapy Tools for acute PTSD.
- Complete development of decision support tools for controlling disease and non-battle injuries on Navy vessels.
- Initiate program to examine comorbidity of traumatic brain injury and PTSD. (This effort moves to Casualty Care and Management activity in this PE in FY 2009.
- Initiated research to determine the safety and efficacy of perfluorocarbons in treating decompression sickness and arterial gas embolism. (This effort moves to Casualty Prevention activity in this PE in FY 2009)

C. OTHER PROGRAM FUNDING SUMMARY - NAVY RELATED RDT&E:

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603729N PROGRAM ELEMENT TITLE: WARFIGHTER PROTECTION ADVANCED TECHNOLOGY
PROJECT NUMBER: 2914 PROJECT TITLE: WARFIGHTER PROTECTION ADVANCED TECHNOLOGY

PE 0601153N Defense Research Sciences
PE 0602235N Common Picture Applied Research
PE 0602236N Warfighter Sustainment Applied Research
PE 0603236N Warfighter Sustainment Advanced Technology
PE 0604771N Medical Development

OTHER PROGRAM FUNDING SUMMARY - NON-NAVY RELATED RDT&E:
PE 0602716A Human Factors Engineering Technology
PE 0602785A Manpower/Personnel/Training Technology
PE 0602787A Medical Technology
PE 0603002A Medical Advanced Technology
PE 0602202F Human Effectiveness Applied Research
PE 0603231F Crew Systems and Personnel Protection Technology

D. ACQUISITION STRATEGY:
Not applicable.

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603729N PROGRAM ELEMENT TITLE: WARFIGHTER PROTECTION ADVANCED TECHNOLOGY
PROJECT NUMBER: 9999 PROJECT TITLE: CONGRESSIONAL PLUS-UPS

CONGRESSIONAL PLUS-UPS:

	FY 2007	FY 2008
BRAIN INJURY DISEASE MANAGEMENT INITIATIVE	1,992	0

This effort supported the Brain Injury Disease Management initiative.

	FY 2007	FY 2008
C. W. BILL YOUNG BONE MARROW DONOR RECRUITMENT AND RESEARCH PROGRAM	30,662	31,300

FY 2007 Accomplishments - Using the resources of a national network of bone marrow donation and transplantation centers, this research addressed refining a contingency response capability to provide rapid medical treatment for victims of marrow-toxic agents such as ionizing radiation or certain toxic chemicals. Development of a radiation injury treatment network to prepare for the care of patients resulting from a hematopoietic toxic event and expanding the genetic diversity of the registry through continued addition of adult donors and cord blood units are among the many accomplishments of this effort.

FY 2008 Plan - This effort will continue to test, develop and evaluate military contingency capabilities in order to improve care for casualties of marrow-toxic substances. Procedures will be developed, tested, evaluated and refined for identifying and providing correctly matched marrow for casualties with toxic injuries to their marrow as well as matched platelets for a number of military medical problems including combat trauma. Other associated medical therapies including targeted medical care and use of hematopoietic stimulating pharmaceuticals will be incorporated.

	FY 2007	FY 2008
INTEGRATED WARFIGHTER BIODEFENSE PROGRAM	3,254	2,384

FY 2007 Accomplishments - This research addressed the development of novel tools for generating situational awareness, modeling and simulation of the spread of infectious disease, medical and non-medical interventions, and generating a Common Operating Picture (COP).

FY 2008 Plan - This effort will focus on developing pilot versions of modeling software for use by USNORTHCOM

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603729N PROGRAM ELEMENT TITLE: WARFIGHTER PROTECTION ADVANCED TECHNOLOGY
PROJECT NUMBER: 9999 PROJECT TITLE: CONGRESSIONAL PLUS-UPS

and other DoD components responsible for pandemic influenza response, prototype models for infectious diseases other than pandemic influenza and prototype models that address acute and chronic diseases and the options for prophylaxis and treatment to generate improved Force Health Protection.

	FY 2007	FY 2008
MASSIVE TISSUE INJURY/AMPUTATION REPAIR WITH COMPOSITE TISSUE TRANSPLANTATION	0	2,981

This effort supports massive tissue injury/amputation repair with composite tissue transplantation.

	FY 2007	FY 2008
NAVY SPECIAL WARFARE PERFORMANCE AND INJURY PREVENTION PROGRAM	1,074	0

This effort created an aggressive and sustained injury prevention and human performance enhancement initiative to identify risk factors for injury and improvement of suboptimal physical, physiological and nutritional parameters through specifically designed intervention programs.

	FY 2007	FY 2008
NEURAL CONTROL OF EXTERNAL DEVICES (ARTIFICIAL LIMB MOVEMENT)	0	795

This effort supports neural control of external devices (artificial limb movement).

	FY 2007	FY 2008
NURSING TELEHEALTH RESEARCH PROGRAM	1,000	0

This effort supported the Nursing Telehealth Research Program.

	FY 2007	FY 2008
VIRTUAL INTERACTIVE TRAINING AND ASSESSMENT SYSTEM	1,000	0

This effort supported Virtual Interactive Training and Assessment System research.

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

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603747N
PROGRAM ELEMENT TITLE: UNDERSEA WARFARE ADVANCED TECHNOLOGY

COST: (Dollars in Thousands)

Project Number & Title	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
Total PE	34,239	75,422	81,490	74,747	56,626	52,470	61,256
2916 UNDERSEA WARFARE ADVANCED TECHNOLOGY	29,382	72,243	81,490	74,747	56,626	52,470	61,256
9999 CONGRESSIONAL PLUS-UPS	4,857	3,179	0	0	0	0	0

A. MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: The efforts described in this Program Element (PE) are based on investment directions as defined in the Naval S&T Strategic Plan approved by the S&T Corporate Board (Jan 2007). This strategy is based on needs and capabilities from Navy and Marine Corps guidance and input from the Naval Research Enterprise (NRE) stakeholders (including the Naval enterprises, the combatant commands, the Chief of Naval Operations (CNO), and Headquarters Marine Corps). It provides the vision and key objectives for the essential science and technology efforts that will enable the continued supremacy of U.S. Naval forces in the 21st century. The Strategy focuses and aligns Naval S&T with Naval missions and future capability needs that address the complex challenges presented by both rising peer competitors and irregular/asymmetric warfare.

All Navy advanced technology development in undersea target detection, classification, localization, tracking and neutralization is funded through this PE. The related technologies being developed are aimed at enabling Sea Shield, one of the three core operational concepts detailed in the Naval Transformational Roadmap. Associated efforts focus on new Anti-Submarine Warfare (ASW) operational concepts that promise to improve wide-area surveillance, detection, localization, tracking and attack capabilities against quiet adversary submarines operating in noisy and cluttered shallow water environments. The focus is on leveraging technologies that will protect the country’s current capital investment in surveillance, submarine, surface ship and air ASW assets.

