

DEPARTMENT OF THE NAVY  
FISCAL YEAR (FY) 2001  
BUDGET ESTIMATES

20000315036



JUSTIFICATION OF ESTIMATES  
FEBRUARY 2000

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

UNCLASSIFIED

Department of the Navy  
FY 2001 RDT&E Program

Exhibit R-1

APPROPRIATION: 1319n Research, Development, Test and Evaluation, Navy DATE: February 2000

Line Number	R-1 Program Element Number	Item Nomenclature	Thousands of Dollars				Security Classification
			Budget Activity	FY 1999	FY 2000	FY 2001	
1	0601152N	In-House Independent Lab Research	1	14,596	15,544	16,343	U
2	0601153N	Defense Research Sciences	1	339,479	358,757	381,139	U
		Total Basic Research		354,075	374,301	397,482	
3	0602111N	Surface/Aerospace Surv. & Weapons Technology	2	37,630	51,331	37,966	U
4	0602121N	Surface Ship Technology	2	52,934	61,445	44,563	U
5	0602122N	Aircraft Technology	2	30,251	20,545	21,057	U
6	0602131M	Marine Corps Landing Force Technology	2	12,690	17,437	9,793	U
7	0602228N	Historically Black Colleges and Universities (Prior Year Only/RZ Not Required/Transferred to RDT&E-DW)	2	6,024	0	0	U
8	0602232N	C-3 Technology	2	71,147	91,166	79,905	U
9	0602233N	Human Systems Technology	2	33,816	30,417	30,939	U
10	0602234N	Materials, Electronics & Computer Technology	2	74,368	93,233	68,076	U
11	0602270N	EW Technology	2	22,403	37,459	26,043	U
12	0602314N	Undersea Surv. & Weapons Technology	2	46,151	51,123	52,488	U
13	0602315N	MCM, Mining & Special Warfare Technology	2	48,091	44,773	50,864	U
14	0602435N	Ocean & Atmospheric Technology	2	69,420	72,681	60,320	U
15	0602633N	Undersea Warfare Weapon Technology	2	37,203	40,839	35,028	U
16	0602805N	Dual Use Application Program	2	8,541	9,945	10,067	U
		Total Applied Research		550,669	622,394	527,109	
17	0603217N	Air Systems & Weapons Advanced Technology	3	49,234	48,775	39,667	U
18	0603238N	Global Surv/Prec Strike/Air Defense Tech Demo	3	68,179	85,086	68,555	U
19	0603270N	Advanced EW Technology	3	20,818	18,879	17,583	U
20	0603508N	Ship Propulsion System	3	53,245	76,096	37,432	U
21	0603640M	MC Advanced Technology Demo	3	56,304	68,565	54,749	U
22	0603706N	Medical Development (Advanced)	3	59,551	71,072	10,110	U
23	0603707N	Manpower, Pets, & Training Adv Tech Demo	3	29,300	45,479	26,988	U
24	0603712N	Environmental Quality & Logistics Adv Tech	3	22,104	27,657	24,002	U
25	0603727N	Joint Experimentation Program	3	0	43,498	49,506	U
26	0603747N	Undersea Warfare Advanced Technology	3	53,162	59,625	58,296	U
27	0603782N	Mine and Expeditionary Warfare Advanced Technology	3	42,530	57,393	45,618	U
28	0603792N	Advanced Technology Transition	3	72,321	109,926	76,333	U
29	0603794N	C-3 Advanced Technology	3	43,217	41,580	29,673	U
		Total Advanced Technology Development		569,965	753,631	538,512	
		Total Science and Technology (S&T)		1,474,709	1,750,326	1,463,103	

UNCLASSIFIED

Department of the Navy  
 FY 2001 RDT&E Program  
 Alphabetic Listing

Exhibit R-1

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17	0603217N	Air Systems & Weapons Advanced Technology	3	49,234	48,775	39,667	U
5	0602122N	Aircraft Technology	2	30,251	20,545	21,057	U
29	0603794N	C3 Advanced Technology	3	43,217	41,580	29,673	U
8	0602232N	C3 Technology	2	71,147	91,166	79,905	U
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11	0602270N	EW Technology	2	22,403	37,459	26,043	U
18	0603238N	Global Surv/Prec Strike/Air Defense Tech Demo	3	68,179	85,086	68,555	U
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9	0602233N	Human Systems Technology	2	33,816	30,417	30,939	U
1	0601152N	In-House Independent Lab Research	1	14,596	15,544	16,343	U
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6	0602131M	Marine Corps Landing Force Technology	2	12,690	17,437	9,793	U
10	0602234N	Materials, Electronics & Computer Technology	2	74,368	93,233	68,076	U
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12	0602314N	Undersea Surv. & Weapons Technology	2	46,151	51,123	52,488	U
26	0603747N	Undersea Warfare Advanced Technology	3	53,162	59,625	58,296	U
15	0602633N	Undersea Warfare Weapon Technology	2	37,203	40,839	35,028	U
Total Science and Technology (S&T)				1,474,709	1,750,326	1,463,103	

Comparison of FY 1999 Financing as reflected  
in FY 2000 Budget with 1999 Financing as  
Shown in the FY 2001 Budget

(\$ In Thousands)

	<u>Financing per FY 2000 Budget</u>	<u>Financing Per FY 2001 Budget</u>	<u>Increase (+) or Decrease (-)</u>
Program Requirements (Service Account)	8,660,809	8,942,170	+ 281,361
Program Requirements (Reimbursable)	150,000	212,229	+62,229
<b>Appropriation (Adjusted)</b>	<b>8,810,809</b>	<b>9,154,399</b>	<b>+343,590</b>

Explanation of Changes in Financing  
(\$ in Thousands)

The Fiscal Year 1999 program has changed since the presentation of the FY 2000 budget as noted below:

1. Program Requirements (Total). There has been a net increase to the appropriation (adjusted) of +\$281,361 as a result of changes in program requirements as noted below.
2. Program Requirements (Service Account). There has been a net increase to the appropriation (adjusted) of \$281,361 which is a result of various changes. These changes include rescissions in the FY 2000 DoD Appropriations Act, specifically section 8058 (-\$14,900) and section 8090 (-\$40,900). Other changes are a result of reprogrammings which require congressional prior approval, including CH-60 (+\$4,000), OSCAR (+\$9,615), LASM (+\$6,900), ESSM (-\$22,672), JTCTS (+\$6,000), Combat Systems Integration (+\$18,000), Ship Self Defense (+\$4,000), and various classified programs (+\$275,000). Other transfers into or out of the account resulted in changes (-\$4,484). Internal realignments for Counter Terrorism (+\$8,000) and Counterdrug Operations (+\$32,802) are also included.
3. Program Requirements (Reimbursable). There has been a net increase to the appropriation of \$62,229, as a result of changes in reimbursable program requirements.



Comparison of FY 1999 Program Requirements as reflected  
in the FY 2000 Budget with FY 1999 Program Requirements  
as shown in the FY 2001 Budget

Summary of Requirements (\$ in Thousands)

	<u>Total Program Requirements per FY 2000 Budget</u>	<u>Total Program Requirements per FY 2001 Budget</u>	<u>Increase (+) or Decrease (-)</u>
01 – Basic Research	361,499	354,017	-7,482
02 – Applied Research	566,801	550,569	-16,232
03 – Advanced Technology Development	593,176	569,903	-23,273
04 – Demonstration and Validation (DEMMVAL)	2,408,520	2,427,114	+18,594
05 – Engineering and Manufacturing Development (EMD)	2,199,737	2,134,903	- 64,,834
06 – RDTE Management Support	598,664	726,989	+128,325
07 – Operational Systems Development	1,932,412	2,178,675	+246,263
<b>Total Fiscal Year Program</b>	<b>8,660,809</b>	<b>8,942,170</b>	<b>+281,361</b>

Explanation by Budget Activity  
(\$ in Thousands)

01. Basic Research (-\$7,482) Changes to this budget activity resulted from a transfer to support the Small Business Innovative Research (SBIR) program (-\$5,782), rescissions reflected in the FY 2000 DoD Appropriation Act (-\$1,642) and other changes in program requirements which required minor reprogrammings (-\$58).
02. Applied Research (-\$16,232) Changes to this budget activity resulted from a transfer to support the Small Business Innovative Research (SBIR) program (-\$7,215). Other changes included rescissions reflected in the FY 00 DoD Appropriation Act (-\$2,581) and other changes in program requirements which required minor reprogrammings (-\$6,436).

03. Advanced Technology Development (-\$23,273) Changes to this budget activity resulted from a transfer to support the Small Business Innovative Research (SBIR) program (-\$8,363). These changes included rescissions reflected in the FY 2000 DoD Appropriation Act (-\$2,600), a transfer to Defense-wide R&D for USACOM Joint Experimentation (-\$15,900) other changes in program requirements which required minor reprogrammings (+\$3,590).
04. Demonstration and Validation (DE/MVAL) (+\$18,594) - Changes to this budget activity resulted from a transfer to support the Small Business Innovative Research (SBIR) program (-\$32,812), transfers to support the Counter Drug program (+\$24,802), change in program requirements (+\$7,461), FY 2000 DoD Appropriation Act rescissions (-\$14,946) and other changes in program requirements which required minor reprogrammings (+\$34,089).
05. Engineering and Manufacturing Development (EMD) (-\$64,834) Changes to this budget activity resulted from a transfer to support the Small Business Innovative Research (SBIR) program (-\$52,462), transfers to support the Smart Work/TOC initiatives (+\$1,554), an adjustment realigning COSSI funds from BA-5 to BA-7 (-\$15,208), OSCAR (+\$9,615), CH-60 reprogramming (+\$4,000), a FY 2000 DoD Appropriation Act rescissions (-\$10,162), and other changes in program requirements which required minor reprogrammings, budget activity realignments and accounting updates (-\$3,798).
06. RDTE Management Support (+\$128,325) - Changes to this budget activity resulted from a transfer to support the Small Business Innovative Research (SBIR) program (+\$121,893), a FY 2000 DoD Appropriation Act rescissions (-\$2,709), other changes in program requirements which required minor reprogrammings, budget activity realignments and accounting updates (+\$5,747) and a transfer for Federal Technology (+\$2,945).
07. Operational Systems Development (-\$246,263) - Changes to this budget activity resulted from a transfer to support the Small Business Innovative Research (SBIR) program (-\$23,153), an internal reprogramming into the classified programs (+\$275,000), the Counter-Terrorism Supplemental (+\$8,000) and JTCTS (+\$6,000). These changes also included rescissions reflected in the FY 2000 DoD Appropriations Act (-\$21,160), and other changes in program requirements which required minor reprogrammings, budget activity realignments and accounting updates (-\$1,576).

Comparison of FY 2000 Financing as reflected  
in FY 2000 Budget with 2000 Financing as  
Shown in the FY 2001 Budget

(\$ In Thousands)

	<u>Financing per FY 2000 Budget</u>	<u>Financing Per FY 2001 Budget</u>	<u>Increase (+) or Decrease (-)</u>
Program Requirements (Service Account)	7,984,016	9,056,644	+1,072,628
Program Requirements (Reimbursable)	150,000	198,500	+48,500
<b>Appropriation (Adjusted)</b>	<b>8,134,016</b>	<b>9,255,144</b>	<b>+1,121,128</b>

Explanation of Changes in Financing  
(\$ in Thousands)

The Fiscal Year 2000 program has changed since the presentation of the FY 2001 budget as noted below:

1. Program Requirements (Total). There has been a net increase to the appropriation (adjusted) of +\$1,072,628, result of changes in program requirements as noted below.
2. Program Requirements (Service Account). There has been a net increase to the appropriation (adjusted) of \$1,072,628, as a result of various changes. These changes included rescissions reflected in the FY 2000 DoD Appropriations Act (-\$46,821) and specific FY 2000 Congressional adjustments to start, continue, discontinue, reduce or earmark 205 specific initiatives (including transfers, which resulted in a net increase of \$1,126,310). Reprogramming actions which require congressional prior approval are also included, such as a transfer of funds for the USACOM Joint Experimentation program (+\$1,900), which is managed by the Navy as DoD executive agent, and a transfer to Defense-Wide Chemical/Biological (Chem/Bio) (-\$18,200). Internal reprogrammings actions impacting the FY 2000 program include Electronic Warfare Development (+\$10,000). Also, other changes in program requirements, phasing, or pricing resulted in transfers into or out of the account (-\$561).
3. Program Requirements (Reimbursable). There has been a net increase to the appropriation of +\$48,500, as a result of changes in reimbursable program requirements (+\$48,500).

Comparison of FY 2000 Program Requirements as reflected  
in the FY 2000 Budget with FY 2000 Program Requirements  
as shown in the FY 2001 Budget

Summary of Requirements (\$ in Thousands)

	Total Program		Total Program	Increase (+) or Decrease (-)
	Requirements per FY 2000 <u>Budget</u>	Requirements per FY 2001 <u>Budget</u>		
01 – Basic Research	376,748	374,301	-2,447	
02 – Applied Research	523,839	622,394	+98,555	
03 – Advanced Technology Development	519,523	753,631	+234,108	
04 – Demonstration and Validation (DEM/VAL)	2,086,062	2,366,852	+280,790	
05 – Engineering and Manufacturing Development (EMD)	1,953,882	2,301,795	+347,913	
06 – RDTE Management Support	646,489	641,017	-5,472	
07 – Operational Systems Development	1,877,473	1,996,654	+119,181	
<b>Total Fiscal Year Program</b>	<b>7,984,016</b>	<b>9,056,644</b>	<b>+1,072,628</b>	

Explanation by Budget Activity  
(\$ in Thousands)

01. Basic Research (-\$2,447) - Changes to this budget activity resulted from the rescissions found in the FY 2000 DoD Appropriations Act (-\$2,447).
02. Applied Research (+\$98,555) - These changes included specific FY 2000 Congressional adjustments to start, continue, discontinue, reduce or earmark 35 specific initiatives (including transfers) which resulted in a net increase (+\$102,010). Additionally, this change reflects rescissions found in the FY 2000 Appropriations Act (-\$3,455).

03. Advanced Technology Development (+\$234,108) - These changes included specific FY 2000 Congressional adjustments to start, continue, discontinue, reduce or earmark 14 specific resulting initiatives (including transfers), which resulted in a net increase (+\$235,400), as well as the rescissions reflected in the FY 2000 Appropriations Act (-\$4,194). Additionally, FY 2000 includes a transfer for the USACOM Joint Experiments program (+\$1,900) and other changes in program requirements which required minor reprogrammings (+\$1,002).
04. Demonstration and Validation (DEMVAL) (+\$280,790) - These changes included specific FY 2000 Congressional adjustments to start, continue, discontinue, reduce or earmark 49 specific initiatives (including transfers), which resulted in a net increase (+\$287,300) as well as the rescissions reflected in the FY 2000 Appropriations Act (-\$11,841). Additionally, FY 2000 includes changes in program requirements which required minor reprogrammings (+\$5,331).
05. Engineering and Manufacturing Development (EMD) (+\$347,913) - These changes included specific FY 2000 Congressional adjustments to start, continue, discontinue, reduce or earmark 40 specific initiatives (including transfers), which resulted in a net increase of (+\$367,139), as well as rescissions reflected in the FY 2000 Appropriations Act (-\$11,910). Additionally, changes in program requirements which required minor reprogrammings are reflected (-\$7,316).
06. Management Support (-\$5,472) - These changes included specific FY 2000 Congressional adjustments to start, continue, discontinue, reduce or earmark 13 specific initiatives (including transfers), which resulted in a net increase of (+\$24,300), as well as rescissions reflected in the FY 2000 Appropriations Act (-\$1,784). Other decreases included a transfer to Defense-wide Chem/Bio (-\$18,200) and changes in program requirements which required minor reprogrammings (-\$9,788).
07. Operational Systems Development (+\$119,181) - These changes included specific FY 2000 Congressional adjustments to start, continue, discontinue, reduce or earmark 28 specific resulting initiatives (including transfers), which resulted in a net increase (+\$131,200), as well as rescissions reflected in the FY 2000 Appropriations Act (-\$11,190). Additionally, changes in program requirements which required minor reprogrammings (-\$829).

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2000

PROGRAM ELEMENT: 0601152N  
 PROGRAM ELEMENT TITLE: In-House Laboratory Independent Research

BUDGET ACTIVITY: 1

(U) COST: (Dollars in Thousands)

PROJECT NUMBER & TITLE	FY 1999 ACTUAL	FY 2000 ESTIMATE	FY 2001 ESTIMATE	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	TO COMPLETE	TOTAL PROGRAM
Ocean Sciences	586	786	821	1,002	1,038	1,242	1,274	CONT.	CONT.
Advanced Materials	1,760	2,202	2,300	2,504	2,595	2,838	2,911	CONT.	CONT.
Information Sciences	1,173	1,886	2,301	2,672	3,115	3,550	3,640	CONT.	CONT.
Sustaining Programs	11,075	10,670	10,921	10,316	10,112	9,474	9,748	CONT.	CONT.
TOTAL	14,594	15,544	16,343	16,494	16,860	17,104	17,573	CONT.	CONT.

A. (U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: This program supports the missions of the Naval Warfare Centers, Naval Personnel Research and Development Center (NPRDC), and Bureau of Medicine and Surgery (BUMED) with high-risk/high-payoff research, responding as shown below to the Department of the Navy (DON) Integrated Warfare Architecture (IWAR) and enabling the technologies that could significantly improve Joint Chiefs of Staff's Future Joint Warfighting Capabilities. The research addresses fundamental questions regarding existing and anticipated naval systems, and is supported within the Office of Naval Research (ONR) by thrusts in Ocean Sciences, Advanced Materials, Information Sciences, and its Sustaining

R-1 Line Item 1

Budget Item Justification  
(Exhibit R-2, page 1 of 6)

# UNCLASSIFIED

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 1

PROGRAM ELEMENT: 0601152N

PROGRAM ELEMENT TITLE: In-House Laboratory Independent Research

Programs. This program reflects the integration of efforts both within Warfare Centers, NPRDC, BUMED, and among other research performers. Research efforts are proposed and selected by the Warfare Centers, NPRDC, and BUMED, and reviewed after the fact for the quality of science produced and for relevance to the naval mission.

(U) This program responds to the Littoral Warfare IWAR through ocean sciences research into the variability of the marine environment, such as acoustic shallow water (SW) models that incorporate wave-breaking sources, allowing superior signal processing in SW environments. Research advancing fundamental understanding of Department of the Navy (DON)-essential materials and processes responds to operational capability requirements in the Strategic Mobility IWAR, such as the recent development of an aluminum based, metal-matrix, high-temperature superconducting material that can be extruded into wires for significantly improved naval electrical power systems. The program responds to the Intelligence, Surveillance, Reconnaissance IWAR through thrusts in information sciences that address naval-relevant computing applications including software engineering, high performance computing, artificial intelligence, and the use of computers in manufacturing. For example, the development of an advanced signal processing technique for the analysis of real Anti-Submarine Warfare (ASW) broadband acoustic data provides detection performance, which exceeds the conventional energy detector in high noise ASW applications. Research in other areas supports requirements of the Readiness IWAR, such as discovering redox chemicals for use in "smart" coatings, which alter color when degraded and serve as early warning systems for corrosion of naval systems.

(U) Due to the sheer volume of efforts included in this program element, the programs described in the Accomplishments and Plans sections are representative selections of the work included in this program element.

(U) The DoN Science and Technology (S&T) program includes projects that focus on or have attributes that enhance the affordability of warfighting systems.

(U) JUSTIFICATION FOR BUDGET ACTIVITY: This program is funded under BASIC RESEARCH because it encompasses scientific study and experimentation directed towards increasing knowledge and understanding in broad fields directly related to long-term DoN needs.

(U) PROGRAM ACCOMPLISHMENTS AND PLANS:

R-1 Line Item 1

Budget Item Justification  
(Exhibit R-2, page 2 of 6)

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 1

PROGRAM ELEMENT: 0601152N

PROGRAM ELEMENT TITLE: In-House Laboratory Independent Research

1. (U) FY 1999 ACCOMPLISHMENTS:

- (U) Ocean Sciences responded to the Littoral Warfare IWAR by investigating physical mechanisms for deposition of high energy acoustic or seismic pulses on elastic objects deployed on or in the bottom of a shallow water ocean environment.
- (U) Advanced Materials responded to the Strike and Littoral Warfare IWARs by studying energetic materials using nanosize fuels and high heat of reaction intermetallic ingredients to enhance warhead performance; by synthesizing high performance, insensitive explosive ingredients (based on principles of molecular charge delocalization and graphitic-like crystal structures) for penetrator applications; by studying the dynamic shock wave properties of warhead materials to support the modeling and design of warheads; and by developing equations of state and reaction rate models for use in hydrodynamic code modeling of warheads.
- (U) Information Sciences statistical analyses reduce the complexities of signals and of the algorithms for signal processing to advance the capability for electronic warfare and electronic countermeasures in Strike and Intelligence, Surveillance, and Reconnaissance IWAR, with enhanced detection probability and diminished tracking time in cluttered environments and in the presence of false targets.
- (U) Sustaining Programs responded to the Strike and Command, Control, Communications, Computers and Information Warfare IWARs by investigating the three-dimensional effects of loss mechanisms in non-ideal, thin-film, integrated waveguide structures for opto-electronic applications, and will respond to the readiness IWAR with research focused on the medical areas of Aviation Medicine, Diving and Submarine Medicine, Toxicology, Human Performance, Infectious Disease, and Combat Casualty Care.

3. (U) FY 2000 PLAN:

- (U) Ocean Sciences will respond to the Littoral IWAR, to the Air and Sea Superiority IWAR and to the Strike IWAR by investigating acoustical propagation with application in mine countermeasures, underwater acoustic communications, and underwater target detection.

R-1 Line Item 1

Budget Item Justification  
(Exhibit R-2, page 3 of 6)

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 1

PROGRAM ELEMENT: 0601152N

PROGRAM ELEMENT TITLE: In-House Laboratory Independent Research

- (U) Advanced Materials will respond to: (1) The Readiness IWAR by investigating material corrosion reduction and coatings; (2) the Strike IWAR and the Sea and Air Superiority IWAR by investigating energetic materials; (3) the Strike IWAR, the Littoral IWAR, and the Strategic Sealift IWAR through research into new types of structural and electronic materials.
- (U) Information Sciences will respond to the Joint Surveillance IWAR, the Strike IWAR, the Littoral IWAR, the Sea and Air Superiority IWAR, and the Electronic Warfare (EW) IWAR through research into network controls and security, displays, and advanced methods in digital signal processing.
- (U) Sustaining Programs will respond to the EW IWAR through research into: (1) the electromagnetic response of materials, and (2) sensors. It will respond to the Strategic Mobility IWAR through research into ways to improve the protection of the assets by improved defensive warheads. It will respond to the readiness IWAR with medical research in the areas of Aviation Medicine, Diving and Submarine Medicine, Toxicology, Human Performance, Infectious Disease, and Combat Casualty Care.
- (U) Modify the current ILIR Project Selection Process to emphasize multi-year team projects in critical mission areas of each of the In-House Laboratories. These projects will allow ILIR claimants to attract and exploit new technical expertise from academia and industry and have a significant impact on Navy and Marine Corps needs.
- (U) Assign responsibility for oversight and management of the overall ILIR program to the ONR Chief Scientist, ensure Laboratory Commanding Officer and Technical Director personal involvement in project definition and selection to enhance project relevance and improve cost-effectiveness of execution.

#### 4. (U) FY 2001 PLAN:

- (U) Ocean Sciences will continue to respond to the Littoral IWAR, to the Air and Sea Superiority IWAR and to the Strike IWAR by investigating acoustical propagation with application in mine countermeasures, underwater acoustic communications, and underwater target detection.
- (U) Advanced Materials will continue to respond to: (1) The Readiness IWAR by investigating material corrosion reduction and coatings; (2) the Strike IWAR and the Sea and Air Superiority IWAR by investigating energetic

R-1 Line Item 1

Budget Item Justification  
(Exhibit R-2, page 4 of 6)

# UNCLASSIFIED

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 1

PROGRAM ELEMENT: 0601152N

PROGRAM ELEMENT TITLE: In-House Laboratory Independent Research

materials; (3) the Strike IWAR, the Littoral IWAR, and the Strategic Sealift IWAR through research into new types of structural and electronic materials.

- (U) Information Sciences will continue to respond to the Joint Surveillance IWAR, the Strike IWAR, the Littoral IWAR, the Sea and Air Superiority IWAR, and the Electronic Warfare (EW) IWAR through research into network controls and security, displays, and advanced methods in digital signal processing.
- (U) Sustaining Programs will continue to respond to the EW IWAR through research into: (1) the electromagnetic response of materials, and (2) sensors. It will respond to the Strategic Mobility IWAR through research into ways to improve the protection of the assets by improved defensive warheads. It will respond to the readiness IWAR with medical research in the areas of Aviation Medicine, Diving and Submarine Medicine, Toxicology, Human Performance, Infectious Disease, and Combat Casualty Care.
- (U) Ensure that ILIR projects continue to enable the Laboratories and Warfare Centers to enhance their ability to improve Joint Warfighting Capabilities and respond to IWARs through promotion of novel ideas, and attraction of leading researchers.
- (U) Complete the development of, and implement, a consistent process across all ILIR claimants whoich will provide top-down direction, assure relevance to Center mission areas, and provide an appropriate level of oversight of and visibility to senior Naval S&T leadership.
- (U) Relate ILIR projects to ONR Thrusts to ensure total consistency of Navy S&T program with long term needs, and improve collaboration among in-house (Laboratory, Center, and Naval Research Laboratory) and extramural performers.
- (U) Develop project selection criteria and performance metrics for each claimant that emphasize major impact, workforce refreshment, and collaboration.
- (U) Hold first Navy ILIR/Industry/Academia conference to enhance program connectivity and feedback, and stimulate additional collaboration.

B. (U) PROGRAM CHANGE SUMMARY:

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Budget Item Justification  
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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2000

BUDGET ACTIVITY: 1 PROGRAM ELEMENT: 0601152N  
PROGRAM ELEMENT TITLE: In-House Laboratory Independent Research

	FY 1999	FY 2000	FY 2001
(U) FY 2000 President's Budget:	14,663	15,630	16,421
(U) Appropriated Value:	0	15,630	0
(U) Adjustments from FY 2000 PRESBUFG:			
(U) Execution Adjustments	-2	0	0
(U) Inflation Adjustments	-67	0	0
(U) Various Rate Adjustments	0	0	-78
(U) Congressional Rescissions	0	-86	0
(U) FY 2001 PRESBUFG Submission:	W14,594	15,544	16,343

(U) CHANGE SUMMARY EXPLANATION:

(U) Funding: Not applicable.

(U) Schedule: Not applicable.

(U) Technical: Not applicable.

C. (U) OTHER PROGRAM FUNDING SUMMARY: Not applicable.

(U) RELATED RDT&E:

(U) PE 0601101A (In-House Laboratory Independent Research)

(U) PE 0601101F (In-House Laboratory Independent Research)

D. (U) SCHEDULE PROFILE: Not applicable.

R-1 Line Item 1

Budget Item Justification  
(Exhibit R-2, page 6 of 6)

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 1      PROGRAM ELEMENT: 0601153N  
 PROGRAM ELEMENT TITLE: Defense Research Sciences

(U) COST: (Dollars in Thousands)

PROJECT NUMBER & TITLE	FY 1999 ESTIMATE	FY 2000 ESTIMATE	FY 2001 ESTIMATE	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	TO COMPLETE	TOTAL PROGRAM
Ocean Sciences	136,266	144,028	148,731	151,252	154,318	157,738	161,430	CONT.	CONT.
Advanced Materials	58,882	62,875	70,333	66,648	68,647	71,050	73,537	CONT.	CONT.
Information Sciences	44,347	47,355	51,290	50,196	51,702	53,512	55,652	CONT.	CONT.
Sustaining Programs	99,928	104,499	110,785	108,655	109,722	110,608	111,485	CONT.	CONT.
TOTAL	339,423	358,757	381,139	376,751	384,389	392,908	402,104	CONT.	CONT.

A. (U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: This program sustains U.S. naval scientific and technological superiority, provides new concepts and technological options for the maintenance of naval power and national security, and provides the means to avoid scientific surprise, while exploiting scientific breakthroughs. The program responds to the science and technology (S&T) requirements from the Department of the Navy (DON) Integrated Warfare Architecture Requirements (IWARs) and enables the technologies that could significantly improve Joint Chiefs of Staff's Future Joint Warfighting Capabilities. It also seeks to exploit new science opportunities relevant to long term naval requirements. The Office of Naval Research (ONR) responds to requirements through major research thrusts in Ocean Sciences, Advanced Materials, Information Sciences, and the Sustaining Programs. These efforts are part of an integrated DON S&T process initiated in 1993.

R-1 Line Item 2

Budget Item Justification  
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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 1

PROGRAM ELEMENT: 0601153N

PROGRAM ELEMENT TITLE: Defense Research Sciences

(U) This program responds to the Power Projection IWAR through research leading to better structural materials to increase platform survivability; automated target recognition algorithms to improve identification of friend or foe (IFF), and to help improve real-time targeting under camouflage conditions; new concepts in batteries and propellants for improved torpedo performance; and physics and chemistry foundations for improved multispectral, all-weather sensors and electronics. Responses to the Sea Dominance IWAR involve knowledge of near-shore ocean and atmospheric circulation, remote sensing, acoustics, and optical transmission to improve mine detection and removal, special operations capabilities and submarine detection, and novel structural materials for better ship damage tolerance. This program responds to the Information Superiority and Sensors IWAR through research in: data fusion, which integrates environmental prediction products into information systems; advanced materials for improved sensors and electronics; better signal processing for automated target recognition allowing rapid ship self-defense and identifying relocatable targets; ocean and atmospheric properties, allowing sensors to operate more effectively under highly variable (battlespace) environmental conditions; and network and data studies to address real-time, all-weather surveillance and targeting, with short revisit times using multiple high capacity data links. Research into improved aerodynamic shapes for high endurance surveillance responds directly to a requirement of the Deterrence IWAR. Research in response to the Readiness and Infrastructure IWAR Pillars includes developing knowledge of acoustic/boundary interactions for improved navigation capabilities in poorly charted areas; exploring longer service life materials for reduced logistics; and investigating chemical and biological processes for clean handling of shipboard waste. Finally, cognitive research leading to more efficient and cost-effective training, to more user-compatible decision support systems, and to principles for the design of reconfigurable command and control structures responds to the Manpower & Personnel, Force Structure, and Training & Education IWAR Pillars.

(U) Program response to affordability requirements includes research on condition based maintenance, embedded training, manufacturing science, antifouling coatings, advanced materials and coatings, biosensors, and electro-optical and multifunctional electronic devices and concepts that promise to greatly simplify future undersea surveillance arrays and radar systems while reducing life cycle cost.

R-1 Line Item 2

Budget Item Justification  
(Exhibit R-2, page 2 of 8)

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 1

PROGRAM ELEMENT: 0601153N

PROGRAM ELEMENT TITLE: Defense Research Sciences

(U) Due to the sheer volume of efforts included in this program element, the programs described in the Accomplishments and Plans sections are representative selections of the work included in this program element.

(U) JUSTIFICATION FOR BUDGET ACTIVITY: This program is funded under Basic Research because it encompasses scientific study and experimentation directed toward increasing knowledge and understanding in broad fields directly related to long-term DON needs.

(U) PROGRAM ACCOMPLISHMENTS AND PLANS:

(U) FY 1999 ACCOMPLISHMENTS:

- (U) Ocean Sciences responded to Information Superiority and Sensors requirements through investigations of bioluminescence sensors and tactical decision aid software that provide risk-of-detection predictability of swimmers and SEAL delivery vehicles for inshore operations; and to Power Projection requirements with improved chirp sonar techniques and algorithms to analyze sea floor structure for use in rapid dock emplacement during amphibious operations. It also responded to Sea Dominance requirements through transition of a Lidar Model and transfer of data from the Worldwide Ocean Optics Database for improved oceanic weather prediction.
- (U) Advanced Materials responded to Air Dominance requirements through new understanding of low weight high strength composites with carbon nanotubes for conductive coatings with low signatures and to Information Superiority and Sensors requirements through advances in molecular electronics leading to distributed processing networks, real-time tactical information to warfighters, autonomous surveillance, and reconnaissance with low energy sensors.
- (U) Information Sciences responded to Sea Dominance requirements by applying basic studies in wavelet image processing to autonomous robot search and localization programs for improved mine countermeasures area coverage; to Readiness requirements by using deformable shape methods to develop 3-D shape models for biochemical tracking,

R-1 Line Item 2

Budget Item Justification  
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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 1

PROGRAM ELEMENT: 0601153N

PROGRAM ELEMENT TITLE: Defense Research Sciences

and anatomical structures in medical volume data for computer-assisted diagnosis and surgical planning; and to Infrastructure requirements by achieving ultra-high density random access memory for extremely robust and fast read/write operations to replace mechanical hard drive memories with instant-on high volume memories necessary for effective network-centric warfare.

- (U) Sustaining Programs responded to Power Projection requirements through investigations into silica-based composite aerogels for high performance battery and fuel cell electrodes, high surface area sensors for chemical/biological agent detection, and lightweight materials for selective optical absorption in stealth applications. They also responded to Sustainment requirements through work on new, nano-porous polymers for cheap, high-performance membranes for shipboard wastewater processing; to Readiness requirements by preparing and characterizing fluorinated oxetanes with promise for non-toxic, durable fouling release coatings; and to Information Superiority and Sensors requirements by investigations into stochastic resonance array detectors with potential for airborne magnetic detection of submarines in littoral areas.

(U) FY 2000 PLAN:

- (U) Ocean Sciences will respond to Power Projection requirements by developing more reliable coastal predictive models for battlespace environments, evaluating the linkages of small scale to large scale oceanic processes, and exploring environmentally adaptive systems for quantifying the role of the environment on ship systems in order to improve the probability of success of military operations conducted from coastal regions of the sea. It will also respond to Sea Dominance and Air Dominance requirements by exploring in-situ measurement and sonar adaptation to specific environments for significantly improved antisubmarine warfare (ASW) performance, automatic target recognition methods for ultra-low false alarm rate periscope detection radar, wake detection sensors, and theater-level data fusion for cooperative ASW.
- (U) Advanced Materials will respond to Sea Dominance requirements by developing low signature materials for autonomous robotic systems supporting Naval Special Warfare and Explosive Ordnance Disposal, and unique

R-1 Line Item 2

Budget Item Justification  
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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 1

PROGRAM ELEMENT: 0601153N

PROGRAM ELEMENT TITLE: Defense Research Sciences

biomaterials for improved infrared (IR)/acoustic sensors. It will respond to Information Superiority and Sensors requirements through advanced lithography, wide bandgap heterojunctions, and large area, wide bandgap materials for multifunctional wide bandwidth systems with high linearity, efficiency and power.

- (U) Information Sciences will respond to Information Superiority and Sensors requirements by seeking the theoretical basis for high-performance man-machine multi-mode multi-media interface semi-autonomous systems for decision aids, optimal management of dynamic tactical and computer networks, and methods for automated defensive information warfare. It will respond to Infrastructure requirements by research on virtual sensors and battery charger analyzers for improved maintenance, diagnostics and testing of naval machinery.
- (U) Sustaining Programs will respond to Sea Dominance requirements by exploring integrated ship propulsion concepts for higher hydrodynamic efficiency, prediction models of damaged ship motions/loads for damage control and improved maneuvering/seakeeping, and by developing active and passive signature control concepts with compatible shock reduction technology and reduced weight, volume and cost impact for submarines. They will respond to Power Projection requirements by exploring new concepts for torpedo silencing, and by designing high power thermal systems for half-length and supercavitating weapons propulsion.

(U) FY 2001 PLAN:

- (U) Ocean Sciences will respond to Information Superiority and Sensors requirements through validation studies and model development of sediment dynamics for on-scene characterization of the ocean bottom and improved minefield detection capabilities, as well as through studies on the use of millimeter wave radar for imaging and classification of moving targets and for communication intrusion and denial.
- (U) Advanced Materials will respond to Power Projection requirements through synthesis/characterization of insensitive difluoroaminated nitramine ingredients for propellant/explosives for increased performance/lethality. It will respond to Infrastructure requirements through studies of nanometer scale tribology, rejuvenation/

R-1 Line Item 2

Budget Item Justification  
(Exhibit R-2, page 5 of 8)

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 1

PROGRAM ELEMENT: 0601153N

PROGRAM ELEMENT TITLE: Defense Research Sciences

recycling damage and failure prediction, and miniaturized sensors/actuators for condition-based maintenance, damage control and mine countermeasures; and through multiple laser routes to new coatings for long-life engine materials and shafts.

- (U) Information Sciences will respond to Sustainment requirements by developing generic software to enable complex scheduling on a rapid basis, and to Manpower & Personnel requirements by developing computational models for matching command and control organizations to dynamic mission needs, human performance models for design and development of new ship systems, and models providing dynamic allocation of functions between humans and automated systems for an improved engineering/acquisition process.
- (U) Sustaining Programs will respond to Sustainment requirements through investigations of single walled carbon nanotubes for structural and electronic technologies, fluorinated oxetanes for tough, low surface energy fouling release surfaces, and superconducting wires for electric motors. Sustaining Programs will also respond to Information Superiority and Sensing requirements by investigating quantum effect devices and single-electron transistors for ultra-high functional density circuits from nanoelectric, nanomagnetic and nanooptic devices integrated into single and multi-chip configurations. They will respond to Power Projection requirements through exploration of bioluminescence mapping systems to protect covert operations, metal-ion biosensors for environmental/shipboard use, and biocatalysts for 'green' synthesis of explosives. They will respond to Training & Education requirements for better instruction and human learning from studies of scenario-based and case-based instruction; dynamic hybrid neural net and rule-based learning models for tactical decision-making, and synthetic team members and adversaries to improve outcomes in large-scale, simulation-based training.

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 1 PROGRAM ELEMENT: 0601153N  
PROGRAM ELEMENT TITLE: Defense Research Sciences

## B. (U) PROGRAM CHANGE SUMMARY:

	FY 1999	FY 2000	FY 2001
(U) FY 2000 President's Budget:	346,836	361,118	375,056
(U) Appropriated Value:		361,118	
(U) Congressional Rescissions:		-2,361	
(U) Various Rate Adjustments:			-6,821
(U) Program Adjustments:			13,000
(U) Minor Program Adjustments:			-96
(U) SBIR/STTR Transfers:	-5,782		
(U) Inflation Adjustments:	-1,575		
(U) Execution Adjustments:	-56		
(U) FY 2001 PRESEUDG Submission:	339,423	358,757	381,139

## (U) CHANGE SUMMARY EXPLANATION:

(U) Schedule: Not applicable.  
(U) Technical: Not applicable.

## C. (U) OTHER PROGRAM FUNDING SUMMARY: Not applicable.

(U) RELATED RDT&E:

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 1

PROGRAM ELEMENT: 0601153N  
PROGRAM ELEMENT TITLE: Defense Research Sciences

(U) PE 0601102A Defense Research Sciences (Army)  
(U) PE 0601102F Defense Research Sciences (Air Force)

Activities are coordinated through Defense S&T 6.1 Reliance Scientific Planning Groups.

D. (U) SCHEDULE PROFILE: Not applicable.

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Budget Item Justification  
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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET      DATE: February 2000

BUDGET ACTIVITY: 2      PROGRAM ELEMENT: 0602111N  
 PROGRAM ELEMENT TITLE: Air and Surface Launched Weapons Technology

COST: (Dollars in Thousands)

PROJECT NUMBER & TITLE	FY 1999 ESTIMATE	FY 2000 ESTIMATE	FY 2001 ESTIMATE	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	TO COMPLETE	TOTAL PROGRAM
Air & Surface Launched Weapons Technology	37,624	51,331	37,966	38,706	37,297	36,568	36,194	E CONT.	E CONT.

A. (U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: This program element (P.E.) develops new and innovative technologies which will support future weapons systems for surface and air platforms for Naval Warfare.

(U) The Air and Surface Weapons Technology (ASWT) program has been developed to implement a structured weapons technology program that will maintain the Naval air and surface weapons capability through the 21st century. The ASWT program provides technology traceability by identifying System payoffs and warfighter benefits and the quantitative goals that will provide those payoffs/benefits. Objectives, technical challenges, and approaches that will meet the goals are then identified for each of the four mission areas. The following paragraphs describe the time phased technology goals for each of the four mission areas.

(U) Air Superiority: The projects within the ASWT Air Superiority mission area are focused on the achievement of time-phased technology goals for the 2005, 2010, and 2015 time frame, which will reproduce a number of technology options for future air superiority weapons, significantly increase pilot survivability by allowing them to look first, shoot first, and kill first, while increasing air superiority weapon affordability. The 2005, 2010, and 2015 technology goals, which have been coordinated with N88, are to increase missile flyout range 25%, 50%, and 100%; increase missile average

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Budget Item Justification  
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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602111N

PROGRAM ELEMENT TITLE: Air and Surface Launched Weapons Technology

velocity 10%, 20%, and 30%; increase missile maneuverability 45%, 65%, and 85%; increase weapon launch angle 20%, 40%, and 60%, increase missile seeker acquisition range 100%, 250%, and 300%; increase seeker off boresight angle 135 degrees and 180 degrees; increase seeker probability of detect 10%, 20%, and 30%; decrease missile payload size 20%, 30% and 50%; and increase warhead control accuracy to centroid, image centroid, and edge detect. All improvements are relative to the AIM-9x and AIM-120C system. Work being performed under the Integrated High Payoff Rocket Propulsion Technology (IHRPT) is supporting the achievement of the flyout range, average velocity, maneuverability, and weapon launch angle goals. As with the IHRPT program, the ASWT program is an integrated Navy/industry program, comprised of government funded and industry funded projects. For FY 99 through FY04, the emphasis will be on the achievement of the Phase 1 goals. The technologies developed under this task will be transitioned to the Phase 1 air superiority demonstrator, which is funded under P.E. 0603217N, R0447. After successful demonstration, these technologies are available for air superiority or ship-based defense weapon system demonstration/validation or Engineering and Manufacturing Development (EMD).

(U) Naval Fire Support: The projects within the ASWT Naval Fire Support mission area are focused on the achievement of time-phased technology goals for the 2005, 2010, and 2015 time frame. The achievement of these goals will produce a number of technology options for future naval fire support weaponry, significantly improving the probability of kill per round as well as the amount of sustained call fire while increasing the affordability of future naval fire weapon systems. The 2005, 2010, and 2015 goals, which have been coordinated with N86, are increase gun launched projectile flyout range to 70 nmi, 150 nmi, and 200 nmi; increased missile flyout range to 150 nmi, 250 nmi, and 350 nmi; achieve gun projectile flyout times for the range goals of 6 minutes or less, 14 minutes, and 10 minutes or less; achieve missile flyout times for the range goals of 5 minutes, 4 minutes, and 4 minutes; increase target aimpoint accuracy to 10m, 1m, and 1m for moving targets; increase payload density to 15%, 30%, and 45%; decrease rounds per kill to 3, 1.2(stationary target), and 1.2 (hard target); and develop improved warheads that can: deliver a variety of submunitions, operate in a dual or multifunction mode and, utilize high energy reactive materials for greater effectiveness. All these goals are relative to 1995 state-of-the-art. The projectile range and time of flight goals are being supported in part by the IHRPT program. The emphasis of the FY99-FY04 program will be on the achievement of the Phase 1 (2005) goals. Technologies developed to support this phase will be transitioned to the phase 1 Land Attack

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602111N

PROGRAM ELEMENT TITLE: Air and Surface Launched Weapons Technology

demonstrator, funded by P.E. 0603217N, R0447. Upon successful demonstration, these technologies are available for Naval Fire Support or Land Attack weapon system demonstration/validation or EMD. As with the IHRPT program, the ASWT program in an integrated Navy/industry program with tasks being funded and performed by government and industry.

(U) Precision Strike: The ASWT Precision Strike program is focused on the achievement of time-phased technology goals for the 2005, 2010, and 2015 time frame. The achievement of these goals will produce technology options to allow the warfighter to successfully engage time critical targets, improve weapon and platform survivability, significantly increase weapon hard target capability, and significantly increase single shot probability of kill while increasing the affordability of future precision strike weapon systems. The 2005, 2010, and 2015 goals, which have been coordinated with N88, are to decrease target location error to 8m, 1m, and 1m; increase target/weapon pairing rate to 20/hr, 100/hr, and 500/hr; decrease mission planning and optimization time to less than 5 minutes, then to less than 1 minute; increase weapon based Automatic Target Recognition (ATR) capability to greater than 90% acquisition in limited clutter, greater than 90% acquisition in moderate clutter, and greater than 60% acquisition in heavy clutter; increase average weapon velocity to M4, M6, and M8; increase weapon flyout range 30%, 50%, and 100%; increase hard target penetration by 5x and 7x; and increase seeker Global Positioning System (GPS) antijam capability to +10db, +20db, and +30db. All goals are relative to 1995 state of the art. The weapon velocity and range goals are partially supported by the projects within the IHRPT program. The emphasis of the FY99-FY04 projects are to achieve the Phase 1 goals. The technologies developed by the funded projects will be transitioned to the Land Attack demonstrator, funded by P.E. 0603217N, R0447. Upon successful demonstration, these technologies will be available for Precision Strike or Land Attack weapon system demonstration/validation or EMD. As with IHRPT, the ASWT program is an integrated Navy/industry program with work being funded and performed by the government and industry.

(U) Ship Based Defense: The ASWT Ship-Based Defense program is focused on the achievement of time-phased technology goals for the 2005, 2010, and 2015 time frame. The achievement of these goals will produce technology options to significantly increase the effectiveness and affordability of future ship-based defense weapon systems. The 2005, 2010, 2015 goals, which have been coordinated with N86, are to increase the number of engagements per threat to 2-3, 6-7, and 6-7; increase

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Budget Item Justification  
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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602111IN

PROGRAM ELEMENT TITLE: Air and Surface Launched Weapons Technology

the available command decision time to 15 sec, and 15 seconds in adverse conditions; increase the probability of catastrophic kill per intercept to 0.6, 0.8, and 0.95; increase the total number of targets simultaneously engagable to 2-4, 4-6, and 6-8; and increase maneuver counter capability to 15gs, 30gs, and 50gs. All goals are relative to 1995 state of the art. The emphasis of the FY99-FY04 projects are on the Phase 1 goals. The technologies developed to achieve these goals will be transitioned to a ship-based defense technology demonstrator, funded by P.E. 0603127N, R0447. Upon successful demonstration, these technologies will be available for Ship-Based Defense or Air Superiority demonstration/validation or EMD. The ASWT program is an integrated Navy/industry program with projects being funded and performed by government and industry.

(U) Integrated High Payoff Rocket Propulsion Technology (IHRPRT): The projects within the IHRPRT program are focused on the achievement of time-phased technology goals for the 2000, 2005, and 2010 time frame, which will produce a number of rocket propulsion technology options to significantly increase the effectiveness of air superiority, naval fire support, and precision strike weapon systems by increasing missile range 50%; increasing missile speed 20%, which results in shorter time to target, increased opportunity for shoot-look-shoot, allowing earlier disengagement of launch platforms, and allowing greater energy for maneuvering; increasing missile payload by 100%, decreasing propulsion size and weight by 25%, and doubling the missile no-escape zone and launch acceptability regions. The 2000, 2005, and 2010 goals, which have been coordinated with N86 and N88, and endorsed by Deputy Director Research and Engineering (DDR&E), are to improve the propulsion system delivered energy by 3%, 7% and 15%; improving motor mass fraction (without thrust vector control (TVC)/throttling) 2%, 5%, 10%; and improving motor mass fraction (with TVC/throttling) 10%, 20%, and 30%. IHRPRT is an integrated Department of Defense (DoD)/National Aeronautics and Space Administration (NASA)/Industry program with projects being funded and performed by government and industry.

(U) Due to the sheer volume of efforts involved in this P.E., the efforts described in the accomplishments and plans section are representative selections of the work included in this P.E..

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET      DATE: February 2000

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602111N

PROGRAM ELEMENT TITLE: Air and Surface Launched Weapons Technology

(U) These efforts support the Joint Warfare Strategy "Forward...from the Sea". Programs in this P.E. are jointly planned in the Defense Reliance process with the Air Force and Army.

(U) JUSTIFICATION FOR BUDGET ACTIVITY: This program is budgeted within the APPLIED RESEARCH Budget Activity because it investigates technological advances with possible applications toward solution of specific naval problems, short of a major development effort.

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Budget Item Justification  
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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602111N

PROGRAM ELEMENT TITLE: Air and Surface Launched Weapons Technology

## PROGRAM ACCOMPLISHMENTS AND PLANS:

### 1. FY 1999 ACCOMPLISHMENTS:

- (U) SHIP BASED DEFENSE IN SUPPORT OF SURFACE BATTLESPACE: The efforts in Ship Based Defense will develop weapons technologies to achieve minimum and maximum intercept ranges of 100 meters to 3 nmi, to reduce reaction time to 10 seconds, and to increase the probability of robust kills from 0.3 to 0.6.
  - (U) Demonstrated the terminal accuracy of a 60mm projectile attainable with low cost strapdown W-band seeker in a track-via-projectile mode.
  - (U) Conducted preliminary concept design studies for Ram Accelerator high-pressure gas management. Performed computational fluid dynamic modeling of in-bore high-pressure combustion processes. Provided documentation of results of experimental and computational high-pressure investigations.
- (U) AIR SUPERIORITY:
  - Demonstrated Radio Frequency (RF) Guidance Integrated Fuse (GIF) algorithms to provide real time estimates of warhead firing commands under a range of high-speed air-to-air encounters.
  - (U) Quantified technology objectives and parameter matrix for clutter rejection in Infrared (IR) terminal seeker performance task.
  - (U) Investigated aimable ordnance to increase missile lethality equal to or less than 80% of the current weight/volume of Advance Medium Range Air to Air Missile (AMRAAM) warhead.
- (U) Integrated High Payoff Rocket Propulsion Technology (IHRPRT):
  - (U) Tested materials for low-erosion nozzle task complete. The results will be analyzed and documented.
  - (U) Fabricated candidate nozzles for a Phase I improved delivered energy and improved mass fraction goals.

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Budget Item Justification  
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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602111N

PROGRAM ELEMENT TITLE: Air and Surface Launched Weapons Technology

- (U) Validated slow cook-off engineering model. Completed slow cook-off technology task.
  - (U) STRIKE AND Anti Surface Warfare (ASUW) WEAPONRY:
    - (U) Demonstrated portable Laser Radar (Ladar) performance model to identify optimum performance against mobile targets.
    - (U) Developed automatic target acquisition algorithms for standoff weapon seekers utilizing linear fracture correlation techniques.
  - (U) Naval Fire Support (NFS):
    - (U) Performed Image Video Analysis for near real time integrated detection, tracking, and location of targets with image. Completed fabrication of demo hardware and began software modifications for rehost on the weapon host computer.
    - (U) Developed Hyperspectral decoy recognition technologies for use by air platforms such as Unmanned Air Vehicle (UAVs). Performed field measurements against decoys and targets from aircraft.
    - (U) Investigated Inteferometric Synthetic aperture Radar (IFSAR) technologies to reduce the cost per kill through improved aimpoint accuracy and supporting mission planning and Bomb Damage Analysis (BDA). Test using L-band and X-band IFSAR in aircraft.
3. FY 2000 Plan:
- (U) SHIP BASED DEFENSE IN SUPPORT OF SURFACE BATTLESPACE:
    - (U) Initiate:
      - (U) Weaponization assessment for variable lethality weapon systems for ship defense to address asymmetrical threats.

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Budget Item Justification  
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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602111N

PROGRAM ELEMENT TITLE: Air and Surface Launched Weapons Technology

- (U) Investigation of technologies designed to reduce command decision time in littoral environments.
- (U) Continue:
- (U) Lethality assessment for solid state High Energy Laser (HEL) self defense-investigate aerokill and critical component kill.
- (U) Conformal seeker technology development. Complete design of conformal seeker breadboard.
- (U) Low altitude Target Detection Device (TDD) technology development. Perform critical technology definition of laser, high bandwidth receiver and electronics, optics and detectors.
- (U) Integration of the digital receiver, aperture, and processor for the Wideband Seeker.
- (U) Complete:
- (U) Evaluation and testing of IR clutter suppression techniques. Documentation of results. Potential transitions to Thermal Imagery Sensor System (TISS), or MK56 Electro Optic sight, SM-2, Blk IV B.
- (U) Evaluation of low altitude propagation sensing techniques applied to sensor real-time adaptation. Incorporate into P.E. 0603217N technology demonstration.
- (U) Surface launched, high-speed propulsion investigations
- (U) AIR SUPERIORITY:
  - (U) Initiate:
  - (U) Air platform internal carriage environment weapon sensitivity study.
  - (U) Systems investigation of medium to long range target acquisition and track capabilities in conjunction with projected missile kinematic improvements.
  - (U) Investigation of technical issues relating to cooperative engagement/network centric warfare.
  - (U) Investigation of the feasibility of the variable warhead output (beam spray and frag size). Identification of the missile integration requirements to implement roll to aim.
  - (U) Continue:

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 06021111N

PROGRAM ELEMENT TITLE: Air and Surface Launched Weapons Technology

- (U) Seeker counter-counter measure (CCM) technology and IR seeker performance algorithm development based on wavelet transforms.
- (U) Precision intercept task that evaluates functional allocation of lethality factors among the warhead fragments, timing, and missile kinematic subsystems.
- (U) Development of functioning transmitter/receiver hardware for the Surface Wave Antenna Guidance (SWAG) based seeker.
- (U) Analysis of the use of advanced weapons against a specific set of enemy air targets.
- (U) Development of range and range rate target state algorithms for the Precision Intercept technology.
- (U) Complete:
- (U) Investigation of aimable ordnance to increase missile lethality equal to or less than 80% of the current weight/volume of AMRAAM warhead. Prioritize recommendations among the fireset, reactive materials and explosive kills provided.
- (U) Laboratory demonstrations of laser counter measure (CM) technique.
- (U) IHPRPT:
  - (U) Initiate:
    - (U) Propellant formulation tasks to identify and evaluate propellant ingredients to meet Phase III IHPRPT delivered energy and mass fraction goals.
    - (U) Surface launched propulsion task to develop innovation case, insulation, and liner technologies to meet Phase II IHPRPT mass fraction goals.
  - (U) Continue:
    - (U) Conduct full-scale, "hot" testing of on-command pintle Thrust Vector Control (TVC) components.
  - (U) Complete:
    - (U) Complete "hot" testing of full-scale dual movable nozzle, demonstrating Phase I IHPRPT mass fraction goals.

R-1 Line Item 3

Budget Item Justification  
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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602111N

PROGRAM ELEMENT TITLE: Air and Surface Launched Weapons Technology

- (U) Complete ballistic and mechanical evaluation testing on dual plateau propellants, achieving Phase I delivered energy and mass fraction goals
- (U) Conduct full scale firing of gun-launch rocket, using "optimal" grain and case design, which completes the gun-launched rocket task by demonstrating Phase II IHRPT goals
- (U) Complete ballistic characterization testing of aluminum hydride propellants, showing possible achievement of Phase II IHRPT delivered energy goal.
- (U) Complete ballistic characterization testing of ammonium dinitramide (ADN) propellants, showing possible achievement of Phase II IHRPT delivered energy goal.
- (U) STRIKE AND ASUW WEAPONRY:
  - (U) Initiate:
    - (U) Precision auto weaponizing task that generates a desired meanpoint of impact (DMPI) in support of the achievement of Air and Surface Weapons Technology (ASWT) fire control accuracy goal of <3m Circular Error Probability (CEP), meeting Phase I ASWT goals.
    - (U) Develop investment strategy for autonomous system weapon control capability.
  - (U) Continue:
    - (U) Tuned Automatic Target Recognition (ATR) extraction and registered data base
    - (U) Fuzzy ATR characterization to develop seeker (ATR) algorithms.
    - (U) Assessment of low cost seeker components in the millimeter wave (MMW) spectral region.
    - (U) Counterflow thrust vectoring control (TVC) task to increase mass fraction performance.
    - (U) ATR performance prediction task for imaging seeker-based ATR systems.
    - (U) Development of a low cost MMW antenna element using micro electronic machine systems (MEMS) technology using MMW radar.
    - (U) Investigation of advanced wavelet-based signal processing techniques to reject global positioning system (GPS) jammers.

R-1 Line Item 3

Budget Item Justification  
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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602111N

PROGRAM ELEMENT TITLE: Air and Surface Launched Weapons Technology

- (U) Investigation into the design of an autonomous attack and weaponizing capability for Uninhabited Combat Air Vehicles (UCAV)
- (U) Investigation and development of autonomous mission planning package for UCAV applications. Mission planning capability to include path planning, obstacle avoidance, and resource allocation.
- (U) Precision Target Handoff and Advanced Data Assimilation for precision targeting tasks. These tasks are developing technology tasks to support the ASWT goals of 10m fire control accuracy and a 20/hr target/weapon pairing rate.
- (U) Configurable ATR system and ATR performance prediction tasks supporting the weapons based ATR and Rapid planning ASWT goals.
- (U) GPS Anti-jam and MEMS aperture tasks addressing the robust CEP and target detection goals
- (U) Develop airframe and modular data link and seeker components for affordable weapon project. Complete:
- (U) Demonstration of Suppression of Energy Air Defenses (SEAD) fuze discrimination techniques for masted targets in clutter.
- (U) Evaluation of laser radar image processing algorithms based on fuzzy logic and variational principal processing techniques supporting ATR of relocatable targets.
- (U) Assessment of supersonic lifting body airframe technology with emphasis on high-speed propulsion/airframe integration issues.
- (U) NFS:
  - (U) Initiate:
  - (U) Marine Corps responsive volume fire weapon system study.
  - (U) Development of tunable explosives for controlled lethality effects.
  - (U) Continue:
  - (U) Investigation of weapon control and target sensing techniques comparable with mission responsive ordnance concept. Complete direct capability analysis in selected weapons.

R-1 Line Item 3

Budget Item Justification  
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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET      DATE: February 2000

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602111N

PROGRAM ELEMENT TITLE: Air and Surface Launched Weapons Technology

- (U) Finalize algorithm and packaging design of seeker for the Electro Optic/Infrared (EO/IR) gun launched seeker to improve terminal guidance of projectiles.
  - (U) Weapons modeling and simulation to provide tools for design of NFS systems include Computational Fluid Dynamics (CFD) for vertical launchers and aero-prediction codes.
  - (U) Complete missile warhead feasibility analysis for the Mission Responsive Ordnance (MRO) technology task. Continue MRO effort to improve warhead capabilities.
  - (U) Investigate Image Video Analysis for near real time integrated ability to detect, track, classify, and precisely locate targets with image and video to increase targeting accuracy and provide a reduced response time for targeting.
  - (U) IFSAR to demonstrate and validate techniques for processing multi-path IFSAR into Digital Elevation Maps (DEMS) with techniques to control DEMS to GPS. These efforts will attempt to reduce the cost per kill through improved aimpoint accuracy as well as supporting mission planning and BDA. Evaluate optical computing for real time performance.
  - (U) Precision targeting with GPS/Inertial Measurement Unit (IMU) for precise attitude. Demonstrate sub-milliradian attitude measurement accuracy.
  - (U) Complete:
  - (U) Hyperspectral seeker tasks supporting target detection and location by air platforms
4. FY 2001 Plan:
- (U) SHIP BASED DEFENSE IN SUPPORT OF SURFACE BATTLESPACE:
    - (U) Initiate:
    - (U) Preliminary investigation into solid state laser technology ship self defense weapons.
    - (U) Continue:
    - (U) Variable lethality weapon technology assessment against asymmetric threats. Preliminary design of lethality engineering model.

R-1 Line Item 3

Budget Item Justification  
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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602111N

PROGRAM ELEMENT TITLE: Air and Surface Launched Weapons Technology

-- (U) Development of decision aid and sensor technologies designed to increase the time available to the commander to evaluate and make the decisions necessary to engage the threat in littoral environments.

- (U) Complete:

-- (U) Conformal seeker technology development through breadboard demonstration.

-- (U) Development of the demonstration system for the Miniature IDD.

• (U) AIR SUPERIORITY:

- (U) Initiate:

-- (U) Development of multi-spectral sensor fusion GIF algorithms to control the trajectory and output for precision intercept control.

-- (U) Comparative analysis of nanoaluminum for use as a high energy density explosive. Selection of fuel oxidizer combinations and associated reactivity.

- (U) Continue:

-- (U) Propulsion airframe guidance and control and ordnance tasks to achieve the ASWT air superiority phase I goals.

-- (U) Precision intercept task that will be demonstrated by FY05 to decrease payload size by 20%.

-- Document via simulation the missile dynamics required to align aimed ordnance kill axis to target aimpoint.

-- (U) Seeker CCM technology task. Prioritize recommendations for feasibility demonstrations of IR seeker rejection of spectrally tuned decoy technology.

-- (U) Variable warhead output tests for the integrated aimed warhead. Optimize best techniques for variable warhead maximum output.

- (U) Complete:

-- (U) IR seeker performance assessment of multidimensional filter and moving target indication cueing for effectiveness of point target acquisition in the presence of ground clutter.

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602111N

PROGRAM ELEMENT TITLE: Air and Surface Launched Weapons Technology

- (U) IHRPRT:
  - (U) Initiate:
    - (U) High-performance tactical propellant development task, which will conduct ballistic, mechanical property, and processing evaluation of the promising Phase II propellant task which were completed in FY00.
    - (U) Initiate Phase III propellant ingredient formulation task to identify promising propellant ingredients to meet IHRPRT Phase III delivered energy goal.
    - (U) Initiate case insulation and high temperature resin technology task, which will identify and characterize these subsystems, contributing to the achievement of Phase II and Phase III IHRPRT mass fraction and delivered energy goals.
    - (U) Initiate advanced tactical nozzle technology task, which will characterize materials and develop optimal design methodologies, contributing to the achievement of Phase II and Phase III IHRPRT mass fraction and delivered energy goals.
  - (U) Continue:
    - (U) Development of test matrix and conduct initial ballistic screening testing of possible Phase III IHRPRT propellant ingredients.
    - (U) Subscale case and insulation testing and begin design methodology characterization for surface launched propulsion task.
  - (U) Complete:
    - (U) Full scale "hot" testing of on-command pintle nozzle concept, completing this task. This will contribute to the achievement of the Phase II improved mass fraction goal.
- (U) STRIKE AND ASUW WEAPONRY:
  - (U) Initiate:

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BUDGET ACTIVITY: 2

FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

PROGRAM ELEMENT: 0602111N

PROGRAM ELEMENT TITLE: Air and Surface Launched Weapons Technology

- (U) Development of ATR and fire control techniques for UCAV "single pass, multiple target engagement.
- (U) Continue:
- (U) Precision target handoff and precision auto-weaponeering tasks
- (U) Configurable ATR system investigation to assess performance and predictability of ATR systems.
- (U) Investigation of supervised and automated UCAV weapon control and both adaptive and cooperative swarm techniques.
- (U) Complete:
- (U) Advanced Data Assimilation for Precision Targeting task. This task supports the strike fire control and target/weapon pairing rate goals.
- (U) ATR performance prediction task.
- (U) GPS anti-jam and MEMS aperture tasks.
- (U) Supersonic lifting body airframe effort.

- (U) NFS:

- (U) Initiate:
  - (U) Reactive warhead, barrage projectile, target deconfliction, urban precision targeting, High Energy Density Materials (HEDM) weaponization,
- (U) Continue:
  - (U) NFS tunable explosive formulation and development
  - (U) Surface target lethality assessment.
  - (U) Complete joint testing with Direct Attack Munition Affordable Seeker (DAMASK) and evaluation of template and algorithms for the ongoing EO/IR gun launched seeker effort.
  - (U) Weapons modeling and simulation to provide tools for design of NFS systems include CFD for vertical launchers and aeroprediction codes.

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602111N

PROGRAM ELEMENT TITLE: Air and Surface Launched Weapons Technology

- (U) Finish Controlled Reference Image Base (CRIB) development from aircraft measurements and comparison to ground truth for Image Video Analysis task. Continue other Video Analysis efforts to provide real time target detection location and tracking for fire support missions.
- (U) Develop the technology for processing multipath IFSAR into DEMS and the techniques to accurately align DEMS and GPS.
- (U) Precision targeting with GPS/IMU. Demonstrate 100  $\mu$ radian attitude error using Kalman filter GPS, IMU, and kinematic alignment algorithms.
- (U) Complete:
- (U) Mission responsive warhead technology development for gun-launched projectiles. Technology ready for transition to ASWT 6.3 Land Attack Demonstration.

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Budget Item Justification  
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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2000

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602111N

PROGRAM ELEMENT TITLE: Air and Surface Launched Weapons Technology

## B. (U) PROGRAM CHANGE SUMMARY

	FY 1999	FY 2000	FY 2001
FY 2000 President's Budget:	40,823	37,616	39,572
Appropriated Value:	-	51,616	-
Adjustments from FY 2000 PRESBUDG			
SBIR/STTR Transfer:	-423	0	0
Execution Adjustment	-2,560	0	0
Federal Tech Transfer Adjustment	-32	0	0
Inflation Rate Adjustment	-186	0	0
Program Adjustments	0	0	-1,649
Mil/Civ Pay Rates	0	0	43
Congressional Rescissions	0	-285	0
Congressional Adds:	0	0	0
Phased Array Radar	0	10,000	0
Pulse Detonation Engine	0	4,000	0
FY 2001 President's Budget:	37,624	51,331	37,966

(U) CHANGE SUMMARY EXPLANATION:

(U) Schedule: Not applicable.