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

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603747N
PROGRAM ELEMENT TITLE: UNDERSEA WARFARE ADVANCED TECHNOLOGY

B. PROGRAM CHANGE SUMMARY:

	FY 2007	FY 2008	FY 2009
FY 2008/FY 2009 President's Budget Submission	34,888	73,626	79,450
Congressional Action	0	3,200	0
Congressional Undistributed Reductions/Rescissions	0	-504	0
Program Adjustments	0	0	1,937
Rate Adjustments	0	0	103
SBIR Assessment	-649	-900	0
FY 2009 President's Budget Submission	34,239	75,422	81,490

PROGRAM CHANGE SUMMARY EXPLANATION:
Technical: FY 2007 reflects a $5M Congressional reduction. The following efforts are impacted as a result.
- Lightweight Torpedo Technologies (LTT)(-2,412K): Decrease at-sea test and demonstration phase of LTT project from four years to three years. This increases risk of being ready to conduct final LTT system demonstration in FY 2010 per the approved Technology Transition Agreement with the Naval Sea Systems Command (NAVSEA).
- Reduces demonstration candidates for adjunct sensing methods thus increasing risk of project failure.
- Terminated test of a directed blast prototype for a new LTT warhead.

The funding increase from FY 2007 to FY 2008 and FY 2009 is due to the initiation of Distributed System Processing (DSP), On-Demand Detection Classification and Localization (ODDCL), Innovative Naval Prototype (INP) Persistent Littoral Undersea Surveillance (PLUS) as well as expanded efforts in Deployable Autonomous Distributed System Deployability (DADS-D), Palantir, Submarine Track & Trail, and Deep Water Active Deployable System (DWADS). Further details are provided under the Wide Area ASW Surveillance activity.

Schedule: The following schedule delays were caused by the FY 2007 Congressional reduction of $5M:
- Compact Rapid Attack Weapon (CRAW)(-874K): Delay initiation of CRAW demonstrations from FY 2007 to FY 2008.
- Submarine Track & Trail (STT) (-1,714K): Delay integration of the STT sensor with submersible, checkout testing at-sea, and development and evaluation of tracking algorithms.

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603747N
PROGRAM ELEMENT TITLE: UNDERSEA WARFARE ADVANCED TECHNOLOGY

C. OTHER PROGRAM FUNDING SUMMARY:
Not applicable.

D. ACQUISITION STRATEGY:
Not applicable.

E. PERFORMANCE METRICS:
The overall metrics of advanced research in undersea warfare are to develop technologies aimed at improving target detection, classification, localization, tracking, and increasing attack capabilities against quiet adversary submarines operating in noisy and cluttered shallow water environments, countering enemy torpedoes, providing the ability to conduct long-range engagements, increasing weapons load-out, providing multi-platform connectivity, increasing endurance/survivability, while reducing size and power requirements.

FY 2009 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2008
Exhibit R-2a

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603747N PROGRAM ELEMENT TITLE: UNDERSEA WARFARE ADVANCED TECHNOLOGY
PROJECT NUMBER: 2916 PROJECT TITLE: UNDERSEA WARFARE ADVANCED TECHNOLOGY

COST: (Dollars in Thousands)

Project Number & Title	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
2916 UNDERSEA WARFARE ADVANCED TECHNOLOGY	29,382	72,243	81,490	74,747	56,626	52,470	61,256

A. MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: All Navy advanced technology developments in undersea target detection, classification, localization, tracking and neutralization are funded through this project. Technologies being developed within this project are aimed at enabling Sea Shield, one of the three core operational concepts detailed in the Naval Transformational Roadmap. Associated efforts focus on new ASW operational concepts that promise to improve wide-area surveillance, detection, localization, tracking and attack capabilities against quiet adversary submarines operating in noisy and cluttered shallow water environments. Related efforts are aimed at leveraging technologies that will protect the country's current capital investment in surveillance, submarine, surface ship and air ASW assets.

B. ACCOMPLISHMENTS/PLANNED PROGRAM:

	FY 2007	FY 2008	FY 2009
WIDE AREA ANTI-SUBMARINE WARFARE (ASW) SURVEILLANCE	19,779	49,534	58,254

Wide Area ASW Surveillance is focused on dramatically improving the capability to sanitize large areas relative to the capabilities of legacy ASW sensors. Efforts include the development of affordable off-board systems with associated processing and robust, high-bandwidth communications links. The cornerstone of Wide Area ASW Surveillance is the ability to rapidly distribute sensors from air, surface and sub-surface platforms as well as to develop long-endurance sensors and unmanned ASW vehicles. This activity represents a shift from traditional fixed surveillance systems to autonomous, networked, multi-static operation, supported by passive/active signal processing with the objective of increased detection capabilities.

The net increase from FY 2007 to FY 2008 is due to the initiation of DSP, ODDCL, and INP-PLUS and expanded efforts in DADS-D, Palantir, STT, and DWADS. The further expansion of efforts in DADS-D, Palantir, STT, DWADS, DSP, ODDCL, and INP-PLUS contributes to the net funding increase from FY 2008 to FY 2009.

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603747N PROGRAM ELEMENT TITLE: UNDERSEA WARFARE ADVANCED TECHNOLOGY
PROJECT NUMBER: 2916 PROJECT TITLE: UNDERSEA WARFARE ADVANCED TECHNOLOGY

Additionally, the increase in Wide Area ASW Surveillance supports a basic shift in Naval strategy away from platform-based undersea surveillance systems toward deployable, distributed systems. The initiation of two and ramp-up of five Future Naval Capabilities (FNC) projects directly supports the shift in Naval strategy to off-board distributed systems and contribute to fleet operational requirements. These efforts are funded in accordance with the FNC process and are approved by the Technology Oversight Group.

FY 2007 Accomplishments:

- Continued STT-Baseline advanced research efforts in the areas of advanced undersea sensors, communications, autonomy, and sensor data collection and analysis to support tracking algorithm and automated processing development. This effort transferred to this PE from PE 0603114N due to Enabling Capability realignments.
- Completed at-sea demonstrations and data collections with the Compact Deployable Multistatic Receiver (CDMR) advanced development model.
- Completed integrated at-sea testing of the multistatic system components (CDMR, Compact Deployable Multistatic Source (CDMS), signal processing software, and "field-level" processing). This effort transitioned from PE 0602747N.
- Completed DADS deployability study to investigate various tactical deployment options. This effort transitioned from PE 0602747N.
- Initiated DADS deployability, survivability and classification performance improvement effort.
- Initiated testing of the Palantir (a non-acoustic surveillance system) sensor system. The related test planning is conducted in PE 0602747N.
- Initiated and completed design improvements of the Palantir sensor/data collection system and conduct an FY 2007 data collection exercise.
- Initiated tactical test planning for the Palantir sensor.
- Initiated development of active sonar sensors and processing for wide area surveillance of deep ocean operating areas.
- Initiated STT sensor integration with an undersea submersible.
- Initiated development of an experimental design model of a DWADS for surveillance of deep ocean submarine threats.

FY 2008 Plans:

- Continue all FY 2007 efforts less those noted as completed.
- Complete integration of STT sensors with undersea submersibles.