(U) Technical: Not applicable.

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Budget Item Justification  
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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET      DATE: February 2000

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602111IN

PROGRAM ELEMENT TITLE: Air and Surface Launched Weapons Technology

C. (U) OTHER PROGRAM FUNDING SUMMARY: Not Applicable  
(U) RELATED RDT&E: This P.E. adheres to Defense S&T Reliance agreements with oversight provided by the JDL.

- (U) PE 0601153N (Defense Research Sciences)
- (U) PE 0602203F (Aerospace Propulsion)
- (U) PE 0602232N (Communications, Command and Control, Intelligence, Surveillance & Reconnaissance)
- (U) PE 0602234N (Materials, Electronics and Computer Technology)
- (U) PE 0602302F (Rocket Propulsion and Astronautics Technology)
- (U) PE 0602303A (Missile Technology)
- (U) PE 0602601F (Advanced Weapons)
- (U) PE 0602602F (Conventional Munitions)
- (U) PE 0602618A (Ballistics Technology)
- (U) PE 0602624A (Weapons and Munitions Technology)
- (U) PE 0603004A (Weapons and Munitions Advanced Technology)
- (U) PE 0603609N (Conventional Munitions)
- (U) PE 0603216F (Aerospace Propulsion and Power Technology)
- (U) PE 0603640M (Marine Corps Advanced Technology Demonstration)
- (U) PE 0603790D (NATO Research and Development)
- (U) This is in accordance with the ongoing Reliance joint planning processes.

(U) SCHEDULE PROFILE: Not applicable.

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2000

PROGRAM ELEMENT: 0602121N  
 PROGRAM ELEMENT TITLE: Ship, Submarine & Logistics Technology

UDGET ACTIVITY: 2

OST: (Dollars in Thousands)

PROJECT NUMBER & TITLE	FY 1999 ESTIMATE	FY 2000 ESTIMATE	FY 2001 ESTIMATE	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	TO COMPLETE	TOTAL PROGRAM
Ship, Submarine & Logistics Technology	52,926	61,445	44,563	45,734	43,149	42,911	42,382	CONT.	CONT.

**MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION:** This program element (PE) provides for surface ship, submarine, logistics, and environmental quality applied research that contributes to meeting joint warfare capabilities established by the Joint Chiefs of Staff; namely to promptly engage regional forces in decisive combat on a global level, to employ a range of capabilities more suitable to actions at the lower end of the full range of military operations which allow achievement of military objectives with minimum casualties and collateral damage, and to counter the threat of weapons of mass destruction and future ballistic and cruise missiles to the United States and deployed forces.

This PE develops affordable hull, mechanical, and electrical (HM&E) technology options for both surface ships and submarines. here are four technology thrusts for both surface ships and submarines: Signature Control, Structural Systems, Power and automation, and Maneuvering and Seakeeping. They address electromagnetic and acoustic signature reduction, structural and weapon related survivability improvement, electrical and mechanical system efficiency, damage control, hydrodynamics, and alternative propulsion.

Logistics technologies increase operational readiness through effective management and movement of supplies ashore and at-sea, and advanced techniques for more cost-effective construction and maintenance of shore and offshore facilities. Technology development in these areas responds to a variety of requirements, including: the logistic support needed for amphibious

R-1 Line Item 4

Budget Item Justification  
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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602121N

PROGRAM ELEMENT TITLE: Ship, Submarine & Logistics Technology

anding, the diagnostic technologies that enable the implementation of a condition-based vs. time-based maintenance philosophy, and long distance logistics supply chains with short reaction time.

nvironmental quality technologies enable sustained world-wide Navy operations, in compliance with all national and international laws, regulations and agreements. Technology development in this area supports the Chief of Naval Operations (CNO) prioritized Navy user and Science and Technology (S&T) requirements and leads to systems and processes that provide the fleet with environmentally compliant forward presence, ashore and afloat. Specifically, this area supports requirements to minimize the curtailment of military operations due to ship, shore and aircraft compliance with international regulations; and to sustain Naval forces anywhere in a timely and environmentally compliant manner.

n addition, affordability for reduced acquisition and life-cycle costs is pursued within all technology thrusts. Concepts that reduce the cost of design, fabrication, outfitting, maintenance, and operation are being developed. This HM&E technology plans various Joint Mission Areas and supports the Joint Warfare Strategy "Forward ...From the Sea."

ue to the sheer volume of efforts included in this program element, the programs described in the Accomplishments and Plans sections are representative selections of the work included in this program element.

USTIFICATION FOR BUDGET ACTIVITY: This program is budgeted within APPLIED RESEARCH, Budget Activity, because it investigates technical advances with possible applications toward solution of specific Naval problems, short of a major development effort.

## PROGRAM ACCOMPLISHMENTS AND PLANS:

### 1. FY 1999 ACCOMPLISHMENTS:

SURFACE SHIP STRUCTURAL SYSTEMS:

R-1 Line Item 4

Budget Item Justification  
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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602121N

PROGRAM ELEMENT TITLE: Ship, Submarine & Logistics Technology

## INITIATED:

- Design tool for integrated composite topside structures. (Topside Structures)
  - Development of survivable damage control (DC) sensor/system principles. (Weapons Effects)
  - Concepts for affordable Hybrid Composite Hull capable of achieving "ALL" signature goals. (Hull Structures)
- CONTINUED:
- Development of improved design criteria and tools for analyzing composite primary hulls. (Hull Structures)
  - Development of stainless steel advanced double hull concepts. (Hull Structures)
  - Development and assessment of future combatant topside structural concepts. (Topside Structures)
  - Prediction of composite structural response to explosive loads transmitted in water or air. (Weapons Effects)

## COMPLETED:

- Transition of probabilistic hull strength design methods to NAVSEA. (Hull Structures)
- Development of magazine protection concepts to reduce mass detonation. (Weapons Effects)
- Physical modeling studies of hull response to seaway loading. (Hull Structures)
- Prediction of total ship structural/systems damage to missile impact and penetration. (Weapons Effects)
- Demonstration and evaluation of dynamic failure tools for composite hull structures. (Hull Structures)

## SURFACE SHIP POWER AND AUTOMATION:

### INITIATED:

- Dynamic modeling and simulation of shipboard fuel cell based power systems. (Electrical)
  - Simulation of machinery plant control system. (Mechanical Power and Auxiliary Systems)
- CONTINUED:
- Development of heat pipe, thermal-electric and other advanced heat removal techniques for high heat load thermal management in distributed machinery and electrical systems. (Mechanical Power and Auxiliary Systems)
  - Development of smart, survivable distributed machinery control concepts. (Mechanical Power and Auxiliary Systems)

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Budget Item Justification  
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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602121N

PROGRAM ELEMENT TITLE: Ship, Submarine & Logistics Technology

- Fire suppression and flooding prediction for automated damage control. (Damage Control)  
COMPLETED:
- Shock and vibration testing of reduced scale fuel cell systems. (Electrical)
- Salt contamination testing of reduced scale fuel cell systems. (Electrical)
- Advanced damage control flooding sensor technology. (Damage Control)

#### SURFACE SHIP SIGNATURE CONTROL:

INITIATED:

- Development of next generation topside signature control concepts. (Topside Signature Reduction)
- Development of control technology for corrosion-related electric and magnetic fields. (Underwater Signature Reduction)

CONTINUED:

- Evaluation of ship hull concepts that meet low-observable requirements. (Topside Signature Reduction)
- Integration and validation of lightning prediction models for ships and for composite structures. (Electromagnetic Compatibility)
- Development of radar scattering prediction capabilities for surface ship resonances and surface currents at high frequencies. (Topside Signature Reduction/Electromagnetic Compatibility)
- Development and validations of numerical prediction models for eddy currents. (Underwater Signature Reduction)
- Development of measurements procedures and metrics for evaluation of residual ferromagnetic signatures of non-ferrous materials. (Underwater Signature Reduction)

COMPLETED:

- Assessment of the vulnerability of surface ships to eddy current signatures. (Underwater Signatures)

#### SURFACE SHIP MANEUVERING & SEAKEEPING:

INITIATED:

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Budget Item Justification  
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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2000

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602121N

PROGRAM ELEMENT TITLE: Ship, Submarine & Logistics Technology

- Development of numerical methods for predicting hydrodynamic hull loads. (Seaway Maneuverability, Motions and Loads)
- Development of an integrated propulsor/hull concept to improve signatures. (Integrated Propulsor/Hull) COMPLETED:
- Development and validation of dynamic damage stability. (Seaway Maneuverability, Motions and Loads)

## SUBMARINE SIGNATURE CONTROL:

### INITIATED:

- Development of coating concepts to reduce submarine detection from active acoustic interrogation. (Structural Acoustics)
- Development of next-generation structural acoustics numerical modeling. (Structural Acoustics)
- Development of models to predict wake signatures in the littoral. (Hydrodynamic Signature Reduction)
- Development of optimum control concepts based on sampling/control of the electromagnetic fields that are exterior/posterior to a double hull. (Electromagnetic Signature Reduction)

### CONTINUED:

- Demonstration of proof-of-concept for controlling near-field electromagnetic signatures in shallow water. (EM Signature Reduction)
- Development of advanced degaussing/deamping techniques to integrate sensors/actuators into coatings. (Electromagnetic Signature Reduction)
- Development of methods to predict/reduce acoustic flow noise over appendages. (Hydroacoustics)
- Development of integrated models to assess noise of advanced propulsor. (Hydroacoustics)
- Development of technology to predict real-time acoustic signatures from on-board measurements. (Structural Acoustics)

### COMPLETED:

- Small scale evaluation of quiet hull concepts. (Structural Acoustics)

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602121N

PROGRAM ELEMENT TITLE: Ship, Submarine & Logistics Technology

- Full-scale demonstration of control methodologies for far-field underwater electromagnetic signatures in deep and shallow water. (Electromagnetic Signature Reduction)

## SUBMARINE STRUCTURAL SYSTEMS: CONTINUED:

- Investigation of double hull concepts. (Advanced Structures)
- Development of equipment emulators to assess shock and acoustic applications. (Advanced Structures)
- Development of system requirements and sensor configurations to implement structural monitoring system. (Advanced Structures)

## SUBMARINE POWER AND AUTOMATION: INITIATED:

- Integrated modeling and simulation of electric motor with mounting, shaft, propulsor and machinery support systems to investigate overall acoustic noise reduction. (Machinery)
- Development of solid state circuit breaker technology for quiet operation. (Electrical)

## CONTINUED:

- Technology assessment and development of alternative emergency power energy storage technologies. (Electrical)
- Verification of design tools for internal fluid systems. (Machinery)
- Development of most promising actuator technologies for improved performance of steering and diving systems. (Machinery)

- Development and validation analysis of 3-D design tools for quiet electric motors. (Electrical)

## COMPLETED:

- Validation of 2-D analysis and design tools for quiet electric motors; transition to NAVSEA. (Electrical)
- Development of measurement techniques for electrical motor dynamics. (Electrical)

## SUBMARINE MANEUVERING AND SEAKEEPING:

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2000

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602121N

PROGRAM ELEMENT TITLE: Ship, Submarine & Logistics Technology

## INITIATED:

- Development of maneuvering control effectors to increase low speed control authority. (Maneuvering Systems)
- Hydroacoustic design and analysis for mixed-flow propulsors. (Advanced Propulsors)
- Validation of propulsor force prediction and transition to Hydrodynamics/Hydroacoustics Technology Center. (Maneuvering and Control)
- Development and validation of propulsor concepts utilizing active control to achieve significant system simplification, cost savings, or performance enhancement. (Advanced Propulsors)

## CONTINUED:

- Improved simulation of maneuvering in extreme conditions. (Maneuvering and Control)
- ## COMPLETED:
- Simulation of jam resistant maneuvering concepts. (Maneuvering and Control)
  - Laboratory demonstrations of maneuvering concepts with improved control authority and jam resistance. (Maneuvering and Control)
  - Inviscid inverse design and turbulent flow analysis of mixed flow propulsor concepts. (Advanced Propulsors)
  - Turbulence evaluation of Advanced Stern Concept. (Maneuvering and Control)

## POWER ELECTRONIC BUILDING BLOCKS (PEBB):

### INITIATED:

- Development of advanced PEBB Fast-Turn-Off modules for all occurrences. (Electrical)
- Development of system regulation and stability concepts, algorithms. (Electrical)
- Dual Use PEBB commercialization. (Electrical)
- Development of energy generation and storage concepts and components. (Electrical)

### CONTINUED:

- Evaluation of third-generation modules to demonstrate form, fit, and function of PEBB. (Electrical)

### COMPLETED:

R-1 Line Item 4

Budget Item Justification  
(Exhibit R-2, Page 7 of 25)

# UNCLASSIFIED

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602121N

PROGRAM ELEMENT TITLE: Ship, Submarine & Logistics Technology

- Proof of concept for third-generation modules to demonstrate form, fit, and function of PEBB. (Electrical)
- Transition of third-generation PEBB modules to PE 0603508N to support Electrically Re-configurable Ship demonstration. (Electrical)

LOGISTICS:  
INITIATED:

- Development of sea-based logistics communications link. (Amphibious Logistics)

CONTINUED:

- Development of a high-power microwave built-in test set. (Maintenance)
- Improvement of throughput in higher sea states by identifying and developing new and emerging technologies that can be applied to critical lighterage operations. (Amphibious Logistics)
- Development of micro-electrical mechanical sensor systems. (Maintenance)
- Development of virtual sensors. (Maintenance)

COMPLETED:

- Development of magnetostrictive actuators for cargo/weapons elevator doors. (Replenishment)
- Development of advanced shipboard crane technology. (Replenishment)
- Development of metrology for high-speed optical interconnections. (Maintenance)
- Development of an infrared focal plane array test set. (Maintenance)
- Development of an assessment for using available hulls and sub-systems as low-cost components of systems for logistics or sea-basing operations. (Amphibious Logistics)
- Development of a diagnostic rule extraction technology. (Maintenance)
- Development of nondestructive techniques coupled with computer modeling to rapidly assess pier capacity to resist lateral loads. (Infrastructure)
- Development of technologies required for and easily transported high-sea-state modular platform system. (Amphibious Logistics)

R-1 Line Item 4

Budget Item Justification  
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# UNCLASSIFIED

# UNCLASSIFIED

FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2000

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602121N

PROGRAM ELEMENT TITLE: Ship, Submarine & Logistics Technology

- Development of an autonomous marine booster pump. (Amphibious Logistics)
- Development of technology to significantly improve throughput by providing lighterage the ability to moor alongside ships and piers, enabling cargo transfer in higher sea states. (Amphibious Logistics)
- Development of a collaborative infrastructure assessment tool. (Infrastructure)

## ENVIRONMENTAL QUALITY TECHNOLOGY:

### INITIATED:

- Development of recording, tracking and assessment technologies for mitigating the effects of Navy operations on marine mammals and threatened endangered species. (Environmentally Compliant Platforms)
- Investigation of scope and magnitude of Navy problems relating to non-indigenous species (NIS) in ballast water. (Environmentally Compliant Platforms)
- Feasibility study of applique technology for underwater hull surfaces. (Environmentally Compliant Platforms)

### CONTINUED:

- Development of pollution prevention technology for surface ships. (Environmentally Compliant Platforms)
- Heat exchanger fouling control technology for submarines. (Environmentally Compliant Platforms)
- Neural net classification technology for application to shipboard Oil Content Monitors (OCM). (Environmentally Compliant Platforms)
- Development of information and data for establishing scientifically sound basis for Navy copper discharge regulations. (Environmentally Compliant Platforms)
- Development of automated dry-dock painting of ship hulls. (Environmentally Compliant Platforms)
- Development of a Navy integrated approach to characterization on contaminated marine sediments. (Environmentally Compliant Platforms)

### COMPLETED:

- Development of environmentally acceptable lubricant for aircraft carrier catapult system. Transitioned to Navy Advanced Development Program (PE0603721N). (Environmentally Compliant Platforms)

R-1 Line Item 4

Budget Item Justification  
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# UNCLASSIFIED

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602121N

PROGRAM ELEMENT TITLE: Ship, Submarine & Logistics Technology

- Electrochemical polishing technology for shipboard non-oily wastewater. Transitioned to Navy Advanced Development Program (PE063721N). (Environmentally Compliant Platforms)
- Non-fouling coating for ceramic oily wastewater treatment membranes. Transitioned to Navy Advanced Development Program (PE063721N). (Environmentally Compliant Platforms)
- Feasibility of liquid carbon dioxide treatment of ship bilgewater. Transitioned to Navy Advanced Development Program (PE063721N). (Environmentally Compliant Platforms)
- Industrial wastewater treatment technology development that included Molecular Recognition, Advanced Oxidation and Advanced Reverse Osmosis. Transitioned to the Environmental Security Technology Certification Program (ESTCP) (PE0603851D), Puget Sound Naval Shipyard and Naval Air Station North Island for Demonstration/Validation (PE0603721N) and implementation. (Environmentally Compliant Platforms)

2. FY 2000 PLAN:

## SURFACE SHIP STRUCTURAL SYSTEMS:

### INITIATE:

- Development of shock/acoustic mount design methods with energy absorbing structures. (Weapons Effects)
- Improved magazine protection. (Weapons Effects)
- Hull life assurance methodology. (Hull Structures)
- Improved survivability to future air and underwater threats. (Weapons Effects)

### CONTINUE:

- Development of stainless steel advanced double hull concepts. (Hull Structures)
- Composite structural response prediction to explosion loads in water or air. (Weapons Effects)
- Design tool for integrated composite topside structures. (Topside Structures)
- Concepts of affordable Hybrid Composite Hull capable of achieving "ALL" signature goals. (Hull Structures)

### COMPLETE:

- Future combatant composite topside structural concepts. (Topside Structures)

R-1 Line Item 4

Budget Item Justification  
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# UNCLASSIFIED

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602121N

PROGRAM ELEMENT TITLE: Ship, Submarine & Logistics Technology

- Validation of predictive tools for seaway-induced loads. (Hull Structures)

## SURFACE SHIP POWER AND AUTOMATION:

### INITIATE:

- Demonstration of advanced thermal management techniques for mechanical and electrical systems. (Mechanical Power and Auxiliary Systems)
- Demonstration of smart, survivable distributed machinery control concepts on reduced scale systems. (Mechanical Power and Auxiliary Systems)
- Development of distributed machinery architecture concepts. (Mechanical Power and Auxiliary Systems)
- Demonstration of Advanced Fuel Cell technology (including combined cycle machines) with increased efficiency higher power density for auxiliary and propulsion applications. (Electrical)

### CONTINUE:

- Dynamic modeling and simulation of shipboard fuel cell power systems. (Mechanical Power and Auxiliary Systems)
- Simulation of machinery plant control system. (Mechanical Power and Auxiliary Systems)
- Development of smart, survivable distributed machinery control concepts. (Mechanical Power and Auxiliary Systems)

### COMPLETE:

- Fire suppression and flooding prediction for automated damage control. (Damage Control)
- Development of survivable DC sensor/system principles. (Weapons Effects)

## SURFACE SHIP SIGNATURE CONTROL:

### INITIATE:

- Development of integrated topside reduction and electromagnetic (EM) compatibility prediction capabilities for low-observable (LO) structures. (Topside Signature Reduction/EM Compatibility)
- Assessment of Alternative Uses for the Advanced Degaussing/Deamping Systems. (Topside Signature Reduction)

### CONTINUE:

R-1 Line Item 4

Budget Item Justification  
(Exhibit R-2, Page 11 of 25)

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 060212LN

PROGRAM ELEMENT TITLE: Ship, Submarine & Logistics Technology

- Development of measurement procedures and metrics to evaluate residual ferromagnetic signatures of non-ferrous materials. (Underwater Signature Reduction)
  - Evaluation of ship hull concepts for low-observable requirements. (Topside Signature Reduction)
  - Development of corrosion related signature reduction technologies for underwater electromagnetic signatures. (Underwater Signature Reduction)
  - Development of next-generation topside signature control concepts. (Topside Signature Reduction)
- COMPLETE:
- Development of radar scattering prediction capabilities for surface ship resonances and surface currents at high frequencies. (Topside Signature Reduction/Electromagnetic Compatibility)
  - Development and validations of numerical prediction models for eddy currents. (Underwater Signature Reduction)
  - Integration and validation of lightning prediction models for ships and for composite structures. (Electromagnetic Compatibility)

## SURFACE SHIP MANEUVERING & SEAKEEPING:

INITIATE:

- Development of low-signature turning and maneuvering predictions. (Seaway Maneuverability, Motions and Loads)
- CONTINUE:
- Development of numerical methods for predicting hydrodynamic hull loads. (Seaway Maneuverability, Motions and Loads)
  - Development of integrated propulsor/hull concept to improve signature behavior. (Integrated Propulsor/Hull)

## SUBMARINE SIGNATURE CONTROL:

INITIATE:

- Development of noise model for reduced complexity propulsors. (Hydroacoustics)
- CONTINUE:

R-1 Line Item 4

Budget Item Justification  
(Exhibit R-2, Page 12 of 25)

# UNCLASSIFIED

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602121N

PROGRAM ELEMENT TITLE: Ship, Submarine & Logistics Technology

- Development of models to predict wake signatures in the littoral. (Hydrodynamic Signature Reduction)
  - Development of hull structural concepts with intrinsic acoustic benefit; integration of acoustic coatings and double hull concepts. (Structural Acoustics)
  - Development of active and passive degaussing control techniques based on double hull construction. (Electromagnetic Signature Reduction)
  - Development of advanced degaussing/cleamping techniques to integrate sensors/actuators into coatings. (Electromagnetic Signature Reduction)
  - Development of optimum control concepts based on sampling/control of the electromagnetic fields that are exterior/posterior to a double hull. (Electromagnetic Signature Reduction)
- COMPLETE:
- Development of integrated noise model for advanced propulsor. (Hydroacoustics)
  - Development of methods to predict flow noise over appendages. (Hydroacoustics)
  - Development of technology to predict real-time acoustic signatures from on-board measurements. (Structural Acoustics)
  - Validation of non-linear, stress-magnetization finite element model. (Electromagnetic Signature Reduction)

## SUBMARINE STRUCTURAL SYSTEMS:

CONTINUE:

- Development of preliminary double hull concepts. (Advanced Structures)
  - Development of flanking path acoustic mitigation system. (Advanced Structures)
- COMPLETE:
- Development of equipment emulators to assess shock and acoustic applications. (Advanced Structures)
  - Development of system requirements and sensor configurations to implement structural monitoring system. (Advanced Structures)

## SUBMARINE POWER AND AUTOMATION:

R-1 Line Item 4

Budget Item Justification  
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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 060212IN

PROGRAM ELEMENT TITLE: Ship, Submarine & Logistics Technology

## INITIATE:

- Investigation of electric power distribution and machinery system automation for improved system performance and reduced manning. (Machinery and Electrical)
- Reduced scale demonstration of advanced control and motor design techniques. (Electrical)
- Development of hybrid acoustic filter for fluid systems. (Machinery)
- Integrated modeling and simulation of electric motor with mounting, shaft, propulsor and machinery support systems to investigate overall acoustic noise reduction. (Machinery)
- Development of most promising actuator technologies for improved performance of steering and diving systems. (Machinery)
- Development of solid state circuit breaker technology for quiet operation. (Electrical)
- Development and validation analysis of 3-D design tools for quiet electric motors. (Electrical)

## COMPLETE:

- Technology assessment and development of alternative emergency power energy storage technologies. (Electrical)
- Verification of design tools for internal fluid systems. (Machinery)

## SUBMARINE MANEUVERING AND SEAKEEPING:

### INITIATE:

- Validation of advanced maneuvering prediction codes. (Maneuvering Systems)
- Development of minimal cavitation propulsor designs. (Advanced Propulsors)

### CONTINUE:

- Demonstration of improved ability to simulate maneuvering in extreme conditions. (Maneuvering and Control)
- Development of maneuvering effectors to increased control authority at low speeds. (Maneuvering Systems)
- Hydroacoustic design and analysis for mixed flow propulsors. (Advanced Propulsors)

## COMPLETE:

R-1 Line Item 4

Budget Item Justification  
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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2000

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602121N

PROGRAM ELEMENT TITLE: Ship, Submarine & Logistics Technology

- Validation of propulsor force prediction and transition to Hydrodynamics/Hydroacoustics Technology Center. (Maneuvering and Control)
- Viable mixed flow propulsor concept. (Advanced Propulsors)
- Establishment of propulsor concept based on active control. (Advanced Propulsors)
- Assessment of flow noise reduction over appendages. (Maneuvering and Control)

#### ADVANCED ELECTRICAL POWER MANAGEMENT:

##### INITIATE:

- Development of advanced energy management and control concepts based on advanced regulation, stability, generation and storage concepts and components. (Electrical)
- Development of High Voltage Switch technology. (Electrical)
- Development of High Voltage Passive Component technology. (Electrical)

##### CONTINUE:

- Development of Fast-Turn-Off modules for PEBB. (Electrical)
- Development of system regulation and stability concepts, algorithms, and components. (Electrical)
- Dual Use PEBB commercialization. (Electrical)
- Development of energy generation and storage concepts. (Advanced Concept Electrical Systems)
- Transition Cost and efficiency models for advanced electrical systems and solid-state components to PE 0603508N to support Electrically Re-configurable Ship Demonstrations. (Electrical)

#### LOGISTICS:

##### INITIATE:

- Development of a submersible cache for prepositioning equipment. (Amphibious Logistics)
- Development of existing assets for mobile piers. (Amphibious Logistics)

R-1 Line Item 4

Budget Item Justification  
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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602121N

PROGRAM ELEMENT TITLE: Ship, Submarine & Logistics Technology

## CONTINUE:

- Development of sea-based logistics communication link. (Amphibious Logistics)
  - Development of virtual sensors. (Maintenance)
- COMPLETE:
- Development of high power microwave built-in test set. (Maintenance)
  - Development of expeditionary mooring technology. (Maintenance)
  - Development of micro-electrical mechanical sensor systems. (Maintenance)
  - Development of collaborative infrastructure assessment tool. (Infrastructure)

## ENVIRONMENTAL QUALITY TECHNOLOGY:

### INITIATE:

- Development of advanced waste treatment system process control technology for surface ships and submarines, and ballast water NIS control technology for Navy vessels in order to address development of suitable Marine Pollution Control Devices (MPCD) in support of Uniform National Discharge Standards (UNDS) requirements. (Environmentally Compliant Platforms)
- Development of pollutant sensor technology for Navy wastewater treatment/control systems such as the Automated Underwater Hull Maintenance Vehicle (AUHMV) and Navy shipyard dry-dock industrial wastewater treatment devices. (Environmentally Compliant Platforms)

### CONTINUE:

- Development of biofouling control technology for submarine heat exchangers. (Environmentally Compliant Platforms)
- Development of Navy ballast MPCD technology for NIS. (Environmentally Compliant Platforms)
- Development of recording, tracking and assessment technologies for mitigating the effects of Navy operations on marine mammals and threatened endangered species. (Environmentally Compliant Platforms)
- Development of automated dry-dock ship painting and applique technology for elimination of over-spray and hazardous air pollutants (HAPS). (Environmentally Compliant Platforms)

R-1 Line Item 4

Budget Item Justification  
(Exhibit R-2, Page 16 of 25)

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602121N

PROGRAM ELEMENT TITLE: Ship, Submarine & Logistics Technology

- Integrated Navy sediment characterization and methodology. (Environmentally Compliant Platforms) COMPLETE:
- Development of liquid carbon dioxide shipboard pollution prevention control technology for hazardous industrial rags and transition to Advanced Technology (PE0603712N) or Advanced Development Program (PE 0603721N). (Environmentally Compliant Platforms)
- Development of information and data for establishing scientifically sound Navy copper discharge standards in support of UNDS and transition to PE 0603721N for implementation. (Environmentally Compliant Platforms)
- Development of neural net classification algorithm for Navy shipboard OCMS, transition to PE 0603721N for advanced development, integration and implementation. (Environmentally Compliant Platforms)

3. FY 2001 PLAN:

SURFACE SHIP STRUCTURAL SYSTEMS:

INITIATE:

- Development of design concepts for joining major components of Hybrid Composite Hulls. (Composite Hull Concepts)
- Prediction of Hybrid Composite Hull response to explosive loads in water and air. (Composite Hull Concepts)
- Develop reliability assessment methods for composite and hybrid composite hulls. (Composite Hull Concepts)

CONTINUE:

- Hull life assurance methodology. (Hull Life Assurance)
- Improved magazine protection. (Weapons Effects)
- Shock/acoustic mount design with energy absorbing structures. (Weapons Effects)
- Improved survivability for future threats. (Weapons Effects)
- Concepts for affordable composite Hybrid Hull for achieving "ALL" signature goals. (Composite Hull Concepts)
- Composite Topside response to air explosion. (Topside Structures)

R-1 Line Item 4

Budget Item Justification  
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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602121N

PROGRAM ELEMENT TITLE: Ship, Submarine & Logistics Technology

## COMPLETE:

- Composite Hull response to explosive loads in water and air. (Weapons Effects)
- Assessment of stainless steel advanced double hull concepts. (Hull Structures)
- Design criteria and tools for analysis of composite primary hulls. (Hull Structures)
- Design tool for integrated composite topside structures. (Topside Structures)

## SURFACE SHIP POWER AND AUTOMATION:

### CONTINUE:

- Development of distributed machinery architecture concepts. (Mechanical Power and Auxiliary Systems)
- Demonstration of Advanced Fuel Cell technology (including combined cycle machines) with increased efficiency higher power density for auxiliary and propulsion. (Electrical)

### COMPLETE:

- Self-healing network and commercial off the shelf (COTS) automation demonstration. (Mechanical Power and Auxiliary Systems)
- Dynamic modeling and simulation of shipboard fuel-cell power systems. (Electrical)

## SURFACE SHIP SIGNATURE CONTROL:

### INITIATE:

- Development of double-hull signature reduction technologies for underwater electromagnetic signatures. (Underwater Signature Reduction)
- Development of advanced structural-acoustic signature reduction technologies. (Underwater Signature Reduction)

### CONTINUE:

- Development of integrated topside reduction and EM compatibility prediction capabilities for LO structures. (Topside Signature Reduction/EM Compatibility)
- Development of next-generation topside signature control concepts. (Topside Signature Reduction)

R-1 Line Item 4

Budget Item Justification  
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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602121N

PROGRAM ELEMENT TITLE: Ship, Submarine & Logistics Technology

- Development of corrosion-related signature reduction technologies for underwater electromagnetic signatures. (Underwater Signature Reduction)  
COMPLETE:

- Evaluation of ship hull concepts that meet low-observable requirements. (Topside Signature Reduction)
- Develop measurement procedures and metrics to evaluate residual ferromagnetic signatures of non-ferrous materials. (Underwater Signature Reduction)

SURFACE SHIP MANEUVERING & SEAKEEPING:

INITIATE:

- End-to-end hydrodynamic signature prediction capability. (Integrated Propulsor/Hull)  
CONTINUE:

- Development of numerical methods for predicting hydrodynamic hull loads. (Seaway Maneuverability, Motions and Loads)
- Development of integrated propulsor/hull concept to improve signature behavior. (Integrated Propulsor/Hull)
- Development of low-signature turning and maneuvering predictions. (Seaway Maneuverability, Motions and Loads)

COMPLETE:

- Development of numerical methods for predicting hydrodynamic hull loads. (Seaway Maneuverability, Motions and Loads)
- Development of an integrated propulsor/hull concept to improve signature behavior. (Integrated Propulsor/Hull)

SUBMARINE SIGNATURE CONTROL:

INITIATE:

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Budget Item Justification  
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DATE: February 2000

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602121N

PROGRAM ELEMENT TITLE: Ship, Submarine & Logistics Technology

- Development of active and passive degaussing/deamping control techniques based on non-ferromagnetic pressure hull/outer hull configurations. (Electromagnetic Signature Reduction)  
CONTINUE:
- Development of optimum control concepts based on sampling/control of the electromagnetic fields that are exterior/interior to a double hull. (Electromagnetic Signature Reduction)
- Development of advanced degaussing/deamping to integrate sensors/actuators into coatings. (Electromagnetic Signature Reduction)  
COMPLETE:
- Demonstration of proof-of-concept for controlling near-field electromagnetic signatures in shallow water. (Electromagnetic Signature Reduction)

## SUBMARINE STRUCTURAL SYSTEMS:

INITIATE:

- Small scale acoustic testing of preliminary double hull concepts. (Advanced Structures)
- Development of airborne noise mitigation systems. (Advanced Structures)

CONTINUE:

- Development of preliminary double hull concepts. (Advanced Structures)

## SUBMARINE POWER AND AUTOMATION:

CONTINUE:

- Development of most promising actuator technologies for improved performance of steering and diving systems. (Machinery)
- Reduced scale demonstration of advanced control and motor design techniques. (Electrical)
- Development of Hybrid acoustic filter for fluid systems. (Machinery)  
COMPLETE:
- Development and validation analysis of 3-D design tools for quiet electric motors. (Electrical)

R-1 Line Item 4

Budget Item Justification  
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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2000

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602121N

PROGRAM ELEMENT TITLE: Ship, Submarine & Logistics Technology

- Development of solid state circuit breaker technology for quiet operation. (Electrical)
- SUBMARINE MANEUVERING AND SEAKEEPING:
- INITIATE:
- Assessment of non-rotating propulsion devices. (Advanced Propulsors)
- CONTINUE:
- Validation of advanced maneuvering prediction codes. (Maneuvering and Control)
- COMPLETE:
- Hydroacoustic analysis for mixed flow propulsors. (Advanced Propulsors)
  - Demonstrate improved maneuvering simulation capability. (Maneuvering and Control)
  - Demonstrate advanced concepts for improved maneuvering at low speeds and in shallow water. (Maneuvering and Control)

#### ADVANCED ELECTRICAL POWER MANAGEMENT:

INITIATE:

- Development of solid-state technology for high power distribution systems. (Electrical)

CONTINUE:

- Development of system regulation and stability concepts, algorithms, and components. (Electrical)
- Development of energy generation and storage concepts. (Electrical)
- Development of High Voltage Switch technology. (Electrical)
- Development of High Voltage Passive Component technology. (Electrical)

COMPLETE:

- Dual Use PEBB commercialization. (Electrical)
- Transition Cost and efficiency models for advanced electrical systems and solid-state components to PE 0603508N to support Electrically Re-configurable Ship Demonstrations. (Electrical)

R-1 Line Item 4

Budget Item Justification  
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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602121N

PROGRAM ELEMENT TITLE: Ship, Submarine & Logistics Technology

- Development of advanced PEBB Fast-Turn-Off (FTO) modules. Transition FTO technology to PE 0603508N to support Electrically Re-configurable Ship Demonstrations. (Electrical)

## LOGISTICS:

### INITIATE:

- Development of shipboard integrated logistics system. (Maintenance)
- Development of strategic/tactical integrated logistics system. (Amphibious Logistics)

### CONTINUE:

- Development of a submersible cache for pre-positioning equipment. (Amphibious Logistics)
- Development of a sea-based logistics communication link. (Amphibious Logistics)
- Development of existing assets for mobile piers. (Amphibious Logistics)
- Development of virtual sensors. (Maintenance)

## ENVIRONMENTAL QUALITY TECHNOLOGY:

### INITIATE:

- Development of advanced shipboard and submarine pollution prevention and liquid wastewater treatment technologies for compliance with Uniform National Discharge Standards (UNDS). (Environmentally Compliant Platforms)
- Development of advanced marine mammal threat mitigation technology. (Environmentally Compliant Platforms)
- Development of advanced air pollutant emissions control and treatment technologies for ships in support of International Maritime Organization (IMO) MARPOL requirements. (Environmentally Compliant Platforms)
- Development of advanced pollution prevention technology for Navy industrial wastewater treatment facilities to reduce costs and limit liability. (Environmentally Compliant Platforms)

### CONTINUE:

R-1 Line Item 4

Budget Item Justification  
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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602121N

PROGRAM ELEMENT TITLE: Ship, Submarine & Logistics Technology

- Development of advanced waste treatment process control technology for surface ships and submarines and ballast water NIS control technologies for Navy vessels in support of UNDS. (Environmentally Compliant Platforms)
  - Development of pollutant sensor technology for Navy shore facility wastewater control/treatment systems and development of applique technology for ship hull and structures. (Environmentally Compliant Platforms)
- COMPLETE:
- Development of methodology and scheme for integrated characterization of Navy-contaminated marine sediments. (Environmentally Compliant Platforms)
  - Development of submarine heat exchanger fouling control technology. (Environmentally Compliant Platforms)
  - Development of recording, tracking and assessment technology for mitigation of Navy operations on marine mammals. (Environmentally Compliant Platforms)
  - Automated dry dock ship paint application, overspray control, collection and treatment technologies. Transition to NAVSEA 04 and NAVFAC 15R for advanced development (PE 0603721N). (Environmentally Compliant Platforms)

PROGRAM CHANGE SUMMARY:

FY 1999      FY 2000      FY 2001

R-1 Line Item 4

Budget Item Justification  
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DATE: February 2000

FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602121N

PROGRAM ELEMENT TITLE: Ship, Submarine & Logistics Technology

FY 2000 President's Budget:	55,456	43,786	42,967
Appropriated Value:	-	61,786	-
Adjustments from FY 2000 PRESBUD:			
SBIR/STTR Transfer	-542	0	0
Execution Adjustment	-1,988	0	0
Congressional Rescissions	0	-341	0
Congressional Adds:			
Stainless Steele Advanced Double Hull	0	5,000	0
Curved Plate Double Hull	0	8,000	0
3-D Printing Metalworking Technology		4,000	0
Bioenvironmental Hazards		1,000	0
Various Rate Adjustments		0	-301
Program Adjustments		0	1,857
Mil/Civ Pay Rates		0	40
FY 2001 PRESBUDG Submission:	52,926	61,445	44,563

## CHANGE SUMMARY EXPLANATION:

Schedule: Not applicable.

Technical: Not applicable.

. OTHER PROGRAM FUNDING SUMMARY:

OTHER APPROPRIATION FUNDS: Not applicable.

RELATED RDT&E:

R-1 Line Item 4

Budget Item Justification  
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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

UDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602121N

PROGRAM ELEMENT TITLE: Ship, Submarine & Logistics Technology

E 0601153N (Defense Research Sciences)  
E 0602131M (Marine Corps Landing Force Technology)  
E 0602233N (Human Systems Technology)  
E 0602234N (Materials, Electronics, and Computer Technology)  
E 0602314N (Undersea Warfare Surveillance Technology)  
E 0602315N (Mine Countermeasures, Mining and Special Warfare Technology)  
E 0603502N (Surface and Shallow Water MCM)  
E 0603508N (Surface Ship & Submarine HM&E Advanced Technology)  
E 0603513N (Shipboard System Component Development)  
E 0603514N (Ship Combat Survivability)  
E 0603553N (Surface Anti-Submarine Warfare)  
E 0603561N (Advanced Submarine Systems Development)  
E 0603563N (Ship Concept Advanced Design)  
E 0603564N (Ship Preliminary Design and Feasibility Studies)  
E 0603569E (DARPA S&T Program)  
E 0603573N (Advanced Surface Machinery Systems)  
E 0603712N (Environmental Quality & Logistics Advanced Technology)  
E 0603721N (Environmental Protection)  
E 0603726N (Merchant Ship Naval Augmentation Program)  
E 0603792N (Advanced Technology Transition)  
E 0604558N (New Design SSN Development)  
E 0604561N (SSN-21 Development Program)Under the Tri-Service Reliance Agreement, the Navy has the lead for this Navy-unique program.

. SCHEDULE PROFILE: Not applicable.

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Budget Item Justification  
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# UNCLASSIFIED

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UDGET ACTIVITY: 2      FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET      DATE: February 2000  
 PROGRAM ELEMENT: 0602122N  
 PROGRAM ELEMENT TITLE: Aircraft Technology

U) COST: (Dollars in Thousands)

ROJECT NUMBER & TITLE	FY 1999 ESTIMATE	FY 2000 ESTIMATE	FY 2001 ESTIMATE	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	TO COMPLET PROGRAM	TOTAL PROGRAM
ircraft echnology	30,247	20,545	21,057	21,675	22,031	22,067	21,835	CONT.	CONT.

(U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: This program develops technology for naval aviation, with emphasis on the demands imposed by aircraft carrier flight operations and Marine Corps amphibious and field operations relating to the Joint Mission Areas of Strike and Littoral Warfare. This program exploits the emerging technologies of: (a) structures and light controls to reduce the total life-cycle-cost and extend the operational life of legacy air vehicles; (b) reduced observables, (c) aerodynamic designs of Navy-unique aircraft components; (d) advanced gas turbine engine component designs and power systems for extended range/endurance; and (e) predicting safer, more reliable at-sea operating envelopes. The program provides mission area analysis and concept definition required for the Applied Research phase of air vehicle programs.

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

R-1 Line Item 5

Budget Item Justification  
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# UNCLASSIFIED

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET  
PROGRAM ELEMENT: 0602122N  
PROGRAM ELEMENT TITLE: Aircraft Technology

DATE: February 2000

UDGET ACTIVITY: 2

(U) Aircraft Technology addresses the Air Platforms Defense Technology Area Plan (DTAP), which develops goals and payoffs from both the operational user's and system & technology developer's perspective. At the Project Reliance Fixed Wing Vehicle autonomy level, goals include Aerodynamics, Flight Control, Subsystems, Structures and Integration technologies. The following reflects the Joint Subarea Level goals for fighter/attack aircraft for the year 2003 (baseline F-22 & F-18E/F): 0% increase in production cost/Air Vehicle Weight; 0% increase in development costs/Air Vehicle Weight; 20% reduction in support costs per flight hour/Air Vehicle Weight; 10% increase in lift-to-drag; 8% reduction in Air Vehicle weight fraction; 0% increase in controllable angle-of-attack envelope. Holding constant the three cost goals (0%) represents a break in the paradigm currently faced with high-performance tactical aircraft of ever increasing cost per pound of airframe. There is also an increasing emphasis on developing technology which addresses the cost-of-ownership of legacy airframes.

(U) Based on the Secretary of Defense's Blue Ribbon panel's recommendation, after studying F/A-18E/F transonic wing drop, joint program to develop an understanding of the fundamental flow phenomenon and develop technology to reduce/control abrupt symmetric wing stall of fighter aircraft will be funded under this and other program elements. This effort will fund the development of a basic understanding of the transonic abrupt wing stall problem, figures of merit and guidelines to prevent abrupt transonic wing stall and improve maneuverability. This effort is planned as a joint effort with Navy, NASA, Air Force (AF) and industry.

(U) Aircraft Technology has a limited investment in Navy unique or critical technology for Rotary Wing Vehicles and seabased vertical flight operations. These efforts are coordinated with the Army's Rotary Wing Vehicle (RWV) science and technology subarea under the DTAP.

(U) Other Joint Subarea Level quantified goals are addressed under the Air Platforms DTAP: Aero-propulsion (by year 2003; baseline engine YF-119 for fighter/attack aircraft, T700/T406 for patrol/transport/rotary wing aircraft, and F107 for missiles/Unmanned Air Vehicles (UAVs)): 100% increase in thrust-to-weight, 35% reduction in acquisition & maintenance cost, 0% reduction in fuel consumption, and 120% increase in specific thrust; and by year 2010, 150% increase in thrust-to-weight and 50% reduction in development costs. Aircraft Power (by year 2000; baseline F-18E/F & F-22): Eliminate hydraulic system; 10 times increase in reliability.

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Budget Item Justification  
(Exhibit R-2, page 2 of 14)

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET  
PROGRAM ELEMENT: 0602122N  
PROGRAM ELEMENT TITLE: Aircraft Technology

DATE: February 2000

UDGET ACTIVITY: 2

(U) Other DTAPs addressed by Aircraft Technology: Sensors, Electronics & Electronic Warfare; Integrated Platform electronics (by year 2005): Reduce size, weight and cooling requirements by 50% for Fixed Wing Vehicle (FWV) and 40% for RWV; and 50% reduction in cost for multifunction Radio Frequency (RF) avionics.

(U) Human Systems (by year 2001; baseline F-18E/F & F-22): Achieve crew safe escape to 700 KEAS; 50% reduction in crew workload attributable to effective crew station integration, enabling single-seat, air-to-ground precision weapons delivery at night and in adverse weather; Improve mission effectiveness (50% reduction in target acquisition time); Improve lethality (3:1 increase in targets killed per pass); Increase survivability (2:1 improvement in kill ratio); Enhanced situational awareness (75% reduction of head-in cockpit time).

(U) The Navy S&T program includes projects that focus on or have attributes that enhance the affordability of arming systems. Aircraft Technology addresses the Materials/Processes DTAP by developing Condition Based Maintenance (CBM) enabling technologies for aviation, with the emphasis on increased affordability, safety and operational flexibility. Specific goals of the program include an 80% reduction in aircraft mechanical mishaps, 35% reduction in the required inventory of spare parts and a 30% reduction in overall aircraft maintenance costs. This effort is part of a vertically integrated, multi-disciplinary program in condition based maintenance that leverages from Program Elements 0602233N, 0602234N and 601153N.

(U) Due to the sheer volume of efforts included in this Program Element (PE), the programs described in the accomplishment/Plans sections are representative selections of the work included in this PE.

(U) JUSTIFICATION FOR BUDGET ACTIVITY: This program is budgeted within the APPLIED RESEARCH Budget Activity because it investigates technological advances with possible applications toward solution of specific Naval problems, short of a major development effort.

(U) PROGRAM ACCOMPLISHMENTS AND PLANS:

1. (U) FY 1999 ACCOMPLISHMENTS:

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Budget Item Justification  
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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET      DATE: February 2000  
PROGRAM ELEMENT: 0602122N  
PROGRAM ELEMENT TITLE: Aircraft Technology

UDGET ACTIVITY: 2

- (U) PROPULSION & POWER:
  - (U) Initiated:
    - (U) Development of Power Electronic Building Blocks (PEBBs) for Naval aircraft applications.
    - (U) Testing of Carbon/Carbon lightweight heat exchanger technology for Naval Aircraft application.
  - (U) Continued:
    - (U) Development of Joint Technology Demonstrator Engine (JTDE) Fighter/Attack Phase III fan for 5% increased efficiency, 50% increase in stage loading and improved distortion and Foreign Object Damage (FOD) tolerance. Effort will provide specific thrust allowing F/A-18 growth.
    - (U) Rig testing of advanced high temperature turbine sealing concepts. The reduced leakage will result in a fuel consumption reduction of 2 percent and increased range for both subsonic support and fighter/attack applications.
    - (U) Design and fabrication of a ceramic matrix composite (CMC) turbine vane to increase temperature capability by 400 degrees or improve durability, over metallic designs.
    - (U) Design and sector rig testing of an Advanced Gas Generator/JTDE Phase III affordable combustor. It will provide reduced weight and cost for Fighter/Attack and Vertical/Short Take-Off and Landing (V/STOL) applications.
  - (U) Completed:
    - (U) Rig demonstration of a fuel flow metering system that will provide more precise main fuel system delivery to the engine while reducing weight, production and maintenance costs.
    - (U) Demonstration of Phase II Fighter/Attack category engine fan, turbine and afterburner components in a full engine configuration to increase thrust-to-weight by 50% and reduce acquisition and maintenance cost by 20%.
    - (U) Rig demonstration of a radial turbine blade damping concept which reduces stresses and increases turbine life by 50% and reduces weight by 20%.
    - (U) Demonstration of a turbine blade leading edge cooling concept that will be incorporated into an engine design to improve durability.
- (U) INTEGRATED AVIONICS (includes DISPLAYS AND ADVANCED COCKPIT TECHNOLOGIES):

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Budget Item Justification  
(Exhibit R-2, page 4 of 14)

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET  
PROGRAM ELEMENT: 0602122N  
PROGRAM ELEMENT TITLE: Aircraft Technology

DATE: February 2000

BUDGET ACTIVITY: 2

- (U) Continued:
- (U) Demonstration of an intelligent crewstation concept to include an onboard computer to continuously assess the conditions of the pilot and the aircraft relative to the escape envelope, and a measurement and control system to unobtrusively monitor aircrew physiological functions.
- (U) Development of a smart aircrew interface required to support the effective cockpit sub-system integration of the intelligent crewstation.
- (U) Investigation of an Advanced Multi-Mode Helmet Vision System to effectively merge real-time sensor information as well as synthetically generated environment imagery.
- (U) Development of advanced analog-to-digital Advanced Common Electronic Modules (ACEMs) technology to enhance air vehicle capability by performing multiple avionics functions. This work transitioned to the 0603217N P.E. at the end of FY 99.

(U) Completed:

- (U) Demonstration of a smart cockpit controller to effectively manage the functions of the life support, escape and control/display subsystems to achieve a 50% reduction in aircrew workload and 50% improvement in mission performance (i.e. target acquisition time/survivability/situational awareness). Transitioned smart cockpit controller software to support simulation and flight test efforts under Navy's Active Network Guidance in Emergency Logic (ANGEL) program.
- (U) Demonstration of component building block technology for a (non-moving parts) 3-Dimensional volumetric display.

(U) NAVAL AIR VEHICLE TECHNOLOGY:

(U) Initiated:

- (U) Detailed study of the existing F/A-18E/F wind tunnel, flight test and Computational Fluid dynamic (CFD) database to establish an understanding of the abrupt wing stall phenomena. Design and manufacture of the first set of highly instrumented wings for the 8% F/A-18E wind tunnel model. Develop figures of merit and a preliminary flow physics model for the abrupt wing stall phenomena using flight test, wind tunnel test and CFD data.

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Budget Item Justification  
(Exhibit R-2, page 5 of 14)

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET  
PROGRAM ELEMENT: 0602122N  
PROGRAM ELEMENT TITLE: Aircraft Technology

DATE: February 2000

UDGET ACTIVITY: 2

- (U) Development and real-time simulation demonstration of adaptive and intelligent Flight Control System (FCS) approaches that provide automated and/or assisted maneuvering to improve lethality and survivability for Naval Mission tasks.
- (U) Development and simulation demonstration of an adaptive fault-tolerant flight control system for ship-board auto-land of unconventional aircraft.
- (U) Definition of shipboard control and handling qualities requirements for various class sizes of V/STOL vehicles leading to automated launch and recovery. The requirements will reduce FCS development time/costs and lead to a reduction in shipboard accidents.
- (U) Evaluation of the capability of the Vectored Thrust Ducted Propeller (VTDP) Compound Helicopter technology to: (i) perform/enhance Airborne Mine Counter-Measures (AMCM), (ii) improve multi-mission rotorcraft speed, range, survivability and reduce life cycle cost, (iii) evaluate and mitigate the impact of increased weight empty and hover power required, and (iv) utilize the H-60 as the technology demonstration platform. This effort will transition to Program Element 0603792N in FY 2000.

(U) Continued:

- (U) Technical support to Defense Advanced Research Projects Agency (DARPA) and Boeing in the design, fabrication and testing of an Unmanned Air Vehicle (UAV) to demonstrate conversion from rotary-wing to fixed-wing flight using a canard/rotor wing concept.
- (U) Development of novel concepts to control or limit the suckdown, thermal and acoustical environment penalty associated with the VSTOL from a surface combatant. Developed more accurate and efficient modeling and prediction capability to evaluate VSTOL aerodynamic characteristics of manned aircraft and Uninhabited Combat Air Vehicle (UCAVs). Updated current VSTOL design handbook for modern configurations.
- (U) Development of a corrosion-fatigue interaction analysis to support the aging aircraft service life extension requirements. It provides prediction capabilities to optimize maintenance inspection and repair thereby reducing the corresponding Operation and Maintenance (O&M) cost by at least 10%.
- (U) Development of a durability-based design criteria for bonded composite patching of metal structures. The product allows a service life extension of aircraft heretofore requiring structural component replacement or by replacement with new platforms.

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Budget Item Justification  
(Exhibit R-2, page 6 of 14)

# UNCLASSIFIED

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET      DATE: February 2000  
PROGRAM ELEMENT: 0602122N  
PROGRAM ELEMENT TITLE: Aircraft Technology

BUDGET ACTIVITY: 2

- (U) Development of structural life enhancement techniques applicable to both new and aging aircraft to support objective of increasing fatigue service life by 25%.
- (U) Development of improved tactical aircraft high-lift system configurations and a validated 3-dimensional optimization/design method for high-lift systems.

(U) Completed:

- (U) Generation of a comprehensive document containing past aircraft configurations, which exhibited similar wing stall characteristics. Flight-tested F/A-18E/F configuration to obtain detailed wing surface pressure distributions to provide a better understanding of the existing flow field. Completed the first highly instrumented high-speed wind test and obtained both static and dynamic wing data. Used Computational Fluid Dynamic (CFD) techniques to develop a preliminary flow physics representation of the abrupt wing stall phenomena.
- (U) Development of guidelines to alleviate empennage buffet during high alpha maneuvering of fighter/attack aircraft. Completed development of coupled unsteady aerodynamics and structures interaction methods.
- (U) Joint Service demonstration of an Advanced Molecular Optical Air Data acquisition sensor.
- (U) Demonstration of Nonlinear Adaptive Control Algorithms on both damaged and undamaged aircraft simulations.
- (U) Demonstration of real-time battle and mid-air collision damage identification and estimation algorithms on a high fidelity nonlinear six degree of freedom high performance aircraft simulation.
- (U) Flight test of an adaptive neural network flight control system on an aircraft with simulated failure cases.

- (U) OXIDE PURPLE:
  - (U) Classified.

2. (U) FY 2000 PLAN:

- (U) PROPULSION & POWER:
  - (U) Initiate:

R-1 Line Item 5

Budget Item Justification  
(Exhibit R-2, page 7 of 14)

# UNCLASSIFIED

# UNCLASSIFIED

UDGET ACTIVITY: 2      FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET      DATE: February 2000  
PROGRAM ELEMENT: 0602122N  
PROGRAM ELEMENT TITLE: Aircraft Technology

- (U) Design of advanced prognostic, diagnostic and health monitoring control system to reduce maintenance costs for Fighter/Attack and UCAV systems.
- (U) Design of an advanced high durability, corrosion resistant bearing system for reduced maintenance cost and increased reliability.
- (U) Development of low-cost, integrally bladed rotor for compressors using advanced low cost manufacturing process, relevant to fighter/attack and rotary-wing aircraft applications.
- (U) Continue:
  - (U) Development of PEBBs for Naval aircraft applications in support of the More Electric Aircraft (MEA) initiative.
  - (U) Design and fabrication of JTDE Phase III Fighter/Attack Fan for increased efficiency stage loading and distortion tolerance.
  - (U) Development of improvements in turbine system components to increase durability by 50%.
  - (U) Rig testing of a CMC turbine vane to increase temperature capability by 400 degrees over metallic designs.
- (U) Complete:
  - (U) Rig testing of advanced high temperature turbine sealing concepts. The reduced leakage will result in a fuel consumption reduction of 2% and reduced costs of 50% for increased range for both subsonic support and fighter/attack applications.
  - (U) Sector rig test of an Advanced Gas Generator/JTDE Phase III affordable combustor. It will provide reduced weight and cost for Fighter/Attack and V/STOL applications.
- (U) INTEGRATED AVIONICS (includes DISPLAYS AND ADVANCED COCKPIT TECHNOLOGIES):
  - (U) Continue:
    - (U) Integration of high definition display prototype into flight worthy multi-mode helmet vision system configuration.

R-1 Line Item 5

Budget Item Justification  
(Exhibit R-2, page 8 of 14)

# UNCLASSIFIED

# UNCLASSIFIED

FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET  
PROGRAM ELEMENT: 0602122N  
PROGRAM ELEMENT TITLE: Aircraft Technology

DATE: February 2000

BUDGET ACTIVITY: 2

- (U) Complete:
- (U) Effort that focuses on enhanced affordability and safety by advancing state-of-the-art maintenance technologies, and develops the capability for critical machinery self-diagnosis, in order to transition from a time-based to a condition-based maintenance philosophy.
- (U) Building block helmet mounted display technology for transition to Fleet via the Joint Helmet Mounted Cueing System (JHMCS); basic magnetic head tracker, common helmet/vehicle interface, and visor optics.
- (U) Development and demonstration of algorithms that generate tactically useful, real-time cockpit imagery fused from off-board and on-board information sources. These will automatically choose from sets of images only those which correspond to a specific target and present it on a helmet-mounted or other display.

## (U) NAVAL AIR VEHICLE TECHNOLOGY:

- (U) Initiate:
  - (U) Prediction of dynamic load effects on structural fatigue life for fixed and rotary-wing aircraft.
  - (U) Development and real-time hardware demonstration of flight systems damage and failure diagnostics/prognostics approaches for reconfigurable flight control, condition-based maintenance, and improved pilot situational awareness to improve safety, survivability, and affordability.
- (U) Continue:
  - (U) Development of an improved Abrupt Wing Stall (AWS) flow physics model and aircraft design guidelines using newly acquired wind tunnel, flight test and CFD data. Development of a high-speed ground based dynamic test capability to diagnose the AWS phenomena. Initiate a flight test program in cooperation with NASA. Design and manufacture the second highly instrumented wind tunnel test model.
  - (U) Technical support to DARPA and Boeing in the design, fabrication and flight testing of a UAV to demonstrate conversion from rotary-wing to fixed-wing flight using a canard/rotor wing concept.
  - (U) Development of a corrosion-fatigue interaction analysis with emphasis on random scatter of material properties.
  - (U) Development of a reliability analysis capability for bonded composite patching of cracked metallic structure.

R-1 Line Item 5

Budget Item Justification  
(Exhibit R-2, page 9 of 14)

# UNCLASSIFIED

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UDGET ACTIVITY: 2      FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET      DATE: February 2000  
PROGRAM ELEMENT: 0602122N  
PROGRAM ELEMENT TITLE: Aircraft Technology

- (U) Development of shipboard control and handling qualities requirements for various class sizes of V/STOL vehicles leading to automated launch and recovery.
- (U) Development and real-time simulation demonstration of adaptive and intelligent Flight Control System (FCS) approaches that provides automated and/or assisted maneuvering to improve lethality and survivability for Naval Mission tasks.
- (U) Development and simulation demonstration of an adaptive fault-tolerant flight control system for shipboard auto-land of unconventional aircraft.

- (U) OXIDE PURPLE:
  - (U) Classified.

### 3. (U) FY 2001 PLAN:

- (U) PROPULSION AND POWER:
  - (U) Initiate:
    - (U) Design of a low cost, high temperature turbine system relevant to high-speed missile and UCAV systems.
    - (U) Design of an advanced lightweight, V/STOL-relevant fan system compatible with low cost manufacturing processes.
    - (U) Rig test of a low volume combustor that will reduce frontal area of missiles to reduce drag and increase range.
  - (U) Continue:
    - (U) Fabrication of full annular rig of a CMC combustor for subsonic, UCAV and rotary-wing aircraft applications to increase cycle temperature.
    - (U) Testing of advanced prognostic, diagnostic and health monitoring control system to reduce maintenance costs for Fighter/Attack and UCAV systems.

R-1 Line Item 5

Budget Item Justification  
(Exhibit R-2, page 10 of 14)

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET      DATE: February 2000  
PROGRAM ELEMENT: 0602122N  
PROGRAM ELEMENT TITLE: Aircraft Technology

BUDGET ACTIVITY: 2

- (U) Complete:
  - (U) Rig testing of a full-size Advanced Gas Generator/JTDE affordable combustor. It will provide reduced weight and cost for Fighter/Attack and VSTOL applications.
  - (U) Testing of JTDE Phase III Fighter/Attack Fan for increased efficiency stage loading and Foreign Objective Damage (FOD) and distortion tolerance.
  - (U) Testing of an advanced high-durability, corrosion-resistant bearing system for reduced maintenance cost and increased reliability.
  
- (U) INTEGRATED AVIONICS (includes DISPLAYS AND ADVANCED COCKPIT TECHNOLOGIES):
  - (U) Continue:
    - (U) Overall multi-mode visually-coupled display system technology integration enhancement between visor optics, 3-D audio, precision head tracking and selected threat protection technology.
  
- (U) NAVAL AIR VEHICLE TECHNOLOGY:
  - (U) Initiate:
    - (U) Development of technology for integrated multi-disciplinary optimization of manned aircraft and UAVs.
    - (U) Development of bonded composite patch repair of corrosion damage to supplement the costly practices in current depot maintenance.
  
  - (U) Continue:
    - (U) Development of prediction of corrosion-assisted fatigue degradation within a scatter factor of four to develop engineering guidelines for maintenance practices.
    - (U) Development of analysis of dynamic load effect on fatigue life.
    - (U) Development and real-time simulation demonstration of adaptive and intelligent Flight Control System (FCS) approaches that provides automated and/or assisted maneuvering to improve lethality and survivability for Naval Mission tasks.

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET      DATE: February 2000  
 PROGRAM ELEMENT: 0602122N  
 PROGRAM ELEMENT TITLE: Aircraft Technology

UDGET ACTIVITY: 2

- (U) Complete:
- (U) AWS flow model development, demonstration of aircraft design guidelines and figures of merit on a present/future fighter/attack configuration.
- (U) Flight testing with DARPA and Boeing of a UAV to demonstrate conversion from rotary-wing to fixed-wing flight using a canard/rotor wing concept.
- (U) Definition of shipboard control and handling qualities requirements for various class sizes of V/STOL vehicles leading to automated launch and recovery. The requirements will reduce FCS development time/ costs and lead to a reduction in shipboard accidents.
- (U) Preliminary Design Review of intelligent flight control prognostics and reconfiguration algorithms to improve safety, survivability, and affordability of flight control systems.
- (U) Preliminary Design Review of fault-tolerant adaptive control laws for ship-board auto-land of unconventional vehicles.

(U) PROGRAM CHANGE SUMMARY:

	FY 1999	FY 2000	FY 2001
FY 2000 President's Budget:	28,367	20,660	22,372
Appropriated Value	-	20,660	-
Adjustments from FY 2000 PRESBUDG:			
SBIR/STTR Transfer	-407	0	0
Inflation Rate Adjustment	-132	0	0
Actual Update Adjustments	2,419	0	-1,185
Program Adjustment	0	-115	0
Congressional Rescissions	0	0	-141
Various Rate Adjustments	0	0	11
Mil/Civ Pay Rates	0	0	11
FY 2001 PRESBUDG Submission	30,247	20,545	21,057

(U) CHANGE SUMMARY EXPLANATION:

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Budget Item Justification  
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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET      DATE: February 2000  
PROGRAM ELEMENT: 0602122N  
PROGRAM ELEMENT TITLE: Aircraft Technology

BUDGET ACTIVITY: 2

- (U) Schedule: Not applicable.
- (U) Technical: Not applicable.

(U) OTHER PROGRAM FUNDING SUMMARY: Not Applicable.

(U) RELATED RDT&E: This program adheres to Defense S&T Reliance Agreements on Air Platforms (Fixed Wing, Rotary Wing, Integrated High Performance Turbine Engine Technology (IHPTET), and Aircraft Power), Sensors, Electronics & Electronic Warfare (Integrated Platform Electronics), Human Systems, and Materials/Processes.

(U) Work in this Program Element (PE) is related to and fully coordinated with efforts in the following PEs:

- PE 0601101F (Geophysics)
- PE 0601102F (Materials)
- PE 0601153N (Defense Research Sciences)
- PE 0602201F (Aerospace Flight Dynamics)
- PE 0602202F (Human Systems Technology)
- PE 0602203F (Aerospace Propulsion)
- PE 0602204F (Aerospace Avionics)
- PE 0602233N (Human Systems Technology)
- PE 0602234N (Materials, Electronic and Computer Technology)
- PE 0602708E (Cockpit Autonomous Landing)
- PE 0603003A (Rotary Wing Aircraft Technology)
- PE 0603106F (Logistics Systems Technology)
- PE 0603112F (Advanced Materials)
- PE 0603202F (Aerospace Propulsion Subsystems Integration)
- PE 0603205F (Flight Vehicle Technology)
- PE 0603211F (Aerospace Structures)
- PE 0603216F (Aerospace Propulsion and Power Technology)
- PE 0603217N (Air Systems and Weapons Advanced Technology)

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Budget Item Justification  
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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET      DATE: February 2000  
UDGET ACTIVITY: 2      PROGRAM ELEMENT: 0602122N  
PROGRAM ELEMENT TITLE: Aircraft Technology

- PE 0603231F (Crew Systems and Personnel)
- PE 0603238N (Precision Strike & Air Defense Technology)
- PE 0603245F (Advanced Flight Technology Integration)
- PE 0603706N (Medical, Personnel, and Training Advanced Technology Development)
- PE 0603792N (Advanced Technology Transition)

(U) Advanced Technology Transition in accordance with the ongoing Reliance joint planning process and contains no unwarranted duplication of effort among the Military Departments.

. (U) SCHEDULE PROFILE: Not applicable.