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603747N PROGRAM ELEMENT TITLE: UNDERSEA WARFARE ADVANCED TECHNOLOGY
PROJECT NUMBER: 2916 PROJECT TITLE: UNDERSEA WARFARE ADVANCED TECHNOLOGY

- Complete all Littoral ASW Multistatic Project efforts for CDMR, CDMS, and development of multistatic signal processing algorithms and transition products to PMA-264, Air Anti-Submarine Warfare Assault and Special Missions Program Office, PE 0603254N, Project 1292.
- Complete development of and test an experimental design model of a DWADS system for surveillance of deep ocean submarine threats.
- Initiate DADS at-sea classification performance improvement testing.
- Initiate at-sea testing of integrated STT submersibles and evaluate overall system performance.
- Initiate integration and evaluation of STT tracking algorithms and automated processing.
- Initiate and complete design improvements of the Palantir sensor/data collection system and conduct an FY 2008 data collection exercise.
- Initiate development of DSP threat submarine feature association and field tracking algorithms for active and passive distributed acoustic ASW systems.
- Initiate the ODDCL effort focusing on the development of sensor and platform designs and key components compatible with a notional Concept of Operations.
- Initiate development of an advanced development model of a DWADS System for surveillance of deep ocean submarine threats.
- Initiate development of a tactical area prototype system for PLUS. This effort transferred to this PE from PE 0602747N.

FY 2009 Plans:

- Continue all FY 2008 efforts less those noted as completed.
- Continue development of a tactical area prototype system for PLUS.
- Complete development of and demonstrate an advanced development model of a DWADS System for surveillance of deep ocean submarine threats.
- Complete development of active sonar sensors and processing for wide area surveillance of deep ocean operating areas.
- Complete integration and evaluation of STT tracking algorithms and automated processing.
- Initiate simulation test of the PLUS prototype system in preparation for at-sea experiments.
- Initiate analysis of data collected during the PLUS at-sea experiments.
- Initiate two at-sea experiments of the prototype system for PLUS.
- Initiate DADS deployability, covert communications and survivability testing.
- Initiate system level design and integration for ODDCL.
- Initiate at-sea demonstrations of STT submersible with fully integrated sensor package.

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603747N PROGRAM ELEMENT TITLE: UNDERSEA WARFARE ADVANCED TECHNOLOGY
PROJECT NUMBER: 2916 PROJECT TITLE: UNDERSEA WARFARE ADVANCED TECHNOLOGY

- Initiate test planning of source algorithms to be used to determine the optimal initial placement of uncontrolled drifting distributed systems.
- Initiate research effort aimed at the ideal placement and control of acoustic sources and drifting sensor systems.
- Initiate a research effort focusing on distributed system in-situational environmental characterization and system monitoring.
- Initiate a research effort to determine the placement of and follow-on control and pattern keeping of acoustic sources and distributed sensor systems.

	FY 2007	FY 2008	FY 2009
BATTLEGROUP ANTI-SUBMARINE WARFARE (ASW) DEFENSE	8,458	2,887	0

Battlegroup ASW Defense technology focuses on the development of platform-based sources and receivers aimed at denying submarines the ability to target grey ships. This technology area is primarily concerned with detections inside 10 nautical miles. Battlegroup ASW Defense integrates next-generation technologies, automatic target recognition, sensors that adjust to complex acoustic environments, and environmentally adaptive processing techniques. Battlegroup ASW Defense will enable smaller, lighter, and cheaper arrays, large multi-line arrays, and submarine flank arrays all with environmental adaptation capabilities.

The net decrease from FY 2007 to FY 2008 is due to the planned phase-down of Multi-Mode Magnetic Detection System (MMMDS) and the transition/completion of the Sonar Automation Technology (SAT) and Shallow Water Array Performance (SWAP) efforts. The net decrease in funding from FY 2008 to FY 2009 is due to the transition/completion of the MMMDS project in FY 2008.

FY 2007 Accomplishments:

- Continued the integration of MMMDS sensor hardware/software into towed vehicles and fixed-wing Unmanned Air Vehicles (UAV).
- Completed development and demonstration of SAT threat submarine detection and classification algorithms; transition to NAVSEA under PE 0603561N (Advanced Submarine System Development), Project 0223 (Submarine Combat Systems Improvements) and PE 0204311N (Maritime Surveillance Program).
- Completed MMMDS development of magnetometer sensor technologies.
- Initiated and completed test flights to collect relevant MMMDS data.

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603747N PROGRAM ELEMENT TITLE: UNDERSEA WARFARE ADVANCED TECHNOLOGY
PROJECT NUMBER: 2916 PROJECT TITLE: UNDERSEA WARFARE ADVANCED TECHNOLOGY

FY 2008 Plans:

- Complete the integration of MMMDS sensor hardware/software into towed vehicles flown by vertical takeoff unmanned aerial vehicle surrogates.
- Complete MMMDS final reporting; transition to NAVAIR.
- Initiate/complete MMMDS planning and execution of final over water demonstration with realistic target.

	FY 2007	FY 2008	FY 2009
NEUTRALIZATION	1,145	19,822	23,236

Neutralization focuses on undersea weapons technologies to counter threat submarines by increasing the Probability of Kill (PK). The ultimate goals of Neutralization efforts are to develop reduced size advanced undersea weapons with revolutionary capabilities and to fill Sea Shield mission capability gaps and demonstrate transformational capabilities for ASW weapons.

The increase in funding from FY 2007 through FY 2009 is due to the Lightweight Torpedo Technologies (LTT), which provides a tactically revolutionary PK against quiet diesel-electric submarines operating in harsh shallow water environments, and CRAW which is capable of deployment from an air-vehicle at low altitude to neutralize undersea threat targets from the stand-off ranges of US Naval vessels. These research efforts initiate in FY 2007 and continue for five years and are targeted for transition in FY 2010 and FY 2011 respectively. This project is funded in accordance with the FNC process and is approved by the Technology Oversight Group.

FY 2007 Accomplishments:

- Initiated LTT integration of broadband and adjunct sensors for in-water data collection to result in a new dual-mode sensor guidance and control system for at-sea testing.

FY 2008 Plans:

- Continue all FY 2007 efforts.
- Continue feasibility investigations under LTT to quantify adjunct sensor configurations and signal processing approaches to enable positive discrimination of artificial targets at standoff ranges. This feasibility investigation is expected to result in five (5) new patent applications. (Transitioned from PE

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603747N PROGRAM ELEMENT TITLE: UNDERSEA WARFARE ADVANCED TECHNOLOGY
PROJECT NUMBER: 2916 PROJECT TITLE: UNDERSEA WARFARE ADVANCED TECHNOLOGY