R-1 Line Item 5

Budget Item Justification  
(Exhibit R-2, page 14 of 14)

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602131M

PROGRAM ELEMENT TITLE: Marine Corps Landing Force Technology

(U) COST: (Dollars in Thousands)

PROJECT NUMBER & TITLE	FY 1999 ESTIMATE	FY 2000 ESTIMATE	FY 2001 ESTIMATE	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	TO COMPLETE	TOTAL PROGRAM
Marine Corps Landing Force Technology	12,690	17,437	9,793	11,539	11,499	11,661	11,937	CONT.	CONT.

A. (U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: The basic roles and missions of the Marine Corps (the seizure and defense of advanced naval bases, the conduct of land operations essential to the naval campaign, and other such duties as the President may direct) are specified in Title 10 USC 5063. The National Security Act of 1947 and DoD Directive 5000.1 are the basis for conducting this Marine Corps effort.

(U) By law, the Marine Corps is tasked to develop, in conjunction with the Navy, Army, and Air Force, those phases of amphibious operations that pertain to tactics, techniques, and equipment used by the landing force. This program element (PE) is executed under project MQ1A. It is organized into five Warfighting Imperatives by the Future Naval Capabilities process. These Warfighting Imperatives are: Maneuver, Firepower, Command and Control, Logistics, and Training and Education.

(U) The primary objective of this PE is to develop and demonstrate the technologies needed to meet the Marine Corps unique responsibility for amphibious warfare and subsequent operations ashore. This PE provides the knowledge base to support Advanced Technology (6.3) and is the technology base for future amphibious/expeditionary warfare capabilities. This PE supports the Concept Based Requirements System of the Marine Corps Combat Development Center and responds directly to the United States Marine Corp (USMC) Science and Technology process.

R-1 Line Item 6

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602131M

PROGRAM ELEMENT TITLE: Marine Corps Landing Force Technology

(U) JUSTIFICATION FOR BUDGET ACTIVITY: This program is budgeted within the Applied Research Budget Activity because it investigates technological advances with possible application toward the solution of specific Marine Corps problems, short of a major development effort.

(U) PROGRAM ACCOMPLISHMENTS AND PLANS:

(U) FY 1999 ACCOMPLISHMENTS:

- (U) Maneuver Imperative: Continued risk reduction for the Reconnaissance Surveillance Targeting Vehicle (RST-V) platform and payload integration. Completed integration of survivability technology with RST-V. Fabricated, integrated and tested tunable filter multi-spectral camera upgrade for Coastal Battlefield Reconnaissance and Analysis (COBRA) enhanced detection capability. Completed mine detection processing software development. Initiated investigation leading to the technology to enhance mobility of tactical systems. Conducted market survey of commercial craft and propulsion components to satisfy the Small Unit Riverine Craft. Conducted detailed analysis and modeling of notional solutions to support Mine Countermeasure systems that can be applied to Marine Corps Ground Combat vehicles to support on-the-move, in-stride mine countermeasures. Prepared acquisition plan and supporting documents for commencement of developmental program to test hardware in FY00/01. Conducted joint planning with US Army to leverage existing or non-developmental items for USMC needs.
- (U) Firepower Imperative: Continued sensor integration technology efforts. Demonstrated advanced Enhanced Target Acquisition and Location technology and transitioned to Advanced Technology Demonstration (ATD).
- (U) Command and Control Imperative: Supported USMC requirements for Joint Networked Radios by prototyping modules and capabilities that the USMC will insert into the requirements of the Joint Program Office. Demonstrated communication technologies that were of high relevance to evolving USMC warfighting objectives for possible insertion into joint communication requirements. Demonstrated capability to jam cellular and other Personal Communications Systems devices that are utilized for military purposes. Demonstrated technology capability for further miniaturization of expendable jammers. Completed test target management capability for Advanced Field Artillery Tactical Data System and Contingency Theater Automated Planning System and evaluated the requirement for

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PROGRAM ELEMENT: 0602131M

PROGRAM ELEMENT TITLE: Marine Corps Landing Force Technology

resolving targeting conflicts i.e. Naval surface fires in a USMC target management system. Assessed the requirement and benefits of converting software development to evolving Windows New Technology interface capabilities being made available by Marine Corps Tactical System Support Activity and Defense Information Systems Agency.

- (U) Logistics Imperative: Continued system development of Logistics Information Systems, focusing on decision support tools and data warehousing. Continued corrosion and materials research and testing with insertion of technologies in Light Armored Vehicle/Medium Tactical Vehicle Replacement/Logistics Vehicle System (LAV/MTVR/LVS). Continued to develop bulk liquids technologies in support of future sea basing concept development, focusing on innovation in packaging and distribution, as well as sensor ties to the information system. Conducted concept exploration in precision logistics, improved vehicle supportability over the full life cycle, and integrated diagnostics.
- (U) Training and Education Imperative: Continued Rapid Virtual Data Base development. Continued development of intelligent automated forces and tested by means of operational simulations. Continued training technology concepts development. Started development of a simulation based acquisition tool.

(U) FY 2000 PLAN:

- (U) Maneuver Imperative: Develop advanced propulsion, survivability, and mobility technologies for future expeditionary combat systems. Complete integration and testing of enhanced minefield multi-spectral sensor, illuminator and processor. Begin design for advanced autonomous Mine Countermeasure systems that can be applied to Marine Corps Ground Combat systems.
- (U) Logistics Imperative: Continued system development of Logistics Information Systems, focusing on decision support tools and data warehousing. Continued corrosion and materials research and testing with insertion of technologies in Light Armored Vehicle/Medium Tactical Vehicle Replacement/Logistics Vehicle System (LAV/MTVR/LVS). Additionally, fuel additives will be created and assessed to decrease fuel consumption, leveraging the related Army initiatives. The effort will jointly develop field fuel analysis and testing equipment to allow Marines to

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identify and capitalize on indigenous fuel sources. To accomplish this, hand held fuel quality sensors are being prototyped.

- (U) Firepower Imperative: Establish common High-Level Architecture (HLA) simulation to sensor performance and development analysis and develop an Integrated Management Plan for Test Experimentation Assessment Modeling and Simulation (TEAMS) capability.
- (U) Command and Control Imperative: Conduct network modeling and simulation effort to support Operations Center needs. Develop wide-band antennae to support Joint Tactical Radio Systems (JTRS) requirements for dismounted combatants. Develop mobile direction finding for High Mobility Multi-purpose Wheeled Vehicle (HMMWV) applications. Provide high accuracy, small, portable geo-location capability via Time Differential of Arrival (TDOA) techniques suitable for transition to the USMC TPCS System. Integrate a collaborative, 3-D, visualization capability for mission planning into the Marine Air Ground Task Force (MAGTF) Software Baseline.
- (U) Training and Education Imperative: Complete Rapid Virtual Data Base development and demo. Continue development of intelligent automated forces and test and operational simulations. Continue training technology concept development. Initiate efforts in training technology. Continue Simulation based acquisition.

(U) FY 2001 PLAN:

- (U) Maneuver Imperative: Test risk reduction technologies for the RST-V platform and payload integration. Complete integration of survivability technology with RST-V and LAV and test. Complete mine detection processing software development and transition to Joint Defense Technology Objective. Continued investigation leading to the technology to enhance mobility of tactical systems. Continue design and begin integration of advanced autonomous Mine Countermeasure systems that can be applied to Marine Corps Ground Combat vehicles, to include variant configurations and mission packages.
- (U) Command and Control Imperative: Human-Computer Interface enhancements for Operation Centers and Command Centers will be demonstrated and analyzed based on field test results. Technologies developed for Commander in Chief (CINC) applications from such efforts as the ELB ACTD will be leveraged via further development for lower

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echelon USMC forces. Continue development of wideband antennae to support JTRS requirements. Continue mobile direction finding for HMMWV applications. Continue integration of 3-D visualization capability into software baseline in support of Operation Center evolution.

- (U) Logistics Imperative: Continue logistics technology efforts in direct support of emerging USMC logistics concepts, systems and requirements. Continue specific technology development and insertion in the areas of Logistics Information Resources and Precision Logistics. Continue rapid prototype and experimentally validated logistics equipment concepts into Marine Corps acquisition programs. Initiate efforts to expand logistics capabilities to accommodate emerging concepts of employment and evolving sea base platforms. This task will investigate unconventional means to exploit fluid movement and delivery capabilities. The effort will investigate materials and techniques that will facilitate the expansion of Combat Service Support operating reach. Self-healing bladder materials will be developed. Continue development of fuel additives and assess fuel consumption, leveraging the related Army initiatives. The effort will jointly develop field fuel analysis and testing equipment to allow Marines to identify and capitalize on indigenous fuel sources. To accomplish this, hand held fuel quality sensors are being prototyped. This task covers all emerging needs for CSS technology development in the areas of maintenance, health services, deliberate engineering and transportation/distribution. The effort will develop platforms, packaging materials, and recommended by MCCDC Studies and Analysis, the Naval Expeditionary Warfare Engineering IPT, the MPF 2010 and Beyond Working Group, and the Naval Doctrine Command's Sea Based Logistics concept development group. Recommended parameters of speed/payload/support concepts for surface, ground, and air CSS platforms will be designed into future systems. Solutions in new packaging materials, innovative distribution platforms, expeditionary power/sanitation/construction, and maintenance support will be applied to specific CSS areas.

- (U) Training and Education Imperative: Continue development of intelligent automated forces and test operational simulations. Continue training technology concepts development. Continue simulation-based acquisition. Continue training technology efforts.

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PROGRAM ELEMENT TITLE: Marine Corps Landing Force Technology

## B. (U) PROGRAM CHANGE SUMMARY:

	<u>FY 1999</u>	<u>FY 2000</u>	<u>FY 2001</u>
(U) FY 2000 President's Budget	12,970	10,534	9,867
(U) Appropriated Value		17,534	0
(U) Adjustments President's Budget			
(U) Congressional Plus-ups		7,000	
(U) Various Rate Adjustments	-59	0	-74
(U) Congressional Rescission		-97	
(U) SBIR/STTR Transfer	-144	0	0
(U) Execution Adjustment	-77	0	0
(U) FY 2001 President's Submission	12,690	17,437	9,793

## C. (U) OTHER PROGRAM FUNDING SUMMARY: Not applicable.

## D. (U) RELATED RDT&E:

(U) This program adheres to Tri-Service Reliance Agreements in Chemical/Biological Defense; Command, Control and Communications; Conventional Air/Surface Weaponry; Electronic Devices; Ground Vehicles; Ships and Watercraft; Manpower and Personnel; and Training Systems.

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PE 0206313M Marine Corps Air Ground Task Force Command/Control/Comm/Computers & Intel (MAGTF C4I)  
PE 0206623M Marine Corps Ground Combat/Supporting Arms Systems  
PE 0206624M Marine Corps Combat Services Support  
PE 0602232N Communications, Command and Control, Intelligence, Surveillance and Reconnaissance (C3ISR)  
PE 0603606A Landmine Warfare and Barrier Advanced Technology  
PE 0603611M Marine Corps Assault Amphibious Vehicles  
PE 0603612M Marine Corps Mine/Countermeasures Systems  
PE 0603619A Landmine Warfare and Barrier - Advanced Development  
PE 0603635M Marine Corps Ground Combat/Supporting Arms Systems  
PE 0603640M Marine Corps Advanced Technology Demonstrations  
PE 0603782N Mine and Expeditionary Warfare Advanced Technology

E. (U) SCHEDULE PROFILE: Not applicable.

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PROGRAM ELEMENT: 0602232N

PROGRAM ELEMENT TITLE: Command, Control, Communications, Computers, Intelligence, Surveillance & Reconnaissance (C4ISR)

(U) COST: (Dollars in Thousands)	FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET						TOTAL PROGRAM
	FY 1999 ACTUAL	FY 2000 ESTIMATE	FY 2001 ESTIMATE	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	
C4ISR	71,139	91,166	79,905	81,094	82,000	81,293	79,921
							CONT

A. (U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: This Program Element (PE) supports future command, control, communications, computers and intelligence, surveillance and reconnaissance (C4ISR) systems for surface, subsurface, air and space platforms and ashore for Naval Warfare. C4ISR technology focuses on the delivery of critical, time sensitive, tactical information to decision makers for fusion and management of information between the warrior, command centers, and National Command Authorities. Technology developments include network Centric architecture and information infrastructure, intelligent information exploitation and retrieval, consistent tactical picture development, collaboration environments, and interactive decision support including continuous plan-execute cycles, and navigation. Funding for Computer Technology previously contained within PE 0602234N has been realigned and is now presented in the Command Support thrust of this program element. While this transfer takes place in FY 01, the funding accomplishments and plans for the Computer Technology Program in PE 0602234N for FY 99 and FY 00 are shown here for the sake of program clarity and continuity. The major goal is to provide the Navy with the capacity to interconnect government and commercial telecommunication assets, worldwide, that are efficient and responsive to regional theater challenges and the National interest. Surface/Aerospace/Intelligence, Surveillance and Reconnaissance (ISR) technology emphasizes advanced sensor and processing systems for theater wide air and surface surveillance, battle group surveillance, real-time reconnaissance and ship self-defense. Major technology goals include increased long-range target detection and discrimination, precision track, and positive target identification in complex countermeasure and adverse environmental conditions. Navigation and timing are key to the Department of Defense (DoD) capability to conduct precision engagement, dominant maneuver and information dominance. Navigation is a critical aspect of most naval missions, including precision targeting, amphibious

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assault and mineclearing. Current dependence on the Global Positioning System (GPS) leaves the United States (U.S.) vulnerable to enemy efforts to make GPS unavailable through electronic warfare means (i.e., jamming). Navigation technology emphasizes development of counter-countermeasures for GPS and of GPS alternative navigation such as inertial technology with greater precision. C4ISR technologies directly support the Joint Warfighter Mission Areas and Areas of Precision Force (Strike Warfare) including Littoral Warfare, Combat Identification (ID), Joint Theater Missile Defense, and Information Superiority. Specifically: Precision Force efforts address technology issues in real-time targeting, long range target detection, track and engage and Battle Damage Assessment (BDA). Programs include mission planning, en-route Command, Control, Communications and Computers (C4), precision targeting, precision navigation, multisensor fusion, and temporal and spectral discrimination algorithms. Precision Force in the Littorals addresses issues in air and surface battle-space and develops technology for ship self-defense, cooperative engagement and power projection systems including ship-based and off-ship radar and electro-optic/infrared (EO/IR) sensors, connectivity and robust, enduring communications and navigation. ISR technology efforts address issues of precise target location and real-time targeting, counter-jamming and deception. Program includes multi-platform radar and IR sensors for detection, identification, tracking, BDA, and timely distribution of surveillance information to all levels of command. Command and Control (C2) efforts address Networked Operations supported by distributed collaborative battle management. Navigation technology efforts address Digital-Signal-Processor (DSP) based GPS antennas with adaptive beamforming/null steering and integration of navigation and communications systems (e.g., GPS and Joint Tactical Information Distribution Systems (JTIDS)). GPS alternative technologies to improve inertial navigation capabilities include Fiber Optic Gyroscopes (FOGs), Micro-Electro-Mechanical (MEMS) accelerometers, and miniaturized clocks for precision time information. Operational focus areas are littoral warfare, strike and operations other than war (OOTW) e.g. humanitarian assistance. This PE emphasizes C4ISR technology to provide Naval Warfighters with seamless, timely situational awareness of the total battle-space and indications and warning of threat operations and intentions.

(U) These efforts support the Joint Warfare Strategy "Forward... From the Sea". Programs are jointly planned in the Defense Technology Area Planning Process within the Department of Defense.

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(U) Due to the sheer volume of work included in this PE, the programs described in the Accomplishments and Plans sections are only representative selections of the work included in this PE and are not an exhaustive presentation.

(U) The Navy Science and Technology (S&T) program includes projects that focus on or have attributes that enhance the affordability of warfighting systems.

(U) JUSTIFICATION FOR BUDGET ACTIVITY: This program is budgeted within the APPLIED RESEARCH Budget Activity because it investigates technological advances with possible applications towards solution of specific Naval problems short of a major development effort.

## (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

### 1. (U) FY 1999 ACCOMPLISHMENTS:

- (U) RADAR TECHNOLOGY: The Radar Technology program investment addresses Navy surveillance needs and exploits radar sensor technology opportunities. Emphasis is on major platforms such as ships and aircraft and cross cutting technologies that apply across platforms. Major drivers include affordability and sensor performance in complex target, electronic countermeasures (ECM) and adverse environmental conditions including operations in the littorals.
- (U) Completed multi-band, flexible waveform, shipboard radar sensor test at Wallops Island for performance and operational utility assessments against representative targets in varying environmental clutter and sea state conditions. Report to be delivered.
- (U) Completed evaluation of adaptive waveforms for multi-band shipboard radar to maximize detection and track performance in complex target and multi-path conditions and to minimize system dynamic range and analog-to-digital converter requirements. Addressed Program Executive Officer, Theater Air Defense Surface Combatants (PEO-TAD/SC) and N-86 needs for continuous track in severe multi-path and clutter conditions.

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PROGRAM ELEMENT: 0602232N

PROGRAM ELEMENT TITLE: Command, Control, Communications, Computers, Intelligence, Surveillance & Reconnaissance (C4ISR)

- (U) Integrated scale model voltage controlled diode array with test bed radar system to develop performance versus cost trade-off metrics. Responds to Navy needs for affordable high performance radio frequency (RF) apertures. Joint program with Defense Advanced Research Project Agency (DARPA).
- (U) Continued development of Millimeter Wave High Resolution Radar Demonstration Model for close in anti-ship cruise missile (ASCM) tracking. Incorporated High Power source developed by the Electronics program under PE 0602234N.
- (U) Characterized performance of full scale model of the ultra high frequency (UHF) electronically scanned array in static chamber testing and at the experimental radar facility at Pacific Missile Range Facility (PMRF), Kauai, Hawaii. Performance equaled or exceeded existing E-2C TRAC-A, and ADS-18 antenna systems. Conducted E-2C integration studies including electromagnetic compatibility determinations. This development addresses technology needs identified by Chief of Naval Operations (CNO-N88), Program Executive Officer, Anti-Submarine Warfare (PEO-A) and PMA-231 for multi-target tracking of theater ballistic and cruise missiles and for 360 degree continuous Identification Friend or Foe (IFF) capability.
- (U) Completed technology development of UHF digital receiver and characterized performance in preparation for field testing at the Mountaintop Radar Facility in Kauai, Hawaii.
- (U) Flight tested concealed/buried target detection ultra-wideband radar to quantify target detection and image qualities in high false alarm conditions. DARPA and Army participated in flight test effort.
- (U) Integrated test bed model of airborne multi-mode radar system into test aircraft for performance evaluation against small seaborne craft and moving and stationary ground targets. DARPA, Air Force (AF) (Wright Laboratories) and Joint Surveillance Target Attack Radar System (JSTARS) program participated in evaluation.
- (U) Continued joint program with AF and DARPA to develop automatic target recognition algorithms in support of Tri-Service needs for long range identification of stationary and slow moving ground targets.
- (U) Integrated UHF Electronically Steered Array into Kauai, Hawaii Mountain Top Test Facility. Effort includes improvements to the facilities experimental radar and established connectivity to the Maui High Performance Computing Center (MHPCC).

- (U) EO/IR TECHNOLOGY: The EO/IR technology investment addresses Navy surveillance needs and exploits technology opportunities leading to advanced EO sensor and autonomous processing capabilities. The program emphasizes needs of major Navy air platforms for detection, acquisition, precision targeting and fire control handoff. Technologies such as multi-wavelength passive/active sensors and multi-dimensional signal processing algorithms to enhance detection and track

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performance in adverse environments are stressed. Optical apertures to enable multiple EO sensors to operate simultaneously from a single aperture are being developed.

- (U) Integrated dual band airborne Surveillance Infrared Search and Tracks (IRSTs) sensor into a fleet configured E-2C aircraft for aircraft compatibility and performance evaluation. Ballistic Missile Defense Organization (BMDO) funded laser ranger added to sensor to provide three dimensional (3D) targetting capability was included. This technology addresses needs for long range detection and tracking of Theater Ballistic Missiles identified by PEO- TSC and Program Executive Officer, Tactical Air (PEO-T).
- (U) Continued development of target discrimination and recognition algorithms to distinguish unique characteristics of man made objects relative to naturally occurring background clutter.
- (U) Continued joint program with United States Air Force (USAF) to develop Hyper-spectral infrared sensors for Naval Airborne Intelligence, Surveillance and Reconnaissance missions. Addresses needs identified by PMA-290 and PMA-265.
- (U) Continued modeling and simulation to optimize sensor operating characteristics and fusion of multi-wavelength EO passive and active sensor attributes. Developed cueing and control processing strategies to enable rapid hand-off of precision fire control data to on and off-board engagement systems.
- (U) Integrated multi-function electro-optic sensor technology completed in FY 98 into a distributed aperture infrared sensor system (DAIRS) specifically for the Joint Strike Fighter (JSF). This development addresses the JSF program office needs for passive infrared sensors to provide continuous situational awareness and missile warning. This development was coordinated with the Air Force within the JSF program office as part of Multifunction Infrared Distributed Aperture System (MIDAS) Fleet Air Defense (FAD) program and within the Defense Reliance Sensors, Electronics and Battlespace Environments Panel.
- (U) Initiated joint program with DARPA and PMA-290 to develop and demonstrate Hyper-spectral Electro-Optical Imaging technology on the EP-3 aircraft. Technology development emphasizes high resolution, multi-band imaging sensor and algorithms for target detection and confirmation. Initial plans for insertion of this technology is for EP-3 with follow-on application to F-18F Shared Reconnaissance POD (SHARP). This effort addresses needs identified by CNO-N88 and PEO-T for real time situational awareness, precision targeting and battle damage assessment.

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- (U) MULTI-SENSOR TECHNOLOGY: The Multi-Sensor technology program investment addresses Navy Intelligence, Surveillance and Reconnaissance needs and exploits technology opportunities leading to the integration, fusion and automated management of sensors operating within a platforms Combat System Architecture. The program emphasizes needs of major ship and air platforms and is developing crosscutting technologies that apply across platforms. Technologies such as processing architectures and algorithms to fuse, filter and correlate data and automated resource management processing are pursued.
  - (U) Completed development of targeting avionics sensor technology to provide precision targeting capabilities for U.S Navy and High Speed Anti-Radiation Missile (HARM) capable International aircraft.
  - (U) Demonstrated laser encoded IFF on AV-8B and F/A-18 aircraft at CNO-N66 sponsored All Service Combat ID Evaluation Team (ASCIET) trials. Follow-on evaluation will be conducted by cooperative research groups from North Atlantic Treaty Organization (NATO) member Nations.
  - (U) Integrated Data Fusion/Resource management processing algorithms into the SPY-1 radar at the Aegis Combat Systems Center and conducted ground system characterization and effectiveness assessments during theater ballistic missile tracking exercises. Addresses PEO-T SC needs for sensor resource management technology.
  - (U) Initiated system studies for the E-2C aircraft to define an integrated multi-sensor architecture to include tactical data links and the cooperative engagement capability (CEC) system. This effort responds to needs identified by CNO-N88 and PMA-231 for detection, discrimination, fire control quality tracking and engagements of missile threats.
- (U) COMMUNICATIONS NETWORKS: Continued development of technologies critical to performance and robustness of Naval Communications networks.
  - (U) Completed design of version 2 of the Multicast Dissemination Protocol (MDFPv2) and transitioned technology into the Army's Force XXI Battle Command Brigade and Below (FBCB2) system via successful testing of 50 radios.
  - (U) Tested and analyzed the prototype software for the high performance reliable multicast transport protocol and the Quality of Service (QoS) enhancements to the Internet Protocol (IP). This work extends Commercial off the Shelf (COTS) based reliable multicast protocols to various military applications. Presented the results to the Internet Engineering Task Force (IETF) for consideration in the next generation standards-track protocols. Coordinated via the Information Systems Technology (IST) Panel of the Defense S&T Reliance.

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- (U) Incorporated the enhanced transport and IP prototype software in the Asynchronous Transfer Mode (ATM) network tested and tested their performance relative to existing protocols. Borrowed ATM switches from France for performance testing. Conducted tests employing different ATM switches to determine quality of performance and interoperability. Coordinated via the IST Panel of the Defense S&T Reliance.
- (U) Investigated technical issues related to ATM use, such as signaling, interoperability robustness, and ability to support QoS at the application layer. Military use of ATM switches requires adaptation to RF media and is not limited to fiber-optic wires. Coordinated via the IST Panel of the Defense S&T Reliance.
- (U) Developed robust protocols and Quality of Service mechanisms for expeditionary warfare mobile networks. Coordinated via the IST Panel of the Defense S&T Reliance and co-chairing the IETF working group on Mobile Ad-Hoc Networking.
- (U) RADIO COMMUNICATIONS: Continued development of key communications technologies for air, ship and submarines.
- (U) Concluded the residual noise tests of the on-hull extremely low frequency (ELF) submarine antenna. This development provided first time capability for submarines to receive ELF transmissions without having to deploy a long trailing wire.
- (U) Analyzed data from the sea tests of the low profile buoyant cable submarine antenna. Performed comparative at-sea testing with DARPA buoyant-cable multi-element phased array design. This development enables up to an order of magnitude increase in data rate with UHF operation at speed and depth.
- (U) Completed development of the structurally-embedded, reconfigurable aircraft antenna array reconfiguration using optically activated switches. Structural embedment of antenna arrays reduces life cycle costs and radar cross-section. Coordinated via the IST Panel of the Defense S&T Reliance.
- (U) Conducted laboratory and field tests of the improved modem for UHF line-of-sight ship communications. Compared results with expectations, and defined further improvements as needed in the modem design and the power management algorithms. Coordinated via the IST Panel of the Defense S&T Reliance.
- (U) Demonstrated the use of CDMA and LPI technologies in Navy tactical networks in a series of line-of-sight field tests up to 50 miles using only 25 microwatts of power. CDMA requires adaptation from commercial networks to mobile military networks that require low probability of intercept/detection. Coordinated via the IST Panel of the Defense S&T Reliance.
- (U) Demonstrated a capability to provide a 45 Mbps link via a Ka-band satellite from a disadvantaged user with a 1 meter antenna system to a ship at sea.

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PROGRAM ELEMENT TITLE: Command, Control, Communications, Computers, Intelligence, Surveillance & Reconnaissance (C4ISR)

- (U) Developed Mechanically Assisted Phased Array (MAPA) antenna for the Ultra-Small Aperture Terminal (USAT) capable of Global Broadcast Service (GBS) reception on board Navy ships and aircraft. Demonstrated use of back-channel connectivity to the GBS. Coordinated via the IST Panel of the Defense S&T Reliance.
- (U) C2 AND COMBAT SYSTEMS: This merges previous projects in High Performance Computing, Artificial Intelligence/Human Computer Interface, and Engineering of Complex Systems from PE 0602234N, and Command Support from this program element (0602232N) into a more integrated and comprehensive Command, Control and Combat Systems Technology thrust that supports Navy needs in Network Centric Warfare. Integration of these important technology areas will be pursued in FY 99 and beyond in this PE. Scientific domains of interest include (1) dependable and high assurance computing; (2) image processing and information exploitation; (3) visualization of the Common Operational Picture (COP)/Common Tactical Picture (CTP) including virtual reality environments; (4) decision support and collaboration; and (5) network engagement and operation. Focus is on high assurance requirements specification and requirements testing, image compression and feature recognition, 3D virtual displays, architectures to merge Command and Control and Combat Systems, and distributed software development to support Defense Information Infrastructure Common Operating Environment (DII-COE) systems such as the Global Command and Control System (GCCS).
- (U) In support of the Common Operational Picture/Common Tactical Picture, implemented a video abstract agent and web-based agents; developed a cooperative query capability; and tested inter-agent architecture operation.
- (U) In support of Common Operational Picture/Common Tactical Picture, defined the real-time prototype environment to support distributed nodes; and integrated real-time mechanisms to support distributed collaboration.
- (U) In support of Common Operational Picture/Common Tactical Picture, evaluated the Covariance Intersection approach as a method to fuse data in a distributed environment.
- (U) Advanced decision support technologies through the development of case-based plan authoring and advanced use interfaces; implemented intelligent agents into existing real-time execution decision support; developed common representation and interaction between planning and monitoring support capabilities.
- (U) In support of Network Operations, defined the requirements and design specifications for Adaptive Rules of Engagement. Conducted user experiments with collaboration and decision support capabilities in coordination with Space and Naval Warfare Systems (SPAWAR) and the Sea-Based Battle Lab (USS Coronado). Incorporated collaborative environment and

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602232N

PROGRAM ELEMENT TITLE: Command, Control, Communications, Computers, Intelligence, Surveillance & Reconnaissance (C4ISR)

execution monitoring capabilities into Extending the Littoral Battlespace (ELB) Advanced Concept Technology Demonstration (ACTD) 1999 Demonstration.

- (U) Incorporated intelligent agents into 3D virtual reality architecture to control interactions and data flow between entities.

- (U) Developed collaborative software for combat system applications with allied and coalition countries leading towards interoperable systems.

- (U) Demonstrated the ability to fuse multi-spectral images as well as imagery and digital terrain elevation data to produce improved maps supporting targeting and mission planning. Applied techniques to produce image mosaics with variable spatial resolution.

- (U) Demonstrated feasibility of using ocean wave slope measurement by remote wave sensing in the littoral region toward improving the Rapid Airborne Mine Clearance System (RAMICS) anti-mine system. Devised, implemented, and tested a methodology for removal of capillary wave distortion in airborne lidar images of underwater mines.

- (U) Demonstrated real-time video image compression capability to be implemented onto the next generation Tomahawk. Demonstrated version 2 of the System of Systems software and evaluated the joint effects of compression and noise upon data link performance. Modularized the compression algorithms, template design algorithms and communications channel models and performed Monte Carlo simulations to analyze the effects of compression on the quality of the templates generated.

- (U) Software infrastructure for agent-based systems was developed in compliance with specifications developed by an international organization of R&D organizations, and is being used in ongoing project work and experimentally in at least three other system development efforts sponsored by the Department of Defense (DoD).

- (U) Designed and tested a prototype software tool that uses three formal techniques (term rewriting, Binary Decision Diagrams, and a constraint solver) to detect errors in software requirements specifications containing variables of different types (real, integer, Boolean, and enumerated): analysis of such specifications is not feasible with current technology.

- (U) Demonstrated flexible techniques to significantly reduce vulnerability of Navy Internet traffic to traffic flow analysis, making it difficult for commercial Internet routers to determine which Navy facilities are communicating with other Navy facilities via the commercial Internet infrastructure.

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PROGRAM ELEMENT: 0602232N

PROGRAM ELEMENT TITLE: Command, Control, Communications, Computers, Intelligence, Surveillance & Reconnaissance (C4ISR)

- (U) Developed a technical architecture that will provide needed interfaces for achieving distributed force coordination speed of command and control information grid (non-real-time) and combat system (real-time) grid in support of network centric speed of command and force synchronization.
- (U) Developed a scaleable architecture for a consistent COP/CTP that portrays a coherent visualization of the battlespace among distributed decision makers from the Commander-in-Chief to the unit level.
- (U) NAVIGATION: This program develops key navigation technologies for Naval aircraft, ships and submarines.
- (U) Compared quantum-well mirror ring laser gyro measurement results with conventionally designed ring laser gyros. This development promises to eliminate mechanical dithering and make ring laser gyros more producible and affordable.
- (U) Investigated use of pseudolites for acquiring ranging in addition to timing data using Global Positioning System (GPS) signals. This development would lower the vulnerability of GPS users to enemy jamming.
- (U) Applied modern digital signal processing technologies to the design and development of next generation GPS receivers for improved anti-jam protection.
- (U) Tested the Advanced Development Model II of the high performance fiber-optic gyro for FY01 transition to the Navy Special Project Office (SP-24). This development enables replacing the Electrostatic Suspended Gyro Navigator (ESGN) presently deployed on submarines with more affordable fiber-optic gyro navigators.
- (U) STRATEGIC SYSTEMS TECHNOLOGY: The objective of the Strategic System Sustainment project is to develop and demonstrate technologies in the areas of Missile Flight Science, Submarine Navigation, and Underwater Missile Launch to sustain these strategic capabilities that will (1) reduce the reliance on unique materials and processes, (2) reduce the reliance on human-expertise intensive processes, and (3) reduce the cost of maintaining these systems.
- (U) Assessed the existing missile flight science design and analysis codes for integration into a platform-independent architecture.
- (U) Developed Underwater Launch systems architecture.