0602747N)
- Continue LTT feasibility investigations to select the stealth and propulsion technologies for future integration as a low cost propulsion replacement for the Mk 54 lightweight torpedo (LWT). (Transitioned from PE 0602747N)
- Continue LTT feasibility investigations and selected geo-coordinate based navigation system technologies and connectivity methods (i.e. acoustic communications, fiber link) for future development of technologies for LWT demonstration). (Transitioned from PE 0602747N)
- Continue data collection for LWT broadband and counter-countermeasures in the harsh shallow water environment of the Shore Bombardment Area site off the Southern California Off-Shore Range using an experimental test vehicle fitted with a broadband Mk 54 array. (Transitioned from PE 0602747N)
- Continue LTT sensor package development to achieve integrated coherent broadband sonar and novel adjunct sensors homing and classification capabilities for LWT. (Transitioned from PE 0602747N)
- Continue LTT advanced counter-countermeasure algorithm and tactics development for LWT. (Transitioned from PE 0602747N)
- Continue feasibility assessment of LTT to best utilize precision targeting and distributed sensors for weapon employment from high altitude and standoff range. (Transitioned from PE 0602747N)
- Continue development and integration of adjunct sensors into a lightweight torpedo sensor and design signal processing and data fusion techniques to improve target classification in areas of high contact density. (Transitioned from PE 0602747N)
- Continue a high fidelity weapon frequency model development effort to parallel adjunct sensor developments and provide accurate synthetic data for algorithm design and measurement. (Transitioned from PE 0602747N)
- Complete LTT feasibility investigations addressing adjunct sensor configurations, stealth and propulsion technologies, and geo-coordinate based navigation systems. (Transitioned from PE 0602747N)
- Initiate in-water data collection for development of advanced counter countermeasure processing, weapon-to-weapon acoustic communication and a salvo vehicle intelligent controller.
- Initiate development of a high channel count LTT broadband transmitter.
- Initiate development and integration of a total LTT system prototype in the Mk 54 torpedo form factor for at sea demonstrations.
- Initiate development of a reduced size/weight CRAW for air deployment. This effort will include sensor, guidance and control, warhead, propulsion, and air frame integration tasks.
- Initiate CRAW in water data collection to support development of guidance and control algorithms enabling an ASW offensive capability in the Common Very Lightweight Torpedo.
- Initiate tests to support the development of a CRAW warhead that will achieve required performance against submarine targets, and demonstrate feasibility of achieving final goal.

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603747N PROGRAM ELEMENT TITLE: UNDERSEA WARFARE ADVANCED TECHNOLOGY
PROJECT NUMBER: 2916 PROJECT TITLE: UNDERSEA WARFARE ADVANCED TECHNOLOGY

FY 2009 Plans:

- Continue all FY 2008 efforts less those noted as completed.
- Complete LTT development, scale up and testing prototype components.
- Complete LTT advanced counter-countermeasure algorithm and tactics development for LWT.
- Initiate demonstration of LTT underwater acoustic communications capability to enable coordinated attack and net-centric connectivity. (Transitioned from PE 0602747N)
- Initiate demonstration of LTT weapon salvo capability utilizing behavior-based control (Transitioned from PE 0602747N)
- Initiate development of an integrated LTT set-to-hit simulation capability to evaluate weapon performance gains to include robust representations of component technologies developed and demonstrated under the LTT project.
- Initiate design and development of an integrated LTT full system prototype consisting of hardware and software upgrades for a final at-sea demonstrations to be conducted in FY 2010.
- Initiate in-water data collection on CRAW homing in presence of countermeasures.

C. OTHER PROGRAM FUNDING SUMMARY - NAVY RELATED RDT&E:
PE 0204311N Integrated Surveillance System
PE 0205620N Surface ASW Combat System Integration
PE 0601153N Defense Research Sciences
PE 0602235N Common Picture Applied Research
PE 0602435N Ocean Warfighting Environment Applied Research
PE 0602747N Undersea Warfare Applied Research
PE 0602782N Mine and Expeditionary Warfare Applied Research
PE 0603235N Common Picture Advanced Technology
PE 0603254N ASW Systems Development
PE 0603506N Surface Ship Torpedo Defense
PE 0603513N Shipboard System Component Development
PE 0603553N Surface ASW
PE 0603561N Advanced Submarine System Development
PE 0603734N CHALK CORAL
PE 0603782N Mine and Expeditionary Warfare Advanced Technology
PE 0604221N P-3 Modernization Program

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603747N PROGRAM ELEMENT TITLE: UNDERSEA WARFARE ADVANCED TECHNOLOGY
PROJECT NUMBER: 2916 PROJECT TITLE: UNDERSEA WARFARE ADVANCED TECHNOLOGY

PE 0604261N Acoustic Search Sensors
PE 0604503N SSN-688 and Trident Modernization
PE 0604784N Distributed Surveillance System

OTHER PROGRAM FUNDING SUMMARY - NON-NAVY RELATED RDT&E:
PE 0602702E Tactical Technology
PE 0603175C Ballistic Missile Defense Technology
PE 0603739E Advanced Electronics Technologies

D. ACQUISITION STRATEGY:
Not applicable.

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603747N PROGRAM ELEMENT TITLE: UNDERSEA WARFARE ADVANCED TECHNOLOGY
PROJECT NUMBER: 9999 PROJECT TITLE: CONGRESSIONAL PLUS-UPS

CONGRESSIONAL PLUS-UPS:

	FY 2007	FY 2008
DEEP WATER ACOUSTIC DETECTION SYSTEM	0	3,179

The goal of this effort is to develop a full-scale prototype of a wave-harvesting buoy to operate a moored autonomous sonar continuously for more than a month while reducing the buoy size by ten percent over the previous design.

	FY 2007	FY 2008
DEMONSTRATION WAVE POWER BUOY FOR ADVANCED DEPLOYABLE SYSTEM	1,749	0

This effort defined requirements for the Ocean Test Article (OTA) PowerBuoy, anchor, mooring, riser, and deployment/retrieval and testing system; fabricated the OTA PowerBuoy Subsystem, conducted a sea trial, and optimized the PowerBuoy design for Advanced Development Model applications.

	FY 2007	FY 2008
UNDERSEA VEHICLE TEST AND TRAINING ENVIRONMENT	3,108	0

This effort developed and tested advanced technologies for the Naval Special Warfare (NSW) Swimmer Delivery Vehicle.

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

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603758N
PROGRAM ELEMENT TITLE: NAVY WARFIGHTING EXPERIMENTS AND DEMONSTRATIONS

COST: (Dollars in Thousands)

Project Number & Title	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
Total PE	49,191	40,612	70,216	55,988	71,407	73,590	70,343
2918 NAVY WARFIGHTING EXPERIMENTS AND DEMONSTRATIONS	49,191	40,612	70,216	55,988	71,407	73,590	70,343

A. MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: This Program Element (PE) addresses the development of recent technology breakthroughs to meet current operational needs from a subscale proof-of-principle into a full-scale prototype for warfighter experimentation during laboratory and operational demonstrations, Fleet Battle Experiments (FBE), Limited Objective Experiments (LOEs) and Sea Trial Exercises. The key aspects of this PE are divided into four areas: (1) SwampWorks develops and demonstrates newly invented or recently discovered technologies that address emergent and enduring operational problems in an accelerated timeframe; (2) Naval Warfare Experimentation develops prototypes of recent technology breakthroughs and provides them to the warfighter for experimentation during FBEs, LOEs or Sea Trials; (3) Tech Solutions resolves operational problems submitted by Sailors, Marines and Science Advisors via a collaborative working environment, applies scientific applications to solve these problems, and provides the solution to the sailor for evaluation and use; and (4) Operations Analysis provides the Navy and Marine Corps the means to identify capability needs that can be addressed with science and technology solutions.

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

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603758N
PROGRAM ELEMENT TITLE: NAVY WARFIGHTING EXPERIMENTS AND DEMONSTRATIONS

B. PROGRAM CHANGE SUMMARY:

	FY 2007	FY 2008	FY 2009
FY 2008/FY 2009 President's Budget Submission	41,146	41,196	47,209
Congressional Undistributed Reductions/Rescissions	0	-262	0
Execution Adjustments	8,709	0	0
Program Adjustments	0	0	23,133
Rate Adjustments	0	0	-126
SBIR Assessment	-664	-322	0
FY 2009 President's Budget Submission	49,191	40,612	70,216

PROGRAM CHANGE SUMMARY EXPLANATION:
Technical: Not applicable.

Schedule: Not applicable.

C. OTHER PROGRAM FUNDING SUMMARY:
Not applicable.

D. ACQUISITION STRATEGY:
Not applicable.

E. PERFORMANCE METRICS:
Overall metric goals are to transition the 6.3 advanced technology projects into acquisition programs of record, demonstrate successful technologies to enable new operational concepts, and enable the production of technology products such as proofs of concept and manufacturing packages. The performance of the work funded in this PE is reviewed at several levels to ensure that the investment is relevant and productive:

At the macroscopic level, the investment is coordinated with Navy Warfare Development Command (NWDC) and Commander, Fleet Forces Command (CFFC) to address the goals and objectives identified for Sea Trials and LOEs. At the microscopic level, the work funded in this PE is reviewed periodically by the Program Manager to ensure the investment is meeting the goals defined for each project. This review includes feedback collected from the warfighter community on all Sea Trials and LOE to support the Program Manager's assessment of the value and relevance of each investment. Furthermore, the entire program is reviewed yearly by the Chief of Naval Research.

FY 2009 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2008
Exhibit R-2a

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603758N PROGRAM ELEMENT TITLE: NAVY WARFIGHTING EXPERIMENTS AND DEMONSTRATIONS
PROJECT NUMBER: 2918 PROJECT TITLE: NAVY WARFIGHTING EXPERIMENTS AND DEMONSTRATIONS

COST: (Dollars in Thousands)

Project Number & Title	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
2918 NAVY WARFIGHTING EXPERIMENTS AND DEMONSTRATIONS	49,191	40,612	70,216	55,988	71,407	73,590	70,343

A. MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: This project focuses on the development of recent technology breakthroughs to meet current operational needs from a subscale proof-of-principle into a full-scale prototype for warfighter experimentation during laboratory and operational demonstrations, Fleet Battle Experiments (FBE), Limited Objective Experiments (LOEs) and Sea Trial Exercises.

B. ACCOMPLISHMENTS/PLANNED PROGRAM:

	FY 2007	FY 2008	FY 2009
NAVAL WARFARE EXPERIMENTATION	23,493	14,685	41,593

The objective of this project is to capitalize on recent technology breakthroughs to develop prototypes quickly and provide them to the warfighter for experimentation during laboratory and operational demonstrations, Sea Trials or LOEs. Current efforts include experimentation with a Coherent Stand-In Jamming (CSIJ) for unmanned air vehicles (UAVs), development of test simulation technology for ship affordability, technology to advance riverine warfare operations, an advanced sensor for Anti-Submarine Warfare (ASW) and technology investigation studies.

The funding level decrease from FY07 to FY08 is due to a realignment in support of Net-Centricity - Net-Enabled Command Capability, Maritime Domain Awareness and Operational Adaptation Technology Demonstration. The funding level increase in FY09 is due to additional experimentation with technologies developed in SwampWorks' power and energy initiative, the Maritime Domain Awareness (MDA) Initiative and the Operational Adaptation Technology Demonstration.

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603758N PROGRAM ELEMENT TITLE: NAVY WARFIGHTING EXPERIMENTS AND DEMONSTRATIONS
PROJECT NUMBER: 2918 PROJECT TITLE: NAVY WARFIGHTING EXPERIMENTS AND DEMONSTRATIONS

FY 2007 Accomplishments:

- Continued concept based technology program efforts.
- Continued to identify other promising technology breakthroughs that can be prototyped and delivered to the warfighter for experimentation.
- Continued effort to experiment and demonstrate technology for riverine warfare.
- Completed investigation of operational areas that can be served with KM technologies.
- Completed the development of an unmanned aerial vehicle (UAV) with standoff jamming capability for Suppression of Enemy Air Defenses (SEAD) and IED initiatives.
- Completed experimentation with Fleet ASW Command to assess the effectiveness of the electromagnetic sensors in cueing in a real-time operational scenario.
- Initiated development and demonstration of real time situational awareness technologies.
- Initiated Ship Affordability program to examine ship designs and construction processes and develop technologies that can significantly reduce the costs to conceive, design and construct naval ships.
- Initiated effort to experiment and demonstrate technologies to improve warfighter survivability using electronic warfare systems.

FY 2008 Plans:

- Continue all FY 2007 efforts less those noted as completed above.
- Complete effort to experiment and demonstrate technologies to improve warfighter survivability using electronic warfare systems.
- Complete effort to experiment and demonstrate technology for riverine warfare.
- Complete program to develop technologies to enhance vehicle tactical situational awareness and fuse with intelligence products.

FY 2009 Plans:

- Continue all FY 2008 efforts less those noted as complete above.
- Complete Ship Affordability program and experimentation.
- Initiate experimentation efforts with technologies developed in SwampWorks power and energy initiative.
- Initiate effort to develop and demonstrate an integrated, affordable and minimally-manned warfighting sensor capability to provide adaptive persistent surveillance leading to Operational Adaptation by Naval forces in defeating the Asymetric and Irregular Warfare threat.

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603758N PROGRAM ELEMENT TITLE: NAVY WARFIGHTING EXPERIMENTS AND DEMONSTRATIONS
PROJECT NUMBER: 2918 PROJECT TITLE: NAVY WARFIGHTING EXPERIMENTS AND DEMONSTRATIONS

- Initiate effort to develop and demonstrate integrated intelligence, surveillance, observation, and navigation technologies into a common operation picture accessible throughout the U.S. Government.
- Initiate effort to demonstrate shipboard high temperature degaussing technologies.
- Initiate experiments to demonstrate shipboard high efficiency solid state lighting technologies.

	FY 2007	FY 2008	FY 2009
OPERATIONS ANALYSIS	0	2,904	2,923

The objective of this project is to provide operational analysis through studies, analyses, gaming and experimentation to identify Navy and Marine Corps capability needs that can be addressed with Science and Technology (S&T) solutions. The effort includes core analysis of S&T programs, military utility / capability gaps analyses, war gaming and fleet experimentation analysis. Recent work includes fleet operational readiness assessments, command and control operational performance assessments, participation in Maritime Domain Awareness Simulation Exercises (SIMEX), Sea Basing concept analysis and Electro-Magnetic Railgun S&T transition wargame and targeting analysis, and development of a Combating Terrorism Process Model, and wargaming with technology transfer innovation.

FY 2007 Accomplishments:

Previously funded in PE 0601153N.