2. (U) FY 2000 PLAN:

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BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602232N

PROGRAM ELEMENT TITLE: Command, Control, Communications, Computers, Intelligence, Surveillance & Reconnaissance (C4ISR)

- (U) RADAR TECHNOLOGY: The Radar Technology program investment addresses Navy surveillance needs and exploits radar sensor technology opportunities. Emphasis is on major platforms such as Ships and aircraft and cross cutting technologies that apply across all platforms. Major drivers include affordability and sensor performance in complex target, ECM and adverse environmental conditions including operations in the littorals. The radar technologies being developed in this program element are critical elements of Future Naval Capabilities Programs addressing Naval needs and requirements in Theater Air and Missile Defense (TAMD) and Time Critical Strike (TCS).
- (U) Conduct initial laboratory and field evaluations of High Power Millimeter Wave Radar Demonstration Model. Tracking quality and consistency will be evaluated against a variety of representative targets and countermeasure environments. Jointly conducted with the Electronics program under PE 0602234N.
- (U) Transition baseline UHF Electronically Steered Antenna (UESA) array technology to a technology demonstration phase of development under PE 0603238N. The technology demonstration of UESA is endorsed by OPNAV N-88 and the Commander Naval Air Systems Command (COMNAVAIRSYSCOM) and PEO-T PMA-231.
- (U) Integrate UHF Digital Receiver into the improved Mountaintop experimental Radar at PMRF, Kauai, Hawaii. Complete technology valuation during the UESA demonstration and transition to an advanced Airborne Early Warning (AEW) aircraft sensor system.
- (U) Complete flight test characterization of the Concealed Target Detection/Ground Penetrating UltraWideband Radar. This project is coordinated with the Defense S&T Reliance Sensors, Electronics and Battlespace Environments (SEBE) Panel.
- (U) Conduct flight measurements of the Airborne Multi-Mode Radar system to characterize performance against ground targets in all operating regimes (moving, stationary). Jointly conducted with DARPA, USAF Wright Laboratories and the JSTARS program.
- (U) Complete joint program with AF and DARPA to develop automatic target recognition algorithms and signal processing in support of joint Warfighter and Tri-Service needs for long range identification of stationary and slow moving ground targets. Coordinated with Defense Reliance SEBE Panel.
- (U) Conduct system studies and technology assessments necessary to define and develop advanced digital L/S-band volume surveillance radar (VSR) for surface combatants. Responds to technology needs of PEO-TSC.

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BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602232N

PROGRAM ELEMENT TITLE: Command, Control, Communications, Computers, Intelligence, Surveillance & Reconnaissance (C4ISR)

- (U) Develop algorithms and signal processing technology to enable naval forces to determine Combat Identification (CID) of Air Targets at long range. Supports needs identified by The Joint Theater Air and Missile Defense Office (JTAMDO).

- (U) EO/IR TECHNOLOGY: The EO/IR technology program investment addresses Navy surveillance needs and exploits technology opportunities leading to advanced EO sensor and processing capabilities. The program emphasizes needs of major Navy air platforms and is developing crosscutting technologies that apply across platforms. Technologies such as multi-wavelength passive/active sensors and multi-dimensional signal processing algorithms to enhance detection and track performance in adverse environments are stressed. Optical apertures to enable multiple EO sensors to operate simultaneously from a single aperture are being developed. Electro-Optical sensor technologies developed within this program element are critical elements of Future Naval Capabilities Programs addressing Naval needs and requirements in TAMD and TCS.
- (U) Complete in flight evaluation of the dual band Infrared Search and Tracks (IRST) on a fleet E-2C aircraft participating in Theater Ballistic Missile (TBM) detection and tracking exercises. This effort responds to stated needs of PEO TAD/SC and PEO-T for long range detection and precision tracking of TBMs. Jointly coordinated with the Air Force via Defense Reliance SEBE Panel.
- (U) Integrate BMDO funded eye safe laser sensor into dual band airborne E-2C IRST for sensor compatibility and performance evaluations. Responds to Joint Theater Air and Missile Defense Office needs for long range, detection and precision tracking of TBMs.
- (U) Continue development of target discrimination and recognition algorithms to distinguish unique characteristics of man made objects relative to naturally occurring background clutter.
- (U) Continue modeling and simulation to optimize sensor operating characteristics and fusion of multi-wavelength passive and active EO sensor attributes. Develop and optimize sensor cueing and control processing strategies to enable rapid hand-off of precision fire control information to on- and off-board engagement systems.
- (U) Transition baseline Distributed Aperture Infrared Sensor (DAIRS) to a technology demonstration phase as part of the Multifunction Infrared Distributed Aperture System (MIDAS) under PE 0603238N. This technology is identified as a critical element of the Joint Strike Fighter roadmap for situational awareness and missile warning.

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PROGRAM ELEMENT: 0602232N

PROGRAM ELEMENT TITLE: Command, Control, Communications, Computers, Intelligence, Surveillance & Reconnaissance (C4ISR)

- (U) Continue joint program with DARPA and PMA-290 to develop Hyper-spectral Imaging sensor and processing for demonstration on the EP-3 aircraft. This effort addresses needs identified by CNO-N-88 and PEO-A for real time situational awareness, precision targeting and battle-space assessment.
- (U) Develop concepts for development of laser and laser identification image profiling, leveraging DARPA developments in high frame rate Focal Plane Arrays to provide Navy and Marine Corps platforms with real-time, long-range target discrimination and identification capability.
- (U) MULTI-SENSOR TECHNOLOGY: The Multi-Sensor technology program investment addresses Navy Intelligence, Surveillance and Reconnaissance needs and exploits technology opportunities leading to the integration, fusion and automated management of sensors operating within a platform Combat System Architecture. The program emphasizes needs of major ship and air platforms and is developing crosscutting technologies that apply across platforms. Technologies such as Multi-Sensor processing architectures and algorithms to fuse, filter and correlate data and automated resource management processing are pursued. Multi-Sensor technologies are fundamental to addressing needs in platform and network centric warfare. The multi-sensor integration (MSI) technologies addressed within this program element focus on Naval needs and requirements being addressed in the Future Naval Capabilities programs in TAMD and TCS.
- (U) Continue evaluation of Radar Resource Management processing algorithms in SPY-1 Radar at Aegis Combat Systems Center, Wallops Island, VA. This effort responds to needs identified by PEO TSC for long range detection, discrimination and continuous tracking of theater ballistic missiles.
- (U) Evaluate multi-source integration and data fusion algorithms in the E-2C aircraft Sensor Integration Laboratory and assess operational effectiveness improvements in Theater Air and missile defense operating environments. Responds to needs identified by the Fleet, Program Executive Officer, Tactical Aircraft Programs (PEO-T) for timely integration and dissemination of on and off board sensor information in all operating scenarios.
- (U) Develop algorithms and system interfaces incorporating the cooperative engagement capability network into the E-2C MSI and data fusion system architecture.

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PROGRAM ELEMENT: 0602232N

PROGRAM ELEMENT TITLE: Command, Control, Communications, Computers, Intelligence, Surveillance & Reconnaissance (C4ISR)

- (U) COMMUNICATIONS NETWORKS: Continue development of technologies critical to performance and robustness of Naval Communications networks. Technologies within this program support Future Naval Capabilities (FNC) programs Information Distribution.
- (U) Continue development of key communications network technologies for air, ship and submarines necessary for network-centric warfare.
- (U) Evaluate the performance of the new reliable multicast and IP QOS protocols. Make analytic results available to the IETF in order that the commercial standard is compatible with military applications. Coordinated with Information Systems Technology (IST) Panel of the Defense S&T Reliance.
- (U) Conduct performance and interoperability testing of different ATM switches over the high speed ATMtestbed employing the new reliable multicast and IP QOS protocols. Coordinated with the IST Panel of the Defense S&T Reliance.
- (U) Develop end-to-end multicast congestion control technology and simulate performance. Develop involvement with related standards and research community via the Internet Engineering Task Force (IETF).
- (U) Evaluate simulation results of wireless, mobile network performance in relation to projected needs of military applications. Transition results to the Interoperable Networks for Secure Communications (INSC) 6.3 program to enable test/demonstration for coalition warfare. Coordinated with the IST Panel of the Defense S&T Reliance and co-chairing the IETF working group on Mobile Ad-Hoc Networking.
- (U) Develop adaptive, dynamic wireless networking protocol for the Tactical Data Link. Coordinate with the Link-16 Program Office.
- (U) Develop networking requirements and provide a functional description of a wideband networked waveform for the Joint Tactical Radio System (JTRS) Joint Program Office (JPO). Coordinated with the RF Networking IPT within the JTRS JPO and via the IST Panel of the Defense S&T Reliance.
- (U) RADIO COMMUNICATIONS: Continue development of key communications technologies for air, ship and submarines.
- (U) Investigate Code Division Multiple Access (CDMA) links as back channel for GBS, employing very small aperture terminals appropriate for small craft use.

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PROGRAM ELEMENT: 0602232N

PROGRAM ELEMENT TITLE: Command, Control, Communications, Computers, Intelligence, Surveillance & Reconnaissance (C4ISR)

- (U) Demonstrated the use of Code Division Multiple Access (CDMA) technologies in Navy tactical networks. CDMA requires adaptation from commercial networks to mobile military networks that require low probability of intercept/detection. Coordinated via the IST Panel of the Defense S&T Reliance.
- (U) Continue field testing of low probability of intercept/detection technologies using microwatt power levels.
- (U) Transition the low-profile buoyant cable antenna enhancement to 6.3 Advanced Technology Demonstration.
- (U) Transition the on-hull extremely low frequency (ELF) antenna to the Submarine Integrated Antenna System (SIAS) 6.4 project within PMW-173.
- (U) Develop technologies to enable large aperture multiple frequency band, multiple function antennas for current and future Navy attack submarines. Provide enhanced submarine connectivity and maximum stealth. Coordinated via the IST panel of the Defense S&T Reliance.
- (U) Transition the improved modem technology for Ultra-High Frequency (UHF) line-of-sight communications to the Joint Tactical Radio System (JTRS). Coordinated with the JTRS RF Networking IPT and via the IST Panel of the Defense S&T Reliance.
- (U) Incorporate the Mechanically Assisted Phased Array (MAPA) antenna as part of Ultra-Small Aperture Terminal (USAT). Test and evaluate performance of MAPA antenna on different naval platforms. Coordinated via the IST Panel of the Defense S&T Reliance.
- (U) Investigate new advanced waveform and turbo coding technology to achieve higher data throughput within existing military channel bandwidths. Coordinated via the IST Panel of the Defense S&T Reliance.
- (U) COMMAND, CONTROL (C2) AND COMBAT SYSTEMS: This program develops and demonstrates software components and technologies that enable the Navy's concepts of Network-Centric Warfare and the Joint Chiefs Joint Vision 2010. The focus is on militarily-unique information processing technologies that enable information dominance through vastly improved speed of command. Particular emphasis is directed to issues involving the ability of geographically distributed Naval decision-makers to collectively generate and perceive a Common Tactical/Operational picture, and to jointly plan and monitor military missions. All of the research efforts recognize the important role of COTS software components, and consequently they focus on maximizing the integration of such software into software functionality for Naval applications. Technologies within this program support FNC programs addressing Decision Support and Information Distribution.

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PROGRAM ELEMENT: 0602232N

PROGRAM ELEMENT TITLE: Command, Control, Communications, Computers, Intelligence, Surveillance & Reconnaissance (C4ISR)

- (U) In support of Common Operational Picture/Common Tactical Picture, continue development of intelligent agent technology to provide agent-based user profiling. Transition agent architecture to DISA GCCS.
- (U) Integrate visualization basic research efforts into Common Operational Picture/Common Tactical Picture. Apply spatial database techniques for correlating covariance intersection estimates for corresponding entities to enhance consistency across different tactical pictures. Initiate effort on developing techniques to enhance real-time picture with non-real-time information.
- (U) Develop initial prototype for a tactical collaborative environment to use during Littoral Warfare.
- (U) In support of continuous planning-execution cycle, continue advances in a case-based reasoning plan authoring tool; develop a prototype Dynamic Resource Allocation capability to support real-time retargeting situations.
- (U) In support of Network Operations, investigate the process and issues associated with Rules of Engagement (ROE) at all echelons of control starting with the National Command Authority (NCA) through the Commander in Chief (CINC) to the Battle Group to the individual Support Element Weapon System.
- (U) Identify requirements and functional building blocks of a Commander in Chief Pacific Fleet (CINCPACFLT) HQ21 Architecture with the goal of developing a facility to test and evaluate COTS software in a military operational context.
- (U) Demonstrate distributed software that will enable users at remote locations to collaborate for effective planning using 3D, interactive virtual reality displays with objects having physical realism.
- (U) Precisely quantify image spatial domain error propagation and further study the problem of feature detection in wavelet space.
- (U) The agent-based information exploitation and retrieval system will be applied to the task of monitoring dynamic data sources in order to supply information to a decision-support system for planning-execution-re-planning of military operations. Demonstrate this application and the general-purpose information exploitation and retrieval system
- (U) Under the System of Systems program, demonstrate chip out technology and develop/understand transmitting the targeting template through additional compression stages in the presence of channel noise. Introduce techniques to optimize joint channel source encoding to maximize performance and adapt the system.
- (U) Demonstrate a distributed software infrastructure prototype development for use in integrated COTS tools by incorporating Software Process, Configuration Management, and wide-area traceability capabilities.

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PROGRAM ELEMENT: 0602232N

PROGRAM ELEMENT TITLE: Command, Control, Communications, Computers, Intelligence, Surveillance & Reconnaissance (C4ISR)

- (U) Continue development of interface specification and architecture merging command and control functions and platform battle management in a secure distributed network combining non-real-time and real-time databases and operations.
- (U) Continue study and develop methodology for accurate geo-rectification of sensor images with digital terrain elevation data. Integrate algorithms into Powerscene.
- (U) NAVIGATION: This program develops key navigation technologies for Naval aircraft, ships and submarines.
- (U) Transition the high performance fiber-optic gyro, Advanced Development Model-II to the Director, Navy Strategic Systems Project (SP-24).
- (U) Perform laboratory proof-of-concept demonstration of the next generation digital GPS receiver for anti-jam performance.
- (U) Develop advanced aircraft antenna technologies that reduce the vulnerability of GPS to jamming through beamforming/null steering.
- (U) Develop higher stability fiber-optic gyros by reducing fiber thermal dependence.
- (U) Enhance navigation accuracy and robustness through integration of LINK 16, GPS and other applicable navigational sensors and communication systems.
- (U) Transition the quantum-well mirror ring laser gyro technology to Navy tactical missiles and ring laser gyro manufacturers.
- (U) Develop the atom interferometer gravity gradiometry technology to achieve sensitivity adequate for passive terrain avoidance.
- (U) STRATEGIC SYSTEMS TECHNOLOGY: The objective of the Strategic System Sustainment project is to develop and demonstrate technologies in the areas of Missile Flight Science, Submarine Navigation, and Underwater Missile Launch to sustain these strategic capabilities that will (1) reduce the reliance on unique materials and processes, (2) reduce the reliance on human-expertise intensive processes, and (3) reduce the cost of maintaining these systems.
- (U) Continue development of methodologies for drag reduction, nuclear survivability, and solid motor ignition codes for the missile flight science design and analysis tool.

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PROGRAM ELEMENT: 0602232N

PROGRAM ELEMENT TITLE: Command, Control, Communications, Computers, Intelligence, Surveillance & Reconnaissance (C4ISR)

- (U) Continue development of electronic databases for Underwater Missile Launch tool.

3. (U) FY 2001 PLAN:

- (U) RADAR TECHNOLOGY: The Radar Technology program investment addresses Navy surveillance needs and exploits radar sensor technology opportunities. Emphasis is on major platforms such as ships and aircraft and cross cutting technologies that apply across platforms. Major drivers include affordability and sensor performance in complex target, ECM and Adverse environmental conditions including operations in the littorals. The radar technologies being developed in this program element are critical elements of Future Naval Capabilities Programs addressing Naval needs and requirements in TAMD and TCS.
- (U) Continue performance evaluation of High Power Millimeter Wave Radar Demonstration Model in varying target and clutter conditions typical of Naval Surface Combatant operations in littoral environments. Program jointly conducted with the Electronics program under PE 0602234N.
- (U) Continue risk reduction development of UHF Electronically Steered Array emphasizing spacetime adaptive processing and solid State transmitter module development to improve E-2C radar performance in Littoral Environments.
- (U) Continue Multimode Airborne Radar development and integrate into a fleet EP-3 aircraft for flight evaluation.
- (U) Conduct system study and identify critical technologies necessary to develop a Precision Surveillance and Targeting Radar technology in support of Time Critical Strike Targeting needs.
- (U) Continue Volume Surveillance Radar development for surface combatants.
- (U) Continue CID algorithm and signal processing development in support of the Joint Theater Air and Missile Defense office (JTAMDO) needs.
- (U) EO/IR TECHNOLOGY: The EO/IR technology program investment addresses Navy surveillance needs and exploits technology opportunities leading to advanced EO sensor and processing capabilities. The program emphasizes needs of major Navy air platforms and is developing crosscutting technologies that apply across platforms. Technologies such as multi-wavelength

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PROGRAM ELEMENT: 0602232N

PROGRAM ELEMENT TITLE: Command, Control, Communications, Computers, Intelligence, Surveillance & Reconnaissance (C4ISR)

passive/active sensors and multi-dimensional signal processing algorithms to enhance detection and track performance in adverse environments are stressed. Optical apertures to enable multiple EO sensors to operate simultaneously from a single aperture are being developed. Electro-Optical sensor technologies developed within this program element are critical elements of FNC. Programs addressing Naval needs and requirements in TAMD and TCS.

- (U) Initiate development of split aperture optics to enable E-2C surveillance IRST to simultaneously detect and track both theater ballistic and cruise missiles. This development responds to needs for long range detection and precision tracking of theater ballistic and cruise missiles in response to the Joint Theater Air and Missile Defense Office, CNO-N-88, PEO-TSC and PMA-231 needs.

- (U) Conduct performance and operational utility evaluation of E-2C surveillance IRST with integrated eye safe laser (BMDO developed) during theater ballistic missile detection and tracking exercises at PMRF, Kauai, Hawaii. This development responds to needs identified by the Joint Theater Air and Missile Defense Office, CNO-N88, PEO TAD/SC and PMA-231.

- (U) Complete development of target discrimination algorithms once deficiencies identified during FY2000 land and flight evaluations are corrected. These algorithms will be the baseline signal processing for both E-2C IRST and the ship based staring infrared panoramic sensor system. This development responds to needs for long range target detection and discrimination in varying and extreme environmental clutter conditions. Needs identified by PEO (CIA) and PMA-231.

- (U) Continue development modeling and simulation tools to enable cost effective evaluation of new device and signal processing technologies for integration into existing and planned Naval Infrared Sensor systems.

- (U) Integrate Hyper-spectral Imaging Sensor into EP-3 aircraft for in flight sensor performance and operational utility evaluation. Flight evaluation is planned to begin in FY-2002 and will be conducted by PMA-290 in operational scenarios. Joint program with DARPA.

• (U) MULTI-SENSOR TECHNOLOGY: The Multi-Sensor technology program investment addresses Navy Intelligence, Surveillance and Reconnaissance needs and exploits technology opportunities leading to the integration, fusion and automated management of sensors operating within a platforms Combat System Architecture. The program emphasize needs of major ship and air platforms and is developing crosscutting technologies that apply across platforms. Technologies such as processing architectures and algorithms to fuse, filter and correlate data and automated resource management processing are pursued. Multi-Sensor

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technologies are fundamental to addressing needs in platform and network centric warfare. The MSI technologies addressed within this program element focus on Naval needs and requirements being addressed in the FNC programs in TAMD and TCS.

- (U) Transition radar resource management processing technology improvement to Aegis SPY-ID radar to improve track consistency and quality against theater ballistic missile targets. This technology responds to CNO-N-86 and PEO-TSC needs for long-range detection and fire control quality tracking of TBMs.

- (U) Continue development of MSI technology specifically for the E-2C airborne early warning aircraft sensors and network centric warfare systems. This technology program responds to needs for onboard platform fusion of multi-sensor information and networking of sensor measurement information via tactical data links and the cooperative engagement capability system to facilitate real time situational awareness and timely engagement of threats. Needs for this technology identified by Joint Theater Air and Missile Defense Office, CNO-N88, N-86, PEO TAD/SC, PEO-A and PMA-231.

- (U) Continue development of algorithm and interface technology to enable effective integration of CEC into the E-2C MSI system.

- (U) COMMUNICATIONS NETWORKS: Continue development of technologies critical to performance and robustness of Naval Communications networks. Technologies within this program support FNC programs addressing Information Distribution.
- (U) Support planning for mobile networking demonstrations as part of the Interoperable Networks for Secure Communications (INSC) program. Coordinated via the IST Panel of the Defense S&T Reliance and co-chairing the Internet Engineering Task Force (IETF) working group on Mobile Ad-Hoc Networking.
- (U) Complete reliable multicast and congestion control design and simulation. Maintain involvement with related standards and research community via the Internet Engineering Task Force (IETF). Begin transition of technology into Navy Communications (INSC). Continue involvement with related standards and research community via the Internet Engineering Task Force (IETF). Coordinated via the IST Panel of the Defense S&T Reliance.
- (U) Continue development of the adaptive, dynamic wireless networking protocol for the Tactical Data Link and add IP networking with Quality-of-Service capability. Coordinate with the Link-16 Program Office.

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PROGRAM ELEMENT TITLE: Command, Control, Communications, Computers, Intelligence, Surveillance & Reconnaissance (C4ISR)

- (U) Complete expeditionary warfare mobile networking design with Quality of Service features and incorporate into INCS 6.3 program for demonstration in a coalition environment. Coordinated via the IST Panel of the Defense S&T Reliance.
- (U) Participate in the Joint Tactical Radio System (JTRS) RF Networking IPT and evaluate candidate wideband networked waveforms for inclusion in the future JRR. Coordinated with the JTRS Joint Program Office.
- (U) RADIO COMMUNICATIONS: Continue development of key communications technologies for air, ship and submarines.
- (U) Demonstrate CDMA satellite link as a GBS back channel employing commercial or military satellites. Coordinated via the IST Panel of the Defense S&T Reliance.
- (U) Integrate submarine electromagnetic structures with large aperture multi-band, multifunction submarine antenna for satellite communications. Technology to eventually transition into new attack submarines.
- (U) Complete design of new advanced waveform and turbo coding technology to achieve 3 to 5 times higher data throughput within existing military channel bandwidths. Complete prototype hardware and testing for satellite application. Coordinated via the IST Panel of the Defense S&T Reliance.
- (U) Complete development of the Ultra Small Aperture terminal (USAT) for K&Ka band satellite connectivity to mobile users. This technology is expected to provide 1.5 Mbps data rates to mobile users (aircraft, ships and ground mobile vehicles).
- (U) C2 AND COMBAT SYSTEMS: This program develops and demonstrates software components and technologies that enable the Navy's concepts of Network-Centric Warfare and the Joint Chiefs Joint Vision 2010. The focus is on militarily-unique information processing technologies that enable information dominance through vastly improved speed of command. Particular emphasis is directed to issues involving the ability of geographically distributed Naval decision-makers to collectively generate and perceive a Common Tactical/Operational picture, and to jointly plan and monitor military missions. All of the research efforts recognize the important role of Commercial-off-the-Shelf software components, and consequently they focus on maximizing the integration of such software into software functionality for Naval applications. Technologies within this program support FNC programs addressing Decision Support and Information Distribution.
- (U) In support of Common Operational Picture/Common Tactical Picture, continue development of intelligent information retrieval techniques that automate a user's profile with intelligent agent software for retrieval of data (i.e. right

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PROGRAM ELEMENT: 0602232N

PROGRAM ELEMENT TITLE: Command, Control, Communications, Computers, Intelligence, Surveillance & Reconnaissance (C4ISR)

information, right time, right person); continue enhancing the Common Operational Picture/Common Tactical Picture using 3D virtual reality display techniques.

- (U) Test and evaluate data fusion techniques (e.g., covariance intersection) on various platforms and with diverse sensor data sources. Continue effort to develop software for use in interoperable real-time and near-real time systems.

- (U) Continue to test, evaluate, and enhance collaborative software for application to Littoral Warfare.

- (U) Integrate a case-based reasoning plan-authoring tool for mission planning with intelligent decision support visualization techniques for user experimentation.

- (U) In support of Theater Missile Defense, continue development of a prototype for an Adaptive Rules of Engagement. Incorporate collaborative environments and interactive decision support tools into the Extending the Littoral Battlespace ACTD.

- (U) Demonstrate a full multi-modal Human Factor Interface for the Virtual Reality Responsive Workbench and GROTO systems including voice, sound, gesture, and other interactive methods that can be used by decision makers.

- (U) Develop a framework of data compression techniques to be used in a two-way communications link.

- (U) Develop, test and evaluate algorithms exploiting geometrically invariant techniques for image-on-image (multi-spectral) and image-on-map registration in a coarse-to-fine multi-resolution approach.

• (U) NAVIGATION: This program develops key navigation technologies for Naval aircraft, ships and submarines.

- (U) Transition the high performance fiber-optic gyro, Advanced Development Model-II to the Director, Navy Strategic Systems Project (SP-24).

- (U) Complete accuracy and stability assessment of the atom interferometer gravity gradiometer to enable passive avoidance of undersea terrain for submarine.

- (U) Design a high dielectric 7-element GPS Antenna array with digital beamforming and null steering electronics.

- (U) Develop demonstration hardware/software for the integrated LINK-16/GPS/inertial navigation system.

- (U) Design and test in the laboratory a low observable M-CRPA (Miniature-Controlled Reception Pattern Antenna) GPS anti-jam aircraft antenna.

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Budget Item Justification  
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DATE: February 2000

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602232N

PROGRAM ELEMENT TITLE: Command, Control, Communications, Computers, Intelligence, Surveillance & Reconnaissance (C4ISR)

- (U) Plan to transition techniques that reduce GPS vulnerability to jamming and spoofing to the Navy GPS modernization program in PMW/PMA-187.
- (U) SPACE/STRATEGIC SYSTEMS TECHNOLOGY: This program is developing new component technologies, design codes and simulations to preclude obsolescence in ballistic missile system circuitry, design approaches and launch systems.
- (U) Continue the development a design code to minimize the expertise required to design Ballistic Missiles.
- (U) Continue the development of an underwater missile launch computer simulation model.

## B. (U) PROGRAM CHANGE SUMMARY:

	FY 1999	FY 2000	FY 2001
(U) FY 2000 President's Budget	67,008	68,823	70,272
(U) Appropriated Value		82,823	
(U) Program Execution Adjustments	-2,685		
(U) Comparability Adjustment	7,929	8,857	
(U) Program Adjustments			10,985
(U) FY 99 SBIR/STTR Transfer	-823		
(U) Inflation Adjustment	-290		
(U) Various Rate Adjustments			
(U) Congressional Recission		-514	
(U) Congressional Plus Ups		14,000	
(U) FY 2001 PRESUDG Submission	71,139	91,166	79,905

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Budget Item Justification  
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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602232N

PROGRAM ELEMENT TITLE: Command, Control, Communications, Computers, Intelligence, Surveillance & Reconnaissance (C4ISR)

(U) CHANGE SUMMARY EXPLANATION:

(U) Schedule: Not applicable.

(U) Technical: Not applicable

C. (U) OTHER PROGRAM FUNDING SUMMARY: Not applicable

(U) RELATED RDT&E: This program adheres to Defense Science and Technology Reliance Agreements with oversight provided by the Joint Directors of Laboratories-(JDL) Reliance. Work in this PE is related to and fully coordinated with efforts in the following PEs:

- (U) PE 0602702F (Command, Control and Communications)
- (U) PE 0602204F (Aerospace Avionics)
- (U) PE 0602782A (Command, Control and Communications (C) Technology)
- (U) PE 0602204F (Aerospace Avionics)
- (U) PE 0602709A (Night Vision Technology)
- (U) PE 0601153N (Defense Research Science)
- (U) PE 0603792N (Advanced Technology Transition)
- (U) PE 0603217N (Air Systems and Weapons Advanced Technology)
- (U) PE 0603238N (Precision Strike and Air Defense Advanced Technology)
- (U) PE 0603794N (C3 Advanced Technology)
- (U) PE 0602234N (Materials, Electronics and Computer Technology)

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DATE: February 2000

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602232N

PROGRAM ELEMENT TITLE: Command, Control, Communications, Computers, Intelligence, Surveillance & Reconnaissance (C4ISR)

D. (U) SCHEDULE PROFILE: Not applicable.

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DATE: February 2000

FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

PROGRAM ELEMENT: 0602233N  
 PROGRAM ELEMENT TITLE: Human Systems Technology

BUDGET ACTIVITY: 2

(U) COST: (Dollars in thousands)

PROJECT NUMBER & ACTUAL	FY 1999 ACTUAL	FY 2000 ESTIMATE	FY 2001 ESTIMATE	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	TO COMPLETE	TOTAL PROGRAM
Human Systems Technology	33,790	30,417	30,939	31,898	29,452	29,358	28,922	CONT.	CONT.

A. (U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: This program element (PE) provides generic affordable technologies in support of: a) the Integrated Warfare Architecture (IWAR) Support Areas for Manpower & Personnel, Training, Readiness, and Technology; b) all the IWAR Mission Areas; and c) the Future Naval Capabilities (FNCs) for Decision Support Systems, Capable Manpower, Total Ownership, and Warfighter Protection. The IWAR Support Areas encompass requirements for manning, operating, and maintaining fleet assets and for providing the necessary training to maintain operating forces in a high state of readiness. The PE also supports the Joint Warfare Strategy "Forward...From the Sea" as well as three of the "Top Five" Future Joint Warfighting Capabilities identified by the Joint Chiefs of Staff -- in particular, capabilities related to: a) conducting limited-objective warfare (e.g., technology for enhancing the performance of special forces personnel, aiding decision makers in highly ambiguous situations, and improving casualty care); b) promptly engaging regional forces worldwide (e.g., technology for deployable training and mission rehearsal); and c) countering weapons of mass destruction (e.g., technology for responding to chemical and biological threats). This PE encompasses the following areas:

(U) Personnel, Training, and Human Factors technologies enhance the Navy's ability to select, assign, and manage its people; to train effectively and affordably in classroom settings, in simulated environments, and while deployed; and to operate effectively in the complex, high-stress, information-rich and ambiguous environments of modern warfare. Technology development in these areas responds to a variety of requirements, including: providing more affordable approaches to

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Budget Item Justification  
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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602233N

PROGRAM ELEMENT TITLE: Human Systems Technology

training and skill maintenance; 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.

(U) Medical technologies increase cost savings; improve safety and enhance personnel performance capabilities under adverse conditions; enhance diagnosis of medical emergencies and treatment of casualties; and prevent costly occupational injury and disease in hazardous environments. Requirements which support technology development in these areas include: improving warfighting capabilities through enhanced supply and long-term storage of prepositioned medical supplies such as blood; providing better stress endurance/control for key personnel; and providing enhanced casualty care onboard amphibious casualty receiving ships.

(U) This PE also seeks to strengthen the educational pipeline vital for maintaining a strong technology development capability, by supporting programs at a wide range of educational institutions, including Historically Black Colleges & Universities, and other Minority Institutions. In addition, the PE provides funding for the Navy Science Assistance Program, (NSAP) the purpose of which is to improve the ability of the Navy's science and technology community to respond rapidly to urgent fleet needs. Programs in this PE are jointly planned in the Reliance process with the Air Force and Army via panels of the Joint Directors of Laboratories, the Training & Personnel Systems Science & Technology Evaluation and Management Committee, and the Armed Services Biomedical Research Evaluation and Management Committee.

(U) Due to the volume and diversity of efforts included in this PE, the programs described in the Accomplishments and Plans sections are representative selections of work performed in this PE.

(U) The Navy S&T program includes projects that focus on or have attributes that enhance the affordability of warfighting systems.

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Budget Item Justification  
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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602233N  
PROGRAM ELEMENT TITLE: Human Systems Technology

(U) JUSTIFICATION FOR BUDGET ACTIVITY: This program is budgeted within the Applied Research Budget Activity because it investigates technological advances with possible applications toward solution of specific Naval problems, short of a major development effort.