FY 2008 Plans:

- Continue to conduct Military Utility Analyses (MUAs) of future naval capability technologies.
- Continue to conduct capability gaps analyses to identify areas that can be addressed with products from the science and technology portfolio.
- Continue to conduct war games focused on technical issues for S&T transitions to acquisition and the fleet.

FY 2009 Plans:

- Continue all FY 2008 efforts.

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603758N PROGRAM ELEMENT TITLE: NAVY WARFIGHTING EXPERIMENTS AND DEMONSTRATIONS
PROJECT NUMBER: 2918 PROJECT TITLE: NAVY WARFIGHTING EXPERIMENTS AND DEMONSTRATIONS

	FY 2007	FY 2008	FY 2009
TECH SOLUTIONS	7,402	7,389	10,000

The objective of this program is to provide deckplate Sailors and Marines in the field with technical solutions to common operational problems and the Office of Naval Research Science Advisors with solutions to current technology gaps. The Sailors, Marines and Science Advisors provide their operational issues and technology gaps throughout the year via a collaborative working environment.

The funding increase in FY09 is due to the initiation and ramping up of a series of new science and technology programs focused on anti-terrorism and force protection as identified by Science Advisors and the Fleet/Force.

FY 2007 Accomplishments:

- Continued to obtain operational problems from the sailors via the web and developed, demonstrated and delivered technical solutions.
- Completed development of a portal for explosive detection that utilizes infrared detection.
- Completed development of a marker for search and rescue that does not interfere with Radio Frequency (RF) communications called a Search and Rescue Low Probability of Interference Marker.
- Completed development of ballistic goggles that provide eye protection for ground troops and are adaptive to changing light conditions.
- Completed development and testing of ballistic net protection system.
- Completed prototype of a Battlespace Simulation Trainer to provide 'immersive' simulation training to the warfighter.
- Initiated development of projects that provide solutions to problems identified by Science Advisors, as well as the Fleet/Force.

FY 2008 Plans:

- Continue all FY 2007 efforts less those noted as completed above.
- Initiate development of projects that provide solutions to problems identified by Science Advisors, as well as the Fleet/Force.

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603758N PROGRAM ELEMENT TITLE: NAVY WARFIGHTING EXPERIMENTS AND DEMONSTRATIONS
PROJECT NUMBER: 2918 PROJECT TITLE: NAVY WARFIGHTING EXPERIMENTS AND DEMONSTRATIONS

FY 2009 Plans:

- Continue all FY 2008 efforts.
- Initiate development of projects that provide solutions to problems identified by Science Advisors, as well as the Fleet/Force.

	FY 2007	FY 2008	FY 2009
SWAMPWORKS	18,296	15,634	15,700

SwampWorks seeks to develop and demonstrate technologies that address emergent and enduring operational problems in an accelerated timeframe. Some of these technologies may end up in the hands of the warfighter for experimentation, or may culminate in a significant exercise that demonstrates capability then transitions into the Acquisition Program of Record (POR). Examples of recent successes are the half-length torpedo which led to the development of the SwampWorks Broadband Sonar and transitioned to the Mk 48 Advanced Capability (ADCAP) program and the Aircraft Carrier Situational Awareness System (ACSAS), which will be incorporated into a POR. Current efforts are the development and demonstration of jet noise mitigation technologies, blast resistant structures, a high resolution sonar for the new lightweight torpedo, the Combat Science and Technology Vehicle (CSTV), energy storage and reduced energy consumption technologies and technology investigation studies.

FY 2007 Accomplishments:

- Continued to identify enduring and emergent operational barriers identified by naval leadership and responded with relevant technology developments and demonstrations.
- Continued the development of new technologies that are responsive to Taskforce Antisubmarine Warfare (TF ASW), a recently developed Concept of Operation.
- Continued an investigation and development of technologies that reduce energy consumption losses during recent operations.
- Completed development of vehicle technologies to address survivability, fuel economies and blast mitigation.
- Completed test and demonstration of technology for F18 noise abatement.
- Initiated novel heavy fuel propulsion system development.
- Initiated and completed a sequencing array prototype for broad-spectrum pathogen surveillance within theatres of U.S. Naval operations.

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603758N PROGRAM ELEMENT TITLE: NAVY WARFIGHTING EXPERIMENTS AND DEMONSTRATIONS
PROJECT NUMBER: 2918 PROJECT TITLE: NAVY WARFIGHTING EXPERIMENTS AND DEMONSTRATIONS

FY 2008 Plans:

- Continue all FY 2007 efforts less those noted as completed above.

FY 2009 Plans:

- Continue all FY 2008 efforts.
- Complete development of new technologies that are responsive to Taskforce Antisubmarine Warfare (TF ASW).
- Complete development of technologies that reduce energy consumption losses during recent operations.
- Initiate development of electronic warfare technologies that are responsive to fleet needs to counter emerging threats.

C. OTHER PROGRAM FUNDING SUMMARY - NAVY RELATED RDT&E:
Not applicable.

OTHER PROGRAM FUNDING SUMMARY - NON-NAVY RELATED RDT&E:
Not applicable.

D. ACQUISITION STRATEGY:
Not applicable.

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

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603782N
PROGRAM ELEMENT TITLE: MINE AND EXPEDITIONARY WARFARE ADVANCED TECHNOLOGY

COST: (Dollars in Thousands)

Project Number & Title	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
Total PE	23,797	28,253	33,426	31,414	27,963	15,221	25,169
2917 MINE AND EXPEDITIONARY WARFARE ADVANCED TECHNOLOGY	19,816	26,464	33,426	31,414	27,963	15,221	25,169
9999 CONGRESSIONAL PLUS-UPS	3,981	1,789	0	0	0	0	0

A. MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: The efforts described in this Program Element (PE) are based on investment directions as defined in the Naval S&T Strategic Plan approved by the S&T Corporate Board (Jan 2007). This strategy is based on needs and capabilities from Navy and Marine Corps guidance and input from the Naval Research Enterprise (NRE) stakeholders (including the Naval enterprises, the combatant commands, the Chief of Naval Operations (CNO), and Headquarters Marine Corps). It provides the vision and key objectives for the essential science and technology efforts that will enable the continued supremacy of U.S. Naval forces in the 21st century. The Strategy focuses and aligns Naval S&T with Naval missions and future capability needs that address the complex challenges presented by both rising peer competitors and irregular/asymmetric warfare.

This PE primarily develops and demonstrates prototype Mine Countermeasures (MCM) and Expeditionary Warfare system components that support capabilities enabling Naval Forces to influence operations ashore. Third-world nations have the capability to procure, stockpile and rapidly deploy all types of naval mines, including new generation mines having sophisticated performance characteristics, throughout the littoral battlespace. Real world operations have demonstrated the requirement to quickly counter the mine threat. Advanced technologies must rapidly detect and neutralize all mine types, from deep water to the inland objective. This program supports the advanced development and integration of sensors, processing, warheads and delivery vehicles to demonstrate improved Naval Warfare capabilities. It supports the MCM-related Future Naval Capabilities (FNC) Enabling Capabilities (ECs). Within the Naval Transformation Roadmap, this investment will achieve one of

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603782N
PROGRAM ELEMENT TITLE: MINE AND EXPEDITIONARY WARFARE ADVANCED TECHNOLOGY

three key transformational capabilities required by Sea Shield as well as technically enable the Ship To Objective Maneuver (STOM) key transformational capability within Sea Strike.

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

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603782N
PROGRAM ELEMENT TITLE: MINE AND EXPEDITIONARY WARFARE ADVANCED TECHNOLOGY

B. PROGRAM CHANGE SUMMARY:

	FY 2007	FY 2008	FY 2009
FY 2008/FY 2009 President's Budget Submission	25,324	26,840	33,877
Congressional Action	0	1,800	0
Congressional Undistributed Reductions/Rescissions	0	-182	0
Execution Adjustments	-1,201	0	0
Program Adjustments	0	0	-365
Rate Adjustments	0	0	-86
SBIR Assessment	-326	-205	0
FY 2009 President's Budget Submission	23,797	28,253	33,426

PROGRAM CHANGE SUMMARY EXPLANATION:
Technical: Not applicable.

Schedule: Not applicable.

C. OTHER PROGRAM FUNDING SUMMARY:
Not applicable.

D. ACQUISITION STRATEGY:
Not applicable.

E. PERFORMANCE METRICS:
The overall metrics of this advanced technology program are the development of technologies supporting the Mine and Expeditionary Warfare challenges of reducing the MCM tactical timeline from months to days and eliminating the need for Navy divers and manned equipment to enter minefields. Another important metric is the scheduled transition of 6.3 advanced technology projects from the FNCs program into Navy and Marine Corps acquisition programs at agreed upon Technology Readiness Levels. Technology-specific metrics include: Mine warfare data fusion capabilities yielding a 10%-25% reduction in time and risk to mine hunting activities; Mine hunting sensors - Probability of Detection = 95%, Probability of Identification of Proud Mines = 90%,

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603782N
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Probability of Classification of Buried Mines = 80%; Unmanned Systems for MCM sized for inclusion in the Littoral Combat Ship Mine Warfare Mission Package; MCM sensors sized, packaged and capable of 12 hour missions with a search rate greater than .05 square nautical mines per hour; Mine sweeping: Modular magnetic and acoustic influence sweeping systems packaged for deployment from Unmanned Surface Vehicles; Minesweeping single sortie coverage > 9.4 square nautical miles at 20 nautical miles per hour during a 4 hour mission up to Sea State 3; Surface-laid mine and obstacle breaching capability > 90% in the Beach Zone (BZ) using unitary warheads, and > 80% in the Surf Zone (SZ).

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603782N PROGRAM ELEMENT TITLE: MINE AND EXPEDITIONARY WARFARE ADVANCED TECHNOLOGY
PROJECT NUMBER: 2917 PROJECT TITLE: MINE AND EXPEDITIONARY WARFARE ADVANCED TECHNOLOGY

COST: (Dollars in Thousands)

Project Number & Title	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
2917 MINE AND EXPEDITIONARY WARFARE ADVANCED TECHNOLOGY	19,816	26,464	33,426	31,414	27,963	15,221	25,169

A. MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: This project primarily develops and demonstrates prototype MCM technologies that support a range of capabilities enabling Naval Forces to influence operations ashore. Third-world nations have the capability to procure, stockpile and rapidly deploy all types of naval mines, including new generation mines having sophisticated performance characteristics. Recent operations have demonstrated the requirement to counter the projected mine threat. Advanced technologies are required to rapidly detect and neutralize all mine types, from deep water to the inland objective. This project supports the advanced development and integration of sensors, processing, warheads and delivery vehicles. It supports the MCM-related FNC ECs.

B. ACCOMPLISHMENTS/PLANNED PROGRAM:

	FY 2007	FY 2008	FY 2009
MINE/OBSTACLE DETECTION	12,152	14,287	18,983

This activity focuses on developing and demonstrating technologies that support detection, classification, identification and multi-sensor data fusion of mine and obstacle data to speed tactical timelines and increase operator standoff. Efforts include: electro-optic sensors/systems to enable Unmanned Aerial Vehicle (UAV) rapid minefield reconnaissance and precise mineline location from Very Shallow Water (VSW) through the BZ; sensors/systems to enable cooperating Unmanned Underwater Vehicles (UUVs) to perform wide-area reconnaissance and assault lane reconnaissance/preparation from shallow water through the SZ; sensor development for detection and classification of buried mines; technologies for MCM Mission Modules for the new Littoral Combat Ships (LCS); and sensor data fusion to enable a theater mine warfare common operating picture and own ship protection. This activity supports the development and transition of technologies for the MCM-related FNCs.

The increase from FY 2008 to FY 2009 reflects the increased investment in the MCM critical S&T areas of Buried

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603782N PROGRAM ELEMENT TITLE: MINE AND EXPEDITIONARY WARFARE ADVANCED TECHNOLOGY
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Mine Sensors and Processing; Undersea Cooperative Cueing (for UUVs); and MCM Sensors for the LCS. The FY 2009 budget reflects the transition of 6.2 applied research into advanced technology development (6.3). Acquisition Programs of Record at the Naval Seas Systems Command have program objectives memorandum funding for the transition of these S&T products from 6.3 to 6.4.

This S&T investment supports the Joint Requirements Oversight Council of the Joint Chiefs of Staff and Office of the Chief of Naval Operations (OPNAV) validated requirements for MCM. This S&T investment of mine and obstacle detection provides critical S&T transitions to the Mine Warfare Mission package of the Navy's new LCS. This investment in MCM S&T is reported as part of OPNAV's annual report to Congress in the MCM Certification Plan. This plan is reviewed and approved by the Office of the Secretary of Defense, and any deviations in ONR's reported S&T funding for MCM throughout the Future Years Defense Plan must be reported and justified through Navy and OSD. Further, the MCM S&T investment plan structure is reviewed and authorized by the Navy's Technology Oversight Group that approves ECs, their supporting products, and funding profiles.

FY 2007 Accomplishments:

-Continued demonstration of capability to enable diver teams with UUVs to efficiently and accurately reacquire previously targeted areas and individual targets.
-Continued demonstration of integrated UUV: search; marking; mapping of bathymetry, threat objects and gaps; and report back in test-bed minefields in VSW environments.
-Continued development of multi-platform fusion from high-resolution mine hunting systems (e.g. AN/AQS-20) for improved mine detection and avoidance.
-Continued development of Rapid Overt Airborne Reconnaissance (ROAR) multi-spectral laser, 3-D camera for airborne VSW/SZ/BZ day/night mine/minefield/ obstacle detection.
-Completed helo integration and first flight test of the ROAR sensor.
-Completed integration of Laser Scalar Gradiometer (LSG) into UUV and field evaluation of LSG performance against buried mines.
-Completed transition of the small object avoidance processing string in the SQS-53C Integrated Peer Review (IPS) adjunct processing system.
-Completed demonstration of buried minehunting systems on UUV platforms with a combined LSG and dual frequency Synthetic Aperture Sonar sensor suite in a UUV in a Fleet exercise.
-Completed flight testing of Tactical Multi-Spectral Imaging (TACMSI) passive multi-spectral sensor for detection of surface mines and obstacles in the BZ/SZ.
-Initiated multiple unmanned system MCM data fusion techniques for reduction in false alarms and reduction in

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603782N PROGRAM ELEMENT TITLE: MINE AND EXPEDITIONARY WARFARE ADVANCED TECHNOLOGY
PROJECT NUMBER: 2917 PROJECT TITLE: MINE AND EXPEDITIONARY WARFARE ADVANCED TECHNOLOGY

tactical timelines.
-Initiated technology development, integration and early demonstration planning for MCM Mission Module systems for Advanced Flight LCS.
-Initiated advanced processing development for Low Frequency Broad Band to enable rapid detection, classification and identification of buried sea mines.
-Initiated development of Tactical Unmanned Aerial Vehicle (TUAV)-based SZ/BZ buried minefield detection capability.