(U) PROGRAM ACCOMPLISHMENTS AND PLANS:

(U) FY 1999 ACCOMPLISHMENTS:

- (U) PERSONNEL, TRAINING AND HUMAN FACTORS TECHNOLOGY:

- Initiated:

- (U) experiments with terrain data to systematically investigate the human performance benefit of Perspective View Technology (PVT) displays for operators and decision makers.
- (U) evaluation of knowledge management tools and agent-base software for the collection, filtering, fusion and presentation of open-source data.
- (U) assessment of the United States Marine Corps (USMC) command post Tactical Decision making performance under conditions of uncertainty using dynamic tactical scenarios.
- (U) development of distributed debriefing capability for network centric warfare in an information intense environment.
- (U) design, development, and evaluation of Direct Perception display formats for aircraft navigation instruments.
- (U) development of visual attention shift scenarios and experiments for studying operator-alerting mechanisms for critical event management under conditions of reduced manning

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602233N  
PROGRAM ELEMENT TITLE: Human Systems Technology

- (U) development of cohort database for screening procedures that can predict those individuals who are disqualified from submarine service at some time after completion of Basic Enlisted Submarine School (BESS) for motivational, psychological, or performance related grounds.
- (U) multi-player business simulation game exercise for a selected cadre of Navy manpower, force structure, and acquisition participants.
- (U) development of a distributed battlespace simulation research facility and identification of principles for training distributed teams.
- (U) investigation of applications of cognitive/perceptual models of performance and cognitive task analysis in simulation-based environments and instructional systems.
- (U) interactive electronic technical manuals and advanced interactive augmentation strategies for technical training and aiding.
- Continued:
- (U) development and evaluation of unconventional visual, auditory and haptic cueing techniques to enhance learning of complex perceptual-motor skills.
- (U) feasibility evaluation of continuous speech recognition technology for the development of a virtual instructor for training complex team skills.
- (U) evaluation of the tactical Response Planner and Manager (RPM) monitoring display with full scale prototype at Surface Warfare Officer School (SWOS) Department Head School.
- (U) development of human-relations skills test items as part of effort to identify, develop and validate multimedia tests that can predict important military behavior including academic and non-academic attrition, and other measures of military success.
- (U) design and development of new visual presentation schemes and testing on sample users.
- (U) development of computer-based tools to improve the Navy's force management capabilities and development of an integrated personnel distribution model.

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602233N  
PROGRAM ELEMENT TITLE: Human Systems Technology

- (U) development of a testbed for examining principles of collaborative decision making in knowledge-rich Collaborative Media System environments.
- (U) establishment of empirical link between mentoring and re-enlistment intentions, and development and testing of a strategy for structured peer mentoring.
- Completed:
- (U) demonstration and evaluation of large flat panel displays for use in aviation mission planning, mission rehearsal, and training systems.
- (U) development of design guidelines for a Combat Supervisory Support System (CSSS) that provides for reduced shipboard manning and increased automation, and supports the use of reconfigurable, collaborative task teams.
- (U) collection of flight simulator navigation performance data to support development of a computational model of Direct Perception.
- (U) evaluation of the effect of PVT in a 3 dimensional (3D) tactical terrain understanding.
- (U) documentation of the effect of uncertainty on tactical decision making in land warfare.
- (U) development of new mathematical algorithms to address two persistent training problems associated with course scheduling and booking of training seats.
- (U) validated a model of ship readiness to improve the Navy's ability to predict fleet readiness based on training and manpower resources expended.
- (U) development of Automated Task Analysis Tool allowing subject matter experts to articulate tactical knowledge through scenario design.
- (U) incorporation of continuous learning concepts into ATGLANT shipboard training and VS-41 training.
- (U) development and testing of SALIANT - a tool for measuring situational awareness; laboratory evaluation of instructional strategies and measurement techniques for aircrew situational awareness.

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602233N  
PROGRAM ELEMENT TITLE: Human Systems Technology

- (U) laboratory investigations that demonstrated combined contributions of integrated instructional strategies and decision support aiding in Combat Information Center (CIC), and that validated guidelines, metrics and tools to dynamically assess tactical decision-making.
- (U) laboratory evaluations of instructional strategies for scenario-based training.
- (U) design of scaleable architecture for distributed interactive simulation and adaptation to high-level architecture networks; development of software tools (SimulationMiddleware Object Classes). development and demonstration of tactical acoustic signal processing in real-time with commercial off-the-shelf hardware.

## • (U) MEDICAL TECHNOLOGY:

- Initiated:
  - (U) comparison of commercially available fluids in an animal model of combined hemorrhage and head injury.
  - (U) maintenance of optimal physiological and cognitive function in cold environments - effects of tyrosine administration.
  - (U) development of multiple biosensor signal integrator for detection of toxic substances.
  - (U) investigation of effects of sopite syndrome on operational performance.
- Continued:
  - (U) investigation of evoked otoacoustic emissions as replacement for pure-tone audiometry to measure hearing loss.
  - (U) investigation of selected methods for measuring electrophysiological-, cellular-, and molecular-level neurotoxic effects for further development and incorporation into neuro-molecular toxicity assessments.

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Budget Item Justification  
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DATE: February 2000

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602233N  
PROGRAM ELEMENT TITLE: Human Systems Technology

- (U) development of supportive resuscitation fluids that minimize tissue damage and facilitate stabilization of hemorrhagic and burn casualties.
- (U) research and development of therapeutic regimens/modalities that prevent reperfusion injuries after combat trauma and hemorrhage.
- (U) development of immune modulators for prevention of multiple organ failure.
- (U) studies on submarine watchstanding regimen for enhanced performance of submariners.
- (U) studies on assessment of spatial thinking abilities in submarine personnel to develop novel command and control interfaces. Initial studies completed on required spatial abilities.
- (U) undersea medicine programs that lead to preventive and treatment methods for oxygen toxicity and enhanced protocols for improving submarine rescue scenarios and special warfare operations.
- (U) investigation of operational durability of G-tolerance due to pilot down time.
- (U) demonstration of the effectiveness of antioxidant rescue of noise induced hearing loss.
- (U) mechanism research to prevent performance decrements during military operations in extreme environments implementing biomedical and pharmacologic interventions.
- (U) research in chronic or high pulse exposure to induced body currents from radio frequency radiation and develop techniques to ameliorate adverse human health effects through physical and/or biological protections.
- Completed:
  - (U) identification of mechanisms involved in hyperbaric oxygen-induced seizure genesis; electrophysiological mechanisms and brain structures mediating the onset of hyperbaric oxygen convulsions identified. Transitioned to large animal hyperbaric oxygen toxicity model.
  - (U) study on countermeasures to physical performance decrements in special operations. Studies reported on time course of muscle glycogen supercompensation and effects of depletion exercise.
  - (U) second phase of testing of oral interleukin-6 for prevention of intestinal ischemia following hemorrhage.

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Budget Item Justification  
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BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602233N  
PROGRAM ELEMENT TITLE: Human Systems Technology

-- (U) evaluation of interleukin-11 for preservation of intestinal barrier function following hemorrhage  
-- (U) optimization of trans-crocininate delivery following hemorrhage.  
-- (U) research to identify biomarkers of cardiac sensitization associated with exposure to refrigerants and fire suppression materials and to develop preventive measures; determine applicability of heart rate variability analysis to identifying adverse impact of toxicants.

• (U) NSAP:

-- (U) identified specific solutions to known operational capability needs and provided the means to develop and demonstrate prototype systems. This program supported the conversion of the Dakota Unmanned Autonomous Vehicle (UAV) engine to run on heavy fuel in support of the UAV payload work being done for CINCUSNAVEUR, COMSIXTHFLT, and COMNAVAIRLANT. Developed options for COMSUBPAC for submarines to support COMSEVENTHFLT Counter-Special Operation Forces operations. Demonstrated Total Asset Visibility during a Maritime Prepositioning Force Offload for COMMARFORPAC. Developed and demonstrated technology for SSNs to perform calibrated acoustic measurements of specific underwater signals of interest for COMSUBPAC.  
-- (U) supported operational commands in Command, Control, Communications, Computers, Intelligence Surveillance & Reconnaissance (C4ISR) for deployed assets. This program supported an Emitter Ambiguity Resolution Study for COMUSNAVCENT, the development and demonstration of Crisis Action Planning and Execution tools for USCINCPAC, and the development and demonstration of an Automated Communications Intercept and Direction Finding System for COMUSNAVCENT.

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FY 2001 RDT&E, N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602233N  
PROGRAM ELEMENT TITLE: Human Systems Technology

-- (U) provided support to the Fleet/Force in high life cycle cost maintenance areas through application of innovative technologies to reduce maintenance frequency and manpower intensiveness. This program supported the demonstration and evaluation of a means to reduce High Mobility Medium Wheel Vehicle (HMMWV) box frame corrosion for COMMARFORLANT and COMMARFORPAC. NSAP also formed a tiger team to demonstrate and evaluate new coatings onboard the COMSIXTHFLT Command Ship, USS IASALLE. In addition, the program partnered with the ONR Condition Based Maintenance (CBM) program to support development of Condition-Based Maintenance tools that will reduce life cycle maintenance costs aboard US Navy ships.

(U) FY 2000 PLAN:

• (U) PERSONNEL, TRAINING AND HUMAN FACTORS TECHNOLOGY:

- Initiate:
  - (U) development and evaluation of 3D PVT strike warfare scenarios.
  - (U) evaluation of cognitive process models, to include influence nets and computational methods, for application to decision support in conditions of uncertainty and incomplete information.
  - (U) demonstration of After Action Review (AAR) principles in Joint Service exercises.
  - (U) evaluation of an advanced processor for speech recognition.
  - (U) experimental evaluation of visual attention shift mechanisms for console operators.
  - (U) development of dynamic threat assessment storyboard and implementation of display in Lightweight Extensible Information Framework (LEIF).
  - (U) comprehensive investigation of first-term attrition in DoD, helping the Navy understand and manage attrition; document the steps a recruit goes through, from initial contact with the Navy to their first duty station.

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Budget Item Justification  
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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602233N

PROGRAM ELEMENT TITLE: Human Systems Technology

- (U) development of enhanced modeling techniques for representing the effects of training in computer generated forces (CGF).
- (U) examination of various training strategies for large, distributed teams; development of measures of effectiveness (MOEs) and measures of performance (MOPs).
- (U) development and evaluation of computer-based Cognitive Task Analysis (CTA) Case Resource Tool.
- Continue:
  - (U) development and evaluation of unconventional visual, auditory and haptic cueing techniques to enhance learning of complex perceptual-motor skills.
  - (U) evaluation of application of reconfigurable organizational design methods to the analysis of effective command and control decision-making in an open-source environment.
  - (U) dynamic assessment and feedback on Tactical Decision performance.
  - (U) demonstration of the efficacy of a framework that specifies how different types of knowledge are presented to decision makers to foster development of appropriate knowledge structures.
  - (U) general investigation of applied Human Factors in the design of interactive information management and interactive display technology to support decision-making.
  - (U) development of distributed debriefing capability for network centric warfare in an information intense environment.
  - (U) examination of the predictive capability of commercially available psychological screening tools designed to measure trait characteristics of personality and adjustment disorders and substance abuse.
  - (U) development of integrated personnel model to include personnel projection.
  - (U) development and evaluation of real-time, automated, scenario-based instruction for tactical decision making.
  - (U) experiments on using Collaborative Media Systems.

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602233N  
PROGRAM ELEMENT TITLE: Human Systems Technology

- (U) laboratory evaluation of the utility of specific CTA approaches for instructional systems development.
- (U) longitudinal investigations of the development of decision-making skills using advanced interactive augmentation strategies, methods, and tools.
- (U) integration of human cognitive and behavioral representations within CCF as simulated teammates and intelligent adversaries.
- (U) development and evaluation of field diagnostic and performance aids for maintenance.
- (U) incorporate Career History Archival Medical and Personnel (CHAMPS) data file into cohort database and statistically identify predictors for various Submarine Service disqualification classifications.
- Complete:
- (U) experiments to systematically investigate the human performance benefit of 3D PVT display features in tactical environments.
- (U) feasibility evaluation of continuous speech recognition technology for the development of a virtual instructor for training complex team skills.
- (U) evaluation of design guidelines for a CSSS that provides for reduced shipboard manning and increased automation, and supports the use of reconfigurable, collaborative task teams using tactical scenarios.
- (U) development of a research plan, outlining the steps necessary for development of a fully implemented version of a SimNavy/ManPower Policy simulation environment.
- (U) laboratory evaluation of prototype human-relations skills test in a broader context of other social intelligence and non-cognitive measures.
- (U) development of graphical presentation techniques that effectively convey to the user the interpretation of the personnel data being displayed.
- (U) transition of a structured peer mentoring strategy to a navy platform.

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Budget Item Justification  
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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602233N

PROGRAM ELEMENT TITLE: Human Systems Technology

-- (U) establishment of a distributed battlespace simulation research facility for CGF.  
-- (U) development of testbed for examining principles of collaborative decision making in knowledge-rich Collaborative Media System environments.

• (U) MEDICAL TECHNOLOGY:

- Initiate:
  - (U) evaluation of potassium adenosine tri-phosphate (ATP) channel blocker in hemorrhagic shock.
  - (U) evaluation of trans-croceinate in combined hemorrhage and trauma.
  - (U) comparison of commercially available colloidal fluids in model of combined hemorrhage and trauma.
  - (U) investigation of methods for grouping chemicals and identifying most appropriate surrogate for toxicity studies of complex mixtures such as jet fuels (JP-8).
  - (U) investigation of the role of glutamate receptors and glutamate modulation in mechanisms and prevention of oxygen toxicity.
  - (U) evaluation of prophylactic agents for management of oxygen toxicity - initial focus on evaluation of antioxidative agents.
  - (U) investigation of medical, aptitude, and personality tradeoffs for selection.
  - (U) development of pilot prediction system.
  - (U) development of gender-neutral standards for garment-borne cooling for heat-stress environments.
  - (U) investigation of: a) alternate techniques to freeze platelets, b) stability of red blood cell membranes during freeze drying, and c) freeze dried platelet function and stability.
  - (U) development of a new hybrid instrument system, easy to operate by untrained personnel, for early and rapid detection of environmental pathologic bacterial and viral agents, by harnessing technological components currently available in governmental, academic and private industry laboratories.

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Budget Item Justification  
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DATE: February 2000

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602233N

PROGRAM ELEMENT TITLE: Human Systems Technology

- Continue:
- (U) investigation of evoked otoacoustic emissions as replacement for pure-tone audiometry to measure hearing loss.
  - (U) development of proof of concept model of multiple biosensor signal integrator, begin field testing to evaluate performance outside of laboratory conditions.
  - (U) investigation of selected methods for measuring electrophysiological-, cellular-, and molecular-level neurotoxicant effects for further development and incorporation into neuro-molecular toxicity assessments.
  - (U) examination of supportive resuscitation fluids that minimize tissue damage and facilitate stabilization of hemorrhagic and burn casualties.
  - (U) evaluation of therapeutic regimens/modalities that prevent shock after combat trauma and hemorrhage.
  - (U) investigation of commercially available colloidal fluids in model of combined hemorrhage and trauma.
  - (U) evaluation of immune modulators for prevention of multiple organ failure.
  - (U) development of neuromodulators for therapy of non-freezing cold injury.
  - (U) development of mission preparation and body protection countermeasure techniques to minimize effects of pulsed radiowave energy.
  - (U) research on operational durability of G-tolerance due to pilot down time.
  - (U) investigation of pharmaceutical rescue of noise-induced hearing loss.
  - (U) research on cognitive spatial abilities in submarine personnel.
  - (U) research on improving submariner performance through new watchstanding protocols.
  - (U) research on tyrosine administration to prevent performance decrements in cold operational environments.

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602233N

PROGRAM ELEMENT TITLE: Human Systems Technology

- Complete:
  - (U) research on chronic or high pulse exposure to induced body currents from RF radiation; development of techniques to ameliorate adverse human health effects through physical and/or biological protections.
  - (U) report on suitability of porcine cardiac sensitization model as alternative to canine model, for consideration by the appropriate regulatory agency as standardized test system more predictive of human effects.
  - (U) testing of interleukin 6 as therapeutic for hemorrhage.
  - (U) testing of nerve growth factor in non-freezing cold injury.
  - (U) testing of guanidine derivative for preservation of mitochondrial function in uncontrolled hemorrhage.
- (U) NSAP:
  - Continue:
    - (U) providing support to the operational Commands in C4ISR for deployed assets.
    - (U) providing support to the Fleet/Force in high life cycle cost maintenance areas through application of innovative technologies to reduce maintenance frequency, manpower intensiveness.
    - (U) identifying specific solutions to known operational capability needs and provide the means to develop and demonstrate prototype systems.

(U) FY 2001 PLAN:

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DATE: February 2000

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602233N  
PROGRAM ELEMENT TITLE: Human Systems Technology

- (U) PERSONNEL, TRAINING AND HUMAN FACTORS TECHNOLOGY:
  - Initiate:
    - (U) development of alternative alerting systems for critical event management in CICs.
    - (U) testing of LEIF supported Threat Assessment algorithms for Anti-Air Warfare (AAW).
    - (U) development of techniques to enable managers to gain insight into the modeling process in the normal course of using a model.
    - (U) exploration of improvements to current econometric modeling techniques.
    - (U) refinement of data mining and statistical techniques for identifying and correcting data errors.
    - (U) experiments to determine training effectiveness of improved behavioral representations in CGF.
  - Continue:
    - (U) development and evaluation of unconventional visual, auditory and haptic cueing techniques to enhance learning of complex perceptual-motor skills.
    - (U) evaluation of 3D PVT strike warfare display prototype and documentation of display feature guidelines.
    - (U) evaluation of the collaborative aspects of cognitive function allocation for establishment of a virtual distributed command presence.
    - (U) general investigation of applied Human Factors in the design of interactive information management and interactive display technology to support decision-making.
    - (U) development of a descriptive theory of 2D and 3D PVT.
    - (U) implementation of AAW threat assessment displays in LEIF.
    - (U) development of attrition instruments and evaluation with respect to their interrelationships, and relationships with social, personality, and intellectual measures as well as demographic indices.

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PROGRAM ELEMENT: 0602233N  
PROGRAM ELEMENT TITLE: Human Systems Technology

- (U) validation of improved human cognitive and behavioral modeling techniques within computer generated forces.
- (U) empirical testing of different strategies and guidelines for training members of large, distributed teams.
- (U) investigations of advanced interactive augmentation strategies, methods, and tools to support transfer of decision making skills from less to more complex tasks.
- Complete:
- (U) test and evaluation of AAR principles in Joint Service exercises, and generation of guidelines, transitions and lessons learned for AAR.
- (U) evaluation of tools and methods to produce visualization of open-source data that are consistent with cognitive knowledge processing.
- (U) evaluation of an advanced processor for speech recognition.
- (U) dynamic assessment and feedback on Tactical Decision performance.
- (U) demonstration of distributed debriefing capability for network centric warfare in an information intense environment.
- (U) demonstration of the efficacy of a framework that specifies how different types of knowledge are presented to decision makers to foster development of appropriate knowledge structures.
- (U) demonstration of the effectiveness of visual attention shift mechanisms in shipboardcritical event management.
- (U) evaluation of LEIF implementation of RPM displays and AAW Threat Assessment algorithms.
- (U) validation of screening procedures to identify individuals unsuitable for submarine service before entry into Basic Enlisted Submarine School.
- (U) validation of integrated personnel model to include aggregated personnel inventory and flows for attrition, promotion, accession, classification, skill training, rotation, distribution, advanced skill training, deployment and unit readiness.

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BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602233N  
PROGRAM ELEMENT TITLE: Human Systems Technology

- (U) evaluation of scenario-based instructional systems for tactical decision making; transition the results to a Navy team trainer.
- (U) documentation of collaborative media system guidelines and principles.
- (U) development of Computer-based CTA Case Resource Tool; guidelines and lessons learned on the utility of CTA approaches for instructional systems development.
- (U) demonstration of automated, realistically behaving simulated forces in virtual and constructive simulations for training, mission planning and rehearsal, and analysis.
- (U) laboratory evaluations of field diagnostic and performance aids for maintenance.

## • (U) MEDICAL TECHNOLOGY:

- Initiate:
  - (U) investigation of health effects/hazards posed by exposure to Very Low Frequency radiowave energy.
  - (U) investigation of hyperbaric oxygen seizure risk using nonlinear dynamical systems theory.
  - (U) pharmacological interventions to maintain optimal operational performance in stressful environments.
- Continue:
  - (U) investigation of selected methods for measuring electrophysiological-, cellular-, and molecular-level neurotoxicant effects for further development and incorporation into neuro-molecular toxicity assessment battery to screen chemicals of operational concern.
  - (U) investigation of supportive resuscitation fluids that minimize tissue damage and facilitate stabilization of hemorrhagic and burn casualties.
  - (U) development of therapeutic regimens/modalities that prevent shock after combat trauma and hemorrhage.

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PROGRAM ELEMENT: 0602233N  
PROGRAM ELEMENT TITLE: Human Systems Technology

- (U) investigation of potassium ATP channel blocker in hemorrhagic shock.
  - (U) evaluation of trans-crocetinate in combined hemorrhage and trauma.
  - (U) further investigation of: a) alternate techniques to freeze platelets, b) stability of red blood cell membranes during freeze drying, and c) freeze dried platelet function and stability.
  - (U) testing of immune modulators for prevention of multiple organ failure.
  - (U) development of neuromodulators for therapy of non-freezing cold injury.
  - (U) development of mission preparation and body protection countermeasure techniques to minimize effects of pulsed radiowave energy.
  - (U) research on durability of G-tolerance due to pilot down time.
  - (U) investigation of pharmaceutical rescue of noise-induced hearing loss.
  - (U) investigation of the role of oxygen inhibition of brain glutamate decarboxylase and alterations of brain glutamate receptors in genesis of oxygen-induced convulsions.
  - (U) investigation of medical, aptitude, personality tradeoffs for selection.
  - (U) development of pilot prediction system.
  - (U) development of gender-neutral standards for garment-borne cooling for heat-stress environments.
- Complete:
- (U) investigation of effects of sopite syndrome on operational performance.
  - (U) investigation of evoked otoacoustic emissions as replacement for pure-tone audiometry to measure hearing loss.
  - (U) development and field testing of proof of concept model of multiple biosensor signal integrator.
  - (U) investigation of methods for grouping chemicals and identifying most appropriate surrogate for toxicity studies of complex mixtures such as jet fuels (JP-8).
  - (U) industrial transition of trans-crocetinate as additive for resuscitation fluid.
  - (U) testing of interleukin 11 as therapeutic for hemorrhage.
  - (U) testing of potassium ATP channel blocker in hemorrhagic shock.

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PROGRAM ELEMENT TITLE: Human Systems Technology

- (U) studies on submarine watchstanding protocols.
- (U) studies of cognitive spatial abilities in submarine personnel.
- (U) investigation of tyrosine utilization to prevent performance decrements in cold environments.

• (U) NSAP:

- Continue:
- (U) providing support to the operational Commands in C4ISR for deployed assets.
- (U) providing support to the Fleet/Force in high life cycle cost maintenance areas through application of innovative technologies to reduce maintenance frequency, manpower intensiveness.
- (U) identifying specific solutions to known operational capability needs and provide the means to develop and demonstrate prototype systems.

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BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602233N  
 PROGRAM ELEMENT TITLE: Human Systems Technology

	FY 1999	FY 2000	FY 2001
B. (U) PROGRAM CHANGE SUMMARY:			
FY 2000 President's Budget	31,426	30,586	29,631
Appropriated Value	-	30,586	-
Adjustments from FY 2000 PRESBUDG			
Biological Hazard Detection System Earmark		+6,000	
Core Project Reduction		-6,000	
SBIR/STTR Transfer	-388	-	-
Various Rate Adjustments	-144	-	-
Execution Adjustments	+2,896	-	-
Congressional Rescissions	-	-169	-
Minor Program Adjustments	-	-	+1,647
Various Rate Adjustments	-	-	-339
FY 2001 President's Budget Submission	33,790	30,417	30,939

(U) CHANGE SUMMARY EXPLANATION:

(U) Schedule: Not applicable.

(U) Technical: Not applicable.

C. (U) OTHER PROGRAM FUNDING SUMMARY: Not applicable.

(U) RELATED RDT&E:

(U) PE 0601152N In-House Laboratory Independent Research

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PROGRAM ELEMENT TITLE: Human Systems Technology

(U) PE 0601153N Defense Research Sciences  
(U) PE 0602232N Communications, Command and Control, Intelligence, Surveillance & Reconnaissance (C3ISR)  
(U) PE 0603706N Medical Development (Advanced)  
(U) PE 0603707N Manpower, Personnel and Training Advanced Technology Development  
(U) PE 0602202F Human Effectiveness Applied Research  
(U) PE 0602716A Human Factors Engineering Technology  
(U) PE 0602785A Manpower, Personnel and Training Technology  
(U) PE 0602787A Medical Technology

(U) This PE adheres to Tri-Service Reliance Agreements on Human Systems Technology, Medical, and CBD Technology. Oversight is provided by the Joint Directors of Laboratories, Training and Personnel Systems Science and Technology Evaluation Management and Armed Services Biomedical Research Evaluation and Management.

D. (U) SCHEDULE PROFILE: Not applicable.

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PROGRAM ELEMENT TITLE: Human Systems Technology

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PROGRAM ELEMENT: 0602234N

PROGRAM ELEMENT TITLE: MATERIALS AND RADIO FREQUENCY/ELECTRO-OPTICS/  
INFRARED ELECTRONICS TECHNOLOGY

(U) COST: (Dollars in Thousands)

PROJECT NUMBER &	FY 1999 ACTUAL	FY 2000 ESTIMATE	FY 2001 ESTIMATE	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	TO COMPLETE	TOTAL PROGRAM CONT.
	74,357	93,233	68,076	71,170	70,662	71,230	70,560	CONT.	CONT.

Materials and Radio Frequency/Electro-Optics/Infrared Electronics Technology

A. (U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: This Program Element (PE) provides Applied Research to support all Navy advanced weapon and platform system concepts and needs in the areas of materials and electronics technology. Developmental tasks address significant improvements in terms of affordability; performance; and reliability to effect transition of advanced technology to the Navy fleet. Development efforts are part of an integrated Department of Navy Science and Technology process managed by the Office of Naval Research.

(U) This PE develops enabling technologies to support most Joint Mission Areas, including:

- (U) Strike: advanced thermal management materials for most platforms to reduce weight and cost.
- (U) Littoral Warfare: acoustic signature reducing materials, torpedo warhead materials, vacuum electronics, solid state high power and low noise amplifiers.
- (U) Joint Surveillance: real-time targeting, connectivity, counter-jamming and deception, infrared (IR) sensors, broadband control components, and fiber optics technology.

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PROGRAM ELEMENT: 0602234N

PROGRAM ELEMENT TITLE: MATERIALS AND RADIO FREQUENCY/ELECTRO-OPTICS/  
INFRARED ELECTRONICS TECHNOLOGY

- (U) Space and Electronics Warfare/Intelligence (SEW/I): lightweight and radiation-hard satellite materials, radio frequency (RF) solid state devices.
- (U) Strategic Deterrence: advanced ballistic missile launcher materials, RF solid-state devices for secure communications.
- (U) Forward Presence issues: high temperature pavements for advanced aircraft, materials for condition based maintenance, RF solid state devices for secure communications, high power transmitters for precision strike.
- (U) Strategic Mobility: development of advanced distributed manufacturing capabilities and advanced long-life materials for repair of aircraft at sea, ultralight materials.

(U) In addition, this PE underpins the Readiness Joint Support Area and Support and Infrastructure Joint Support Area in the domains of affordability, environmental quality, and logistics. Programs include environmentally acceptable coatings for both aircraft and ships and the maintenance of the Navy pier and wharf infrastructure for surge capacity. This PE also contributes to lower system life-cycle costs through development of technologies that realize more compact, lighter weight electronic components.

(U) This PE supports the Office of the Secretary of Defense (OSD) Science and Technology (S&T) Investment Strategy in the following Future Joint Warfighting Capabilities: Real-Time Knowledge of the Enemy, Prompt Engagement of Regional Forces on Global Basis, Lower-End Actions, Space Control, and Countering Threat of Weapons of Mass Destruction; materials projects support affordable performance increases in radomes, infrared windows, advanced engines, and platform signature reduction to allow achievement of military objectives with minimum casualties and collateral damage; materials programs directly support lightweight, survivable satellite and spacecraft thermal control materials to positively affect the United States (U.S.) ability to control space usage. The PE is an integral part of the following Department of Defense (DoD) Technology Areas: Materials and Processes and Electronics Technology.

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INFRARED ELECTRONICS TECHNOLOGY

(U) Due to the sheer volume of efforts included in the PE, the programs described in the Accomplishments and Plans sections are representative selections of the work included in the program.

(U) JUSTIFICATION FOR BUDGET ACTIVITY: This program is budgeted within the APPLIED RESEARCH Budget Activity because it investigates technological advances with possible applications towards solution of specific Naval problems, short of a major developmental effort.

(U) PROGRAM ACCOMPLISHMENTS AND PLANS:

1. (U) FY 1999 ACCOMPLISHMENTS:

- (U) SHORE FACILITIES MATERIALS. Shore Facilities Materials provides technology for the structure of piers, wharves, Naval/Marine Air Station runways, and other facilities required by naval logistics and operations, such as magazines and tank farms. The work is focused on demonstrating affordable materials to increase the life and reduce maintenance costs of such facilities.
- (U) The potential durability of composite materials was demonstrated through characterization and material testing of upgrades of fiber reinforced concrete waterfront structures. Success of these evaluations will reduce the maintenance costs and provide increased lifetime for Naval waterfront facilities. These tests were conducted at Naval Facilities at San Diego and Port Hueneme, CA, and demonstrated the usefulness of fiber reinforced concrete.
- (U) Test protocols and the desired mechanical characteristics of prestressed carbon fiber tendons were established in order to quantify the effects of material parameters on the durability of modularhybride composite/concrete structure for use in long life piers and wharves. These protocols were used to establish testing of specimens at pier sites in San Diego and Port Hueneme, CA.

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PROGRAM ELEMENT: 0602234N

PROGRAM ELEMENT TITLE: MATERIALS AND RADIO FREQUENCY/ELECTRO-OPTICS/  
INFRARED ELECTRONICS TECHNOLOGY

- (U) AIRBORNE MATERIALS. Airborne Materials provides technology for naval aircraft, including airframes, propulsion, and air weaponry. It is focused on those material issues associated with carrier landings, corrosion and affordability.
  - (U) Explored the benefits of beryllium-aluminum and beryllium-titanium alloys for aircraft applications.
  - (U) Demonstrated fabrication technology for compressor outer vane/diffuser using cast gamma titanium aluminides.Result: increased performance and decreased cost in Naval aircraft engines.
  - (U) Completed demonstration of 1500F Ni-turbine disk alloy. Has led to increased performance (thrust-to-weight) for Naval gas turbine engines.
  - (U) Transitioned Sempen touch-up kit (primer/topcoat) to Naval Aircraft Maintenance Groups; successfully flight-tested on F-18s and helicopters.
  - (U) Demonstrated non-toxic trivalent chromium coating for pre-treatment of aluminum alloys and post-treatment of anodized aluminum. Trivalent chromium is a possible replacement for hexavalent chromium which is restricted by the Environmental Protection Agency (EPA).
  - (U) Improved corrosion sensor systems for condition-based maintenance monitoring of aircraft corrosion by replacing hard-wired datalogger systems with a radio transceiver systems capable of downloading corrosion data to a lap-top computer. This provides needed technology for Navy implementation of condition based maintenance.
  - (U) Completed exploration of cost effective processing routes for high strength diamond material for applications such as infrared missile domes and windows.
- (U) SEABORNE MATERIALS. Seaborne Materials provides technology for all ship, submarine, and related materials needs, including hull materials, machinery materials, coatings of all types, and seaborne weapons materials. This work provides the enabling capabilities for reduced cost and maintenance, improved performance, and reliable operations.
  - (U) Initiated environmentally acceptable coating system development for non-magnetic ship hulls required for stealth and mine countermeasures.
  - (U) Developed corrosion sensor system for determining the protectiveness of coatings in ship ballast tanks for implementation of condition based maintenance.

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PROGRAM ELEMENT: 0602234N

PROGRAM ELEMENT TITLE: MATERIALS AND RADIO FREQUENCY/ELECTRO-OPTICS/  
INFRARED ELECTRONICS TECHNOLOGY

- (U) Developed new LC-100 welding wire, with transition to prototype production heat for NSSN & CVN-77, to minimize costly preheat and eliminate hydrogen cracking for more affordable and reliable ship and submarine construction with advanced high strength steels.
- (U) Explored strength, fracture, and weldability characteristics of non-magnetic stainless steel for ship hull structures with reduced signature.
- (U) Demonstrated extraordinary dynamic fracture resistance in very low interstitial titanium alloy for ship and submarine application to enhance survivability.
- (U) Explored high strength, corrosion resistant fastener alloys for marine applications.
- (U) Completed development of HSLA-65 steel for naval construction/transition to CVN77.
- (U) Completed development and exploration of the plasma quench process to produce low cost titanium powder.
- (U) MISSILE/SPACE MATERIALS. Missile/Space Materials provides technology for tactical ballistic missile needs, including thermal management materials for power generation and protection, and spacecraft thermal straps and doublers. While this effort focuses on problems associated with naval systems, it is jointly planned and coordinated with Army, Air Force and Defense Advance Research Project Agency (DARPA) efforts.
  - (U) Demonstrated fabrication technology for affordable and reliable low cost hybrid materials for reentry vehicle heatshield applications. Result: lower cost replacements for defunct heat shield materials.
  - (U) Demonstrated the benefits of ceramic materials for protection of propulsion components and other high temperature impingement applications in terms of predictive models and material screening test development. Result: reduced cost and improved engine performance for Naval missiles.
  - (U) Evaluated advanced ceramic materials in rocket environment. Result: higher operating temperatures and greater reliability for Naval missiles.
- (U) MULTI-MISSION MATERIALS. Multi-mission materials provides developing technologies for promising naval applications such as biomolecular materials for antifouling coatings on ships. It also supports materials technologies for naval

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PROGRAM ELEMENT: 0602234N

PROGRAM ELEMENT TITLE: MATERIALS AND RADIO FREQUENCY/ELECTRO-OPTICS/  
INFRARED ELECTRONICS TECHNOLOGY

systems across a broad spectrum, such as laser eye and sensor protection as well as sensor/transducer materials for sonar and condition based maintenance applications.