FY 2008 Plans:

-Continue all FY 2007 efforts less those noted as completed above.
-Complete demonstration of capability to enable diver teams with UUVs to efficiently and accurately reacquire previously targeted areas and individual targets.
-Complete demonstration of integrated UUV: search; marking; mapping of bathymetry, threat objects and gaps; and report back in test-bed minefields in VSW environments.
-Complete transition of ROAR sensor technology to PMS-495.
-Initiate buried mine sensing identification processing.
-Initiate technology development for multiple UUV Undersea Cooperative Cueing and Intervention in support of MCM operations.

FY 2009 Plans:

-Continue all FY 2008 efforts less those noted as completed above.
-Complete development of multi-platform fusion of high-resolution mine hunting systems (e.g. AN/AQS-20) for improved mine detection and avoidance.
-Complete multiple unmanned system MCM data fusion techniques for reduction in false alarms and reduction in tactical timelines.
-Complete buried mine sensing identification processing development.

	FY 2007	FY 2008	FY 2009
MINE/OBSTACLE NEUTRALIZATION	7,664	12,177	14,443

Mine and Obstacle Neutralization activity is focused on improving the capability to neutralize mines and obstacles from deep water through the beach exit zone. Efforts include the development of technologies for:

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603782N PROGRAM ELEMENT TITLE: MINE AND EXPEDITIONARY WARFARE ADVANCED TECHNOLOGY
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stand-off breaching of mines and obstacles in the SZ/BZ; minesweeping and jamming of sea mines; and Autonomous Underwater Vehicle (AUV) neutralization of sea mines. Stand-off breaching efforts demonstrate a mine and obstacle breaching capability that is enabled by precision weapon guidance and Intelligence, Surveillance, and Reconnaissance (ISR), and delivered by Naval Tactical Aircraft (TACAIR) and USAF Bombers. Tactical performance of existing unitary bombs is being demonstrated. Other efforts will demonstrate a tactical countermine dart and dispenser concept. The minesweeping effort develops a mission package for deployment on Unmanned Surface Vehicles (USVs). Also, efforts will focus on improving an existing breaching weapon fuze and developing a precision assault lane marking navigation capability. This activity supports the development and transition of technologies for the MCM-related FNC ECs.

The funding profile from FY 2007 through FY 2009 reflects the increased emphasis on developing FNC products in AUV technology for neutralization of sea mines, assault lane navigation and improvements to breaching weapons.

FY 2007 Accomplishments:

-Continued development of low drag, low frequency sound source for mine influence sweeping.
-Completed development and demonstration of USV minesweeping module concept and began transition to PMS-495.
-Completed countermine dart lethality optimization.
-Completed Mine/Obstacle Defeat System (MODS) flight test with live darts and tactical mines.
-Completed transition of countermine dart technology to PMS-495.
-Completed countermine dart dispense flight tests with inert darts.
-Initiated development of an autonomous mine neutralization system for VSW MCM.
-Initiated development of advanced Mine Warfare Mission module capabilities in support of the LCS Mine Warfare mission.
-Initiated development effort to extend effectiveness of unitary warheads to greater depths and initiated planning of flight demo with Naval Special Clearance Team 1.
-Initiated technology development of precision navigation capability for targeting, safe navigation through assault lanes including lane marking.

FY 2008 Plans:

-Continue all FY 2007 efforts.
-Complete development of low drag, low frequency sound source for mine influence sweeping.
-Initiate development of an AUV system for neutralization of littoral mines.

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603782N PROGRAM ELEMENT TITLE: MINE AND EXPEDITIONARY WARFARE ADVANCED TECHNOLOGY
PROJECT NUMBER: 2917 PROJECT TITLE: MINE AND EXPEDITIONARY WARFARE ADVANCED TECHNOLOGY

FY 2009 Plans:

-Continue all FY 2008 efforts.

C. OTHER PROGRAM FUNDING SUMMARY - NAVY RELATED RDT&E:
PE 0601153N Defense Research Sciences
PE 0602131M Marine Corps Landing Force Technology
PE 0602435N Ocean Warfighting Environment Applied Research
PE 0602747N Undersea Warfare Applied Research
PE 0602782N Mine and Expeditionary Warfare Applied Research
PE 0603502N Surface and Shallow Water Mine Countermeasures
PE 0603513N Shipboard System Component Development
PE 0603640M USMC Advanced Technology Demonstration (ATD)
PE 0604373N Airborne MCM
PE 0604784N Distributed Surveillance System

OTHER PROGRAM FUNDING SUMMARY - NON-NAVY RELATED RDT&E:
PE 0602712A Countermine Systems
PE 0603606A Landmine Warfare and Barrier Advanced Technology

D. ACQUISITION STRATEGY:
Not applicable.

BUDGET ACTIVITY: 03
PROGRAM ELEMENT: 0603782N PROGRAM ELEMENT TITLE: MINE AND EXPEDITIONARY WARFARE ADVANCED TECHNOLOGY
PROJECT NUMBER: 9999 PROJECT TITLE: CONGRESSIONAL PLUS-UPS

CONGRESSIONAL PLUS-UPS:

	FY 2007	FY 2008
JEOD DIVER SITUATIONAL AWARENESS SYSTEM	1,749	795

FY07: This project initiated the concept, design, and development of a self-contained device housed in a rugged, waterproof, portable container that is capable of gathering and providing critical intelligence and essential technical information for use by the Navy and other government organizations responsible for protecting the nation's seaports and maritime operations.

FY08: This project continues the development of a self-contained, rugged, waterproof, and portable device capable of providing critical intelligence and essential technical information for use by the Navy and other government organizations responsible for protecting the nation's seaports and maritime operations.

	FY 2007	FY 2008
UPWARD LOOKING SONAR (ULS)	1,019	994

FY07: This project initiated support for defining the concept of operating small, autonomous sonar units spaced randomly on the floor of the ocean in relatively shallow water of less than 1000 feet.

FY08: This project continues to define the concept of operating small, autonomous sonar units randomly spaced on the ocean floor in relatively shallow water of less than 1000 feet.

	FY 2007	FY 2008
VISUAL INTEGRATED BRIDGE SYSTEM	1,213	0

This effort supported the Expeditionary Fighting Vehicle operational requirements goal for Light Detection and Ranging data display and supported the Visual Integrated Bridge System Augmented Reality Program by superimposing visual information over the view from a ship’s bridge.