- (U) Demonstrated a computer program to model non-linear optical materials in optical limiting devices for laser eye protection. Such materials have the potential for frequency agile protection for Marine Corps.
- (U) Demonstrated a system and controlling software for a reliable ultrasonic tomography that alleviates the problem of refraction to increase the ability to rapidly inspect aging platforms.
- (U) Demonstrated improved processing technology reducing the cost of microtubule materials and composites for advanced shipboard applications and transferred to industry.
- (U) Analyzed the impact of piezocrystals on torpedo guidance sonar transducers produced a design exhibiting 12dB source level increase and a bandwidth increase from 10 to 35 kHz in a transducer less than one-third the size and weight of present piezoceramic devices.
- (U) Demonstrated the use of nanostructured tungsten carbide cobalt (WC/Co) coatings was demonstrated by fabrication and testing of selected prototype components.
- (U) Developed techniques for fabrication of nanostructured ceramic and aluminum matrix composite coatings were carried out. Production of nanostructured feedstock materials was scaled to pilot plant capacity. Result: maintenance cost reduction due to repair versus replacement for ship and submarine machinery components.
- (U) RF SOLID STATE DEVICE AND CONTROL COMPONENTS. Provides for the generation, radiation, reception, control and processing of Ultra High Frequency (UHF), Very High Frequency (VHF), Microwave (MW), and Millimeter Wave (MMW) power for Navy all-weather radar, surveillance, reconnaissance, electronic warfare (EW), communications, and smart weapons systems. The technology developed cannot be obtained through Commercial Off the Shelf (COTS) as a result of the requirements placed on power, frequency, linearity, bandwidth, weight, and size. Beginning in fiscal year 1998 the Microelectronics thrust has been merged with RF Solid State and Control Components to highlight the increasing digital RF emphasis of Microelectronics.
- (U) Continued to develop 80 kW W-band duplexer for Navy's 94 GHz radar program.

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PROGRAM ELEMENT: 0602234N

PROGRAM ELEMENT TITLE: MATERIALS AND RADIO FREQUENCY/ELECTRO-OPTICS/  
INFRARED ELECTRONICS TECHNOLOGY

- (U) Developed design parameters for heterojunction varactor for use in compact, high Q, tunable bandpass filters and oscillators for transmit/receive (T/R) module applications.
- (U) Continued to develop InGaP/GaAs heterojunction bipolar transistors for applications in pulsed Ka-band phased arrays for dual mode, electronic countermeasure resistant hyper-velocity strike weapon conformal apertures.
- (U) Demonstrated device technology for low power, low volt sub 500nm - 250nm CMOS/SiGe with T-gate structures in 50nm thick Thin Film Silicon-on-Sapphire (TFOS). These devices, which have frequency performance in excess of 50 GHz, allow development of RF analog front end receiver, 16-bit, 125 megasamples/sec and 10-bit, 2.6 gigasamples/sec analog to digital (A/D) converters, for use in digital receiver (X-band)/electronic warfare (EW)/communication/signal intelligence.
- (U) Demonstrated the analog portion of low power, high-resolution 2 - 5 kilosamples/sec A/D converter for sonar, shallow water Anti Submarine Warfare (ASW) applications.
- (U) Demonstrated components of 16 bit, 125 megasamples/sec A/D converter for application to wide bandwidth digital ASW receiver to meet Navy multi-channel acoustic systems requirements.
- (U) Continued development of 25 channel Continuous Wavelet Transform circuit for EW signal identification applications.
- (U) Continued to develop 6.1 Angstrom materials for high frequency applications.
- (U) Demonstrated components of 4-bit 10 gigasamples/sec A/D converter for application to wide bandwidth radar warning receiver (RWR) to meet Navy multi-channel EW system requirements.
- (U) Developed 14 watt Gallium Nitride (GaN) X-band amplifiers for high power transmitter applications.
- (U) Developed GaN heterojunction field effect power transistors for next generation electromagnetic (EM) power amplifiers.
- (U) VACUUM ELECTRONICS. Provides for the generation and reception of MW, MMW, and sub-millimeter wave power. The technology being developed is not available through COTS because of the power and size requirements.
- (U) Developed high-power,high average power (10kw), moderate bandwidth (600 MHz) gyroklystron for Navy 94 GHz radar programs.

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PROGRAM ELEMENT: 0602234N

PROGRAM ELEMENT TITLE: MATERIALS AND RADIO FREQUENCY/ELECTRO-OPTICS/  
INFRARED ELECTRONICS TECHNOLOGY

- (U) Continued to develop a 2 dimensional/3 dimensional (2D/3D) electron gun and collector design code for vacuum devices.
- (U) Developed an ultra-wide band vacuum power booster for EW applications.
- (U) Continued to develop a high-duty, wideband gyro-TWT to support radar and EW applications at millimeter-wavelengths.
- (U) EO/IR TECHNOLOGY. Provides for the development of IR focal plane arrays to detect targets against various backgrounds; RF photonics technology to increase the bandwidth and reduce the size/weight of phased arrays; and IR transmitting fibers for EW applications. The technology being developed is not available through COTS, which is primarily focused at 1.3-1.55um whereas Navy requires electro-optic devices and components in the threat bands of 2.0-2.5, 3.5-5, and 8-12um.
  - (U) Continued to develop a 256 x 256 adaptive infrared focal plane array (IRFPA).
  - (U) Continued to develop optical microwave link with external lithium niobate modulators at 20GHz.
  - (U) Demonstrated 25mW photodetector at 8GHz for higher sensitivity removable antennas; performed initial study of thermal effects on high power detectors with resultant new device design in fabrication.
  - (U) Continued to develop a 3 band IR detector to enhance performance against countermeasures and stealthy targets.
  - (U) Continued to develop mid-IR fibers with low loss region and improved fiber fabrication techniques achieving high tensile strength fibers.
  - (U) Continued to reduce fiber defects and optimized fiber preparation to achieve power damage threshold > 1.2 GW/cm<sup>2</sup>.
  - (U) Continued development of broadband, high damage threshold anti-reflection (AR) coatings for 2 - 5um region.
  - (U) Continued to develop cabling techniques for ruggedized, thermally tolerant one-meter cables.
  - (U) Continued to evaluate InAs/InGaSb growth techniques.
  - (U) Continued to develop small pixel 2-color midwave Focal Plane Array (FPA) for missile threat warning applications and shipboard Infrared Search and Track (IRST).

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PROGRAM ELEMENT: 0602234N

PROGRAM ELEMENT TITLE: MATERIALS AND RADIO FREQUENCY/ELECTRO-OPTICS/  
INFRARED ELECTRONICS TECHNOLOGY

- (U) ADVANCED MULTIFUNCTIONAL RF SYSTEM SUPPORT TECHNOLOGY. With the advances that are currently being made in electronics there exists a strong opportunity to realize multifunctional systems that integrate the functions of radar, EW, and communications into a pair of transmit and receive apertures over a broad bandwidth. It should be noted that this program is in contrast to the Air Force (AF) and Joint Strike Fighter (JSF) programs in that it treats both the transmit and receive functions in separate apertures. This approach avoids the need for time allocation of different RF functions and therefore offers the opportunity for more massive integration of RF functions into the pair of apertures. As a result, this integrated thrust has been formed and the current program enhanced to capitalize upon ongoing and planned applied research to develop RF solid state and photonic devices. This program is coordinated with JSF and the AF and has an oversight group with representatives from Space and Warfare Systems Command (SPAWAR), Naval Air Systems Command (NAVAIR), Program Executive Office (PEO) DD-21, PEO Theater Air Defense/Surface Combatant (TAD/SC), Common Support Aircraft (CSA), N86 and N6. Specific efforts include:
  - (U) Continued to develop a continuous wave (CW) ultra broadband, ultra linear (cross modulation products 28 dbm below fundamental signal) compact amplifiers suitable for use in next generation wide area surveillance systems.
  - (U) Continued to develop a superconducting A/D capable of 19 bits of dynamic range over a 20 MHz spectrum for use in reducing background clutter in littoral warfare surveillance operations.
  - (U) Continued to develop an RF transmit and receive beamforming network for the generation of simultaneously multiple frequency independent RF beams capable of beamsteering over  $\pm 60$  degrees from boresight on transmit and receive with control structure that preserves a 500 MHz instantaneous RF bandwidth for each beam.
  - (U) Fabricated wide bandgap semiconductors and began testing of low parasitic bipolar microwave power amplifier.

2. FY 2000 Plan:

- (U) SHORE FACILITIES MATERIALS.
  - (U) Start tests on samples subjected to freeze/thaw cycles, oxidation, and photothermal conditions to ascertain their effects on the bond of carbon/epoxy to concrete.

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Budget Item Justification  
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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602234N

PROGRAM ELEMENT TITLE: MATERIALS AND RADIO FREQUENCY/ELECTRO-OPTICS/  
INFRARED ELECTRONICS TECHNOLOGY

- (U) Conclude analysis and testing to characterize the bond of carbon fiber reinforced plastic (CFRP) rods and tendons in high strength lightweight concrete. Conclude testing and analysis of glass fiber reinforced plastic (GFRP) under environmental exposures and derive durability factors for use in design of waterfront structures.
- (U) AIRBORNE MATERIALS.
  - (U) Explore fabrication technology for improved single crystal/polycrystalline Ni compressor disks. This will result in improved performance and less weight in Naval aircraft engines.
  - (U) Explore feasibility of oxidation resistant Mo-Alloy w/2500F capability. This will result in revolutionary performance improvements in Naval aircraft engines.
  - (U) Evaluate radio activated corrosion sensor systems for condition based maintenance implementation on H-60 helicopters.
  - (U) Evaluate susceptibility to stress-corrosion cracking of aluminum alloy joints produced by friction stir welding. Friction stir welding eliminates need for fasteners in aircraft construction, resulting in weight saving.
- (U) SEABORNE MATERIALS.
  - (U) Explore improved anticorrosive coatings for non-magnetic ship hulls required for stealth and mine countermeasures.
  - (U) Evaluate corrosion sensors for ship ballast tanks for implementation of condition based maintenance.
  - (U) Explore centrifugal and sedimentation casting for superior durability/life extension of ship shafting and seals.
  - (U) Develop high strength, corrosion resistant fastener alloy for marine applications.
  - (U) Explore property/structure/weldability relationships for lower carbon higher strength/toughness steels.
  - (U) Identify materials upgrades for long life seawater valves to reduce total cost of ownership.
  - (U) Explore guided wave ultrasonics for detecting corrosion/erosion in shipboard piping without removing insulation for implementation of condition based maintenance.

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Budget Item Justification  
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DATE: February 2000

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602234N

PROGRAM ELEMENT TITLE: MATERIALS AND RADIO FREQUENCY/ELECTRO-OPTICS/  
INFRARED ELECTRONICS TECHNOLOGY

- (U) Evaluate strength, fracture, and weldability characteristics of stainless steel and other nonmagnetic alloy for ship and submarine structures with reduced signature.
- (U) Design, fabricate and test improved fiber reinforced urethane composites.
- (U) Investigate fire resistance and low velocity impact damage of carbon reinforced polyurethane as candidate lightweight, non-magnetic material for construction of ships for signature reduction.
- (U) Demonstrate new MIL-100S welding wire designed to enable more affordable and reliable welding of high strength steels in ship and submarine construction through reduction of preheat and elimination of hydrogen cracking for construction and maintenance cost reduction.
- (U) Develop improved models of deformation and fracture of hull materials, for incorporation into computer codes to simulate response of ship and submarine structural materials to underwater explosion, in cooperative program between U.S. and Germany.
- (U) Explore innovative, more affordable processes for improved welding of ship/submarine structural materials, including non-magnetic stainless steel to reduce signatures and provide mine counter measures.
- (U) MISSILE/SPACE MATERIALS.
  - (U) Investigate Refractory metal (Hf, Ta) spraying process for fabrication of low-cost metal nozzles which will increase performance and reduce cost in missile engines.
  - (U) Develop oxidation models for ceramic systems of interest (HfC, HfW, HfB<sub>2</sub>) which will result in improved performance and reduce development costs for missile propulsion systems.
  - (U) Investigate novel cost-reducing processing methods for carbon composite missile heat shields.
- (U) MULTI-MISSION MATERIALS.
  - (U) Explore new formulations of phthalocyanines that do not show performance degradation at high fluences (energy/area) for advanced laser eye and device protective devices.
  - (U) Demonstrate new laser technology to characterize hydraulic fluids and lubricants and predict machine condition.

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DATE: February 2000

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602234N

PROGRAM ELEMENT TITLE: MATERIALS AND RADIO FREQUENCY/ELECTRO-OPTICS/  
INFRARED ELECTRONICS TECHNOLOGY

- (U) Demonstrate the performance of single crystal piezoelectrics (high sensitivity-2 Octave Bandwidth) in high frequency ultrasonic imaging transducers.
- (U) Use of nanostructured oxide ceramic coatings will be demonstrated by fabrication and testing of selected components. Techniques for fabrication of nanostructured Ni-based alloy coatings will be developed for multi-mission applications.
- (U) RF SOLID STATE DEVICE AND CONTROL COMPONENTS.
  - (U) Demonstrate highly compact, high Q, tunable notch filter for T/R module applications.
  - (U) Demonstrate GaN heterojunction field effect power transistor for 6 - 18 GHz operation for next generation electric/magnet (E/M) magnetic power amplifiers.
  - (U) Continue the development of GaN based high electron mobility transistor (HEMT) in the 1 - 18 GHz spectrum and connected as class B, push-pull for maximum efficiency and linearity for ultra wideband microwave power module (MPM) applications.
  - (U) Demonstrate 25 watt GaN X-band amplifier for high power transmitter applications.
  - (U) Develop a programmable time delay hybrid circuit for improving co-site interference canceller accuracy over very high frequency (VHF) operation bandwidth.
  - (U) Demonstrate SiGe T-Gate structures with Ft, Fmax > 100 GHz and equal p/n channel Metal Oxide Semiconductor Field Effect Transistor (MOSFET) mobilities to minimize CMOS circuit area.
  - (U) Apply and transition the technology of Complementary Metal Oxide Silicon (CMOS) low voltage, low power sub 250nm - 100nm SiGe with T-gate structure in 50nm - 30nm TFSOS for the implementation (design, fabrication and demonstration) of K-band (40 GHz) low noise analog front-end receiver functions and 4 bit, 20 gigasamples/sec A/D converters using two time-interleaved 4 bit, 10 GSPS A/D converters.
  - (U) Demonstrate a 25 channel Continuous Wavelet Transform circuit for EW signal identification.
  - (U) Develop 6.1 Angstrom materials for ultra-low power, high frequency applications.

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DATE: February 2000

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602234N

PROGRAM ELEMENT TITLE: MATERIALS AND RADIO FREQUENCY/ELECTRO-OPTICS/  
INFRARED ELECTRONICS TECHNOLOGY

- (U) Develop very compact, high power density, reliable, and affordable Ka band heterojunction bipolar transistor (HBT) devices having InGaP/InGaAs emitter-base materials composition for all-weather multi-mode conformal array guidance weapon systems to combat small radar cross-section (RCS) low-flying anti-ship (and other anti-high value target) cruise missiles.
- (U) VACUUM ELECTRONICS.
  - (U) Develop an ultra-wideband microwave power MPM for EW applications.
  - (U) Develop vacuum power booster technology for a 2-D array MPM for phased array applications.
  - (U) Develop an airborne compatible gyroklystron with gridded electron gun for high pulse repetition frequency (PRF) radar to provide unambiguous Doppler at W band.
  - (U) Develop design for gridded electron beam gun for the airborne capable gyroklystron using 3D electron gun code.
  - (U) Develop 2D/3D electron gun and collector design codes for vacuum devices.
  - (U) Develop high brightness scandate cathode for high perveance traveling wave tubes (TWTs) to increase reliability through lower operating temperature.
- (U) EO/IR TECHNOLOGY.
  - (U) Demonstrate 3.3 V Pi modulator at 20 GHz and improved packaging.
  - (U) Develop optical microwave link with external lithium niobate modulators at 20 GHz.
  - (U) Develop 256x256 adaptive two color IRFPA for increased clutter and background rejection.
  - (U) Demonstrate a three color IR detector to enable discrimination against advanced countermeasures.
  - (U) Develop a small pixel color discriminating IRFPA for wide field of view shipboardIRST for the theatre missile defense interceptor applications and missile threat warning applications.
  - (U) Optimize fiber fabrication techniques to achieve goal of 0.1 dB/m loss in 2 - 5µm region and proof-test fibers to goal of 50,000 psi for EW applications. Reduce AR coatings reflectance to 2% in 2 - 5µm region. Improve optical

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BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602234N

PROGRAM ELEMENT TITLE: MATERIALS AND RADIO FREQUENCY/ELECTRO-OPTICS/  
INFRARED ELECTRONICS TECHNOLOGY

power damage threshold to achieve goal of 1.5 GW/cm<sup>2</sup> in AR coated fibers. Develop cabling techniques for 10 m length cables which are ruggedized and meet system environmental specifications.

- (U) Evaluate InAs/InGaSb growth techniques.
- (U) Develop 6.1 Angstrom materials for high performance IR detection and mid IR lasers.

- (U) ADVANCED MULTIFUNCTIONAL RF SYSTEM SUPPORT TECHNOLOGY.

- (U) Demonstrate moderate power CW ultra broadband (1 - 18 GHz), ultra linear (cross modulation products 28dbm below fundamental signal) compact amplifiers suitable for use in next generation multifunctional wide area surveillance systems and also suitable for use as drivers in microwave power modules.
- (U) Develop low parasitic bipolar microwave power amplifier for the 1 - 5 GHz spectrum.
- (U) Demonstrate critical components for a 100 GHz logic-derived microwave synthesizer for 1 - 5 GHz output.
- (U) Select final approach to A/D converter with real-time adjustment of resolution vs. bandwidth and suitable for use with advanced multifunctional RF systems. Utilize 100 GHz capable digital technologies to develop alternative A/D converters each programmable to trade resolution for bandwidth and thus be usable at will for ship self defense or wide band signal interception.
- (U) Continue the development of a multicomponent model for antenna isolation and coupling to assess options for minimizing interference and self-jamming of multifunction apertures.

3. FY 2001 Plan:

- (U) SHORE FACILITIES MATERIALS.
  - (U) Conduct laboratory tests to characterize system performance and durability of scaled hybrid composite/concrete components having integral fault monitoring systems.

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PROGRAM ELEMENT: 0602234N

PROGRAM ELEMENT TITLE: MATERIALS AND RADIO FREQUENCY/ELECTRO-OPTICS/  
INFRARED ELECTRONICS TECHNOLOGY

- (U) Develop an empirical basis defining relationships between material constituents and performance properties of high strength, lightweight concrete for marine applications.
- (U) AIRBORNE MATERIALS.
  - (U) Continue exploration of advanced turbine disk fabrication technology using single crystal and polycrystalline Ni alloys. This will result in improved performance in naval aircraft engines.
  - (U) Expand exploration of oxidation resistant Mo-Alloys with greater than 2500F capability. This will result in revolutionary engine performance.
  - (U) Explore thermal barrier coating technology for oxidation resistant Mo-Alloys to enhance operating temperature by at least 200 F.
  - (U) Identify cadmium replacement technologies to fleet to comply with EPA regulations.
  - (U) Evaluate radio activated corrosion sensors in P-3 operational aircraft for implementation of condition based maintenance.
  - (U) Evaluate corrosion prevention applique technology in operational carrier environments to reduce hazardous material disposal costs.
- (U) SEABORNE MATERIALS.
  - (U) Integrate composite and multifunctional technologies for reduced signature and weight in ship topside design.
  - (U) Develop innovative, more affordable processes for improved welding/joining of ship structural materials, including non-magnetic stainless steels to reduce signature and provide mine countermeasures.
  - (U) Develop centrifugal and sedimentation casting for superior durability/life extension of ship shafting, seals, and other machinery.
  - (U) Complete development of high strength fastener alloy for marine applications.
  - (U) Investigate advanced low carbon high strength steels for weldability and survivability.

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BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602234N

PROGRAM ELEMENT TITLE: MATERIALS AND RADIO FREQUENCY/ELECTRO-OPTICS/  
INFRARED ELECTRONICS TECHNOLOGY

- (U) Investigate non-magnetic alloys in regard to strength, fracture behavior, fabrication, and corrosion protection for ship hull application to reduce signature.
- (U) Develop improved fire-resistant, low-cost composite material systems to enhance fire-fighting capability.
- (U) Develop prediction capability for underwater explosion loaded hull structural material with rupture to improve warfighting ability.
- (U) Continue evaluation of environmentally acceptable coatings technology for non-magnetic ship hulls required for stealth and mine countermeasures.
- (U) Continue evaluation of corrosion sensors in ballast tanks of operational ships to enable implementation of condition based maintenance.
- (U) Evaluate upgraded seawater valves in operational ship systems to reduce total cost of ownership.
- (U) Transition guided wave ultrasonics corrosion/erosion detection technology to fleet to enable implementation of condition based maintenance.
- (U) MISSILE/SPACE MATERIALS.
  - (U) Explore advanced processes for fabrication of components for missile engines for cost reduction and improved reliability.
  - (U) Expand and refine oxidation models for high performance/low cost missile propulsion systems.
  - (U) Continue exploration of advanced carbon/carbon processing for advanced missile heat shields.
- (U) MULTI-MISSION MATERIALS.
  - (U) Demonstrate the effectiveness of metal nanoshell technology for advanced laser eye protective devices.
  - (U) Synthesize new phthalocyanines with improved optical limiting properties.
  - (U) Demonstrate high strain capability (more than triple conventional piezoceramic devices) in a multilayer actuator fabricated from relaxor piezoelectric crystals.

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DATE: February 2000

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602234N

PROGRAM ELEMENT TITLE: MATERIALS AND RADIO FREQUENCY/ELECTRO-OPTICS/  
INFRARED ELECTRONICS TECHNOLOGY

- (U) The use of nanostructured ceramic, Ni- and Al-based alloy, and cermet coatings will be qualified and transitioned to shipboard use for repair and refurbishment of existing equipment and for life extension of new equipment.
- (U) RF SOLID STATE DEVICE AND CONTROL COMPONENTS.
  - (U) Determine maximum CW power output for a GaN heterojunction field effect power transistor for 6 - 18 GHz operation for next generation EM power amplifiers.
  - (U) Demonstrate GaN based high electron mobility transistor (HEMT) in the 1 - 18 GHz spectrum and connected as class B, push-pull for maximum efficiency and linearity.
  - (U) Develop MPM compatible solid-state control components for phased array applications.
  - (U) Establish tunable band-reject active filter concept with prototype demonstration.
  - (U) Demonstrate low power high performance of logic circuits based on 6.1A materials.
  - (U) Demonstrate high power density Ka-band InGaP/InGaAs HBTs for applications in all-weather multi-mode conformal array missile guidance systems to combat low RCS, low-flying cruise missiles.
  - (U) Develop a functional multi-element coupled-cavity phased-array module and demonstrate power amplification, digital phase shifting and radiated power beam steering.
- (U) VACUUM ELECTRONICS.
  - (U) Develop an efficient, highly linear MPM for digital and wideband communications systems applications.
  - (U) Develop an asymmetric depressed collector using 3-D design code to provide for enhanced array compactness.
  - (U) Develop non-thermionic cathodes based on wide bandgap materials for the low-emittance electron guns required for next generation millimeter-wavelength amplifiers.
  - (U) Develop wideband gyro-TWT for airborne and shipboard non-cooperative target recognition (NCTR), combat ID, and theater ballistic missile defense discrimination applications.
  - (U) Continue coupled cavity TWT and electron design code development to achieve first-pass design success in vacuum electronic amplifiers.

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PROGRAM ELEMENT: 0602234N

PROGRAM ELEMENT TITLE: MATERIALS AND RADIO FREQUENCY/ELECTRO-OPTICS/  
INFRARED ELECTRONICS TECHNOLOGY

- (U) EO/IR TECHNOLOGY.
  - (U) Demonstrate and transition 256 x 256 adaptive IRFPA to Naval Air Warfare Center (NAWC) China Lake.
  - (U) Demonstrate 1024 x 640 readout for the 2 color small pixel IRFPA.
  - (U) Develop a three color IRFPA to enable discrimination against advanced countermeasures
  - (U) Develop a small pixel two color discriminating IRFPA.
  - (U) Develop integrated balanced photoreceivers with high current to suppress noise by > 15 dB.
  - (U) Develop heterodyne transmitters for increased power handling and noise suppression.
  - (U) Develop reconfigurable routing for shared utilization of platform broadband data.
  - (U) Develop broadband wavelength division multiplexing for analog and digital signal processing.
  - (U) Develop low loss fiber with loss < 1dB/m for long wave infrared region (8 - 12 $\mu$ m) and develop technology to make coherent bundles to couple to IR focal plane array detectors for infrared countermeasures (IRCM) applications.
  - (U) Demonstrate performance potential of detectors and lasers based on 6.1 Angstrom materials.
  
- (U) ADVANCED MULTIFUNCTIONAL RF SYSTEM SUPPORT TECHNOLOGY.
  - (U) Demonstrate 3 Watt output CW ultra broadband (1 - 18 GHz), ultra linear (cross modulation products 28dbm below fundamental signal) compact amplifiers suitable for use in next generation multifunctional wide area surveillance systems and also suitable for use as drivers in microwave power modules.
  - (U) Determine maximum power output obtainable for a low parasitic bipolar microwave power amplifier for the microwave synthesizer for 1 - 5 GHz output with internal phase and frequency modulated signals.
  - (U) Demonstrate an A/D converter with real-time adjustment of resolution vs bandwidth and suitable for use with advanced multifunctional RF systems to provide a minimum of 500 MHz bandwidth and 9 bits of resolution.
  - (U) Demonstrate a compact, ultra low phase noise source of pure tones at 10, 94, and 190 GHz as a clocking source for the Advanced Multifunction Radio Frequency System (AMRFS) high speed digital signal processing circuits and true time delay beam steering network.

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DATE: February 2000

BUDGET ACTIVITY: 2  
PROGRAM ELEMENT: 0602234N  
PROGRAM ELEMENT TITLE: MATERIALS AND RADIO FREQUENCY/ELECTRO-OPTICS/  
INFRARED ELECTRONICS TECHNOLOGY

B. (U) PROGRAM CHANGE SUMMARY:

	<u>FY 1999</u>	<u>FY 2000</u>	<u>FY 2001</u>
(U) FY 2000 President's Budget:	87,698	77,957	82,631
(U) Appropriated Value		104,107	
(U) FY 1999 SBIR/STTR Transfer	-1,281		
(U) Execution Adjustments	-2,532		
(U) Inflation Adjustment	-399		
(U) Program Adjustment			-13,307
(U) Comparability Adjustment to 0602232N:	-9,129	-10,357	
(U) Congressional Plus-Ups		26,150	
(U) Congressional Rescission		-517	
(U) Various Rate Adjustments:			-1,248
(U) FY 2001 PRESBDG Submission:	74,357	93,233	68,076

(U) CHANGE SUMMARY EXPLANATION:

- (U) Schedule: Not applicable
- (U) Technical: Not applicable.

C. (U) OTHER PROGRAM FUNDING SUMMARY:

- (U) RELATED RDT&E:

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PROGRAM ELEMENT: 0602234N

PROGRAM ELEMENT TITLE: MATERIALS AND RADIO FREQUENCY/ELECTRO-OPTICS /  
INFRARED ELECTRONICS TECHNOLOGY

- (U) PEs 0601102A, 0601102F, 0601153N (Defense Research Sciences)
- (U) PEs 0602105A, 0602102F, (Materials Technology)
- (U) PE 0602705A, (Electronics and Electronic Devices)
- (U) PE 0602204F, (Aerospace Avionics)
- (U) PE 0602709A (Night Vision Technology)
- (U) PE 0602702F (Command, Control and Communications))
- (U) PE 0602303A (Missile Technology)
- (U) PE 0602601A (Combat Vehicle and Automotive Technology)
- (U) PE 0602786A (Logistics Technology)
- (U) PE 0602111N (Air and Surface Launched Weapons Technology)
- (U) PE 0602121N (Ship, Submarine and Logistics Technology)
- (U) PE 0602122N (Aircraft Technology)
- (U) PE 0602314N (Undersea Warfare Surveillance Technology)

D. (U) SCHEDULE PROFILE: Not applicable

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DATE: February 2000

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602270N

PROGRAM ELEMENT TITLE: Electronic Warfare Technology

(U) COST: (Dollars in Thousands)

PROJECT NUMBER & TITLE	FY 1999 ACTUAL	FY 2000 ESTIMATE	FY 2001 ESTIMATE	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	TO COMPLETE	TOTAL PROGRAM
Electronic Warfare Technology									
	22,399	37,459	26,043	28,510	28,848	28,880	28,651	CONT.	CONT.

A. (U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: The Navy Electronic Warfare (EW) Science and Technology (S&T) Program addresses identified technology requirements for EW in cooperation with the other Services, placing special emphasis on Naval EW roles in Information Warfare. This program develops technologies which support the effective utilization of Naval force capabilities in the conduct of the Navy's Joint Mission Areas defined by Office of the Chief of Naval Operations (OPNAV) (i.e., Strike, Littoral Warfare, Intelligence, Surveillance and Reconnaissance, Command, Control, Communications, and Computers (C4) and Information Warfare, and Nuclear Deterrence/Counterproliferation of Weapons of Mass Destruction). It is also vitally associated with future joint warfighting capabilities of "maintaining near perfect real-time knowledge of the enemy and to counter the threat of cruise missiles to the Continental United States and deployed forces." The program is planned jointly in accordance with Defense S&T Reliance agreements that allocate various EW disciplines and their attendant technology development responsibilities between the Army, Air Force and the Navy. As part of the Integrated S&T EW Program, efforts are subject to review and execution oversight by the Director of Defense Research and Engineering (DDR&E) Technology Panel for Electronic Warfare (TPEW). This program is a primary technology feed for the newly established Platform Protection IPT to the ONR-091 Future Naval Capabilities initiative.

(U) The emergence of a polycentric strategic environment, the evolving and diversified nature of the threat, and the proliferation of arms and technology have contributed to shifting the focus of conflict to regional and littoral areas. Concurrently, the global arms industry continues to supply increasingly sophisticated sensors and weapons to the worldwide arms market. The heterogeneous combination of military and commercial systems dictates the need to develop more advanced EW technologies that will be able to adequately exploit and counter the use of new threats.

(U) The structure and balance of this program are responsive to OPNAV guidance and identified System Command warfighting requirements and needs. The program features the integration of 6.1 and 6.2 programs with 6.3 EW core

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DATE: February 2000

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602270N

PROGRAM ELEMENT TITLE: Electronic Warfare Technology

programs and Advanced Technology Demonstrations (ATDs) which can produce prototypes suitable for naval force deployments and demonstrations. Program integration is achieved through the transition and implementation of program products. The program continues to support the Navy's highest priority need, Ship Self-Defense. It develops EW technologies to counter a range of threats (including multi-spectral/multi-modal sensors and seekers) and spans the entire electromagnetic spectrum by improving threat detection, identification, and location in the battle space. The program transitions new technologies to tactical aircraft (TACAIR), low observable aircraft, surface EW platforms, and Pre-planned Product Improvement (P3I) programs through developmental upgrades and direct technology insertions.

(U) Due to the sheer volume of efforts included in this Program Element (PE), the programs described in the Accomplishments and Plans section are representative selections of the work included in this PE.

(U) The Navy Science and Technology (S&T) program includes projects that focus on or have attributes that enhance the affordability of warfighting systems.

(U) JUSTIFICATION FOR BUDGET ACTIVITY: This program is budgeted within the APPLIED RESEARCH budget activity because it investigates technological advances with possible applications toward solution of specific Naval problems, short of a major development effort.

## (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

1. (U) FY 1999 ACCOMPLISHMENTS: Work continues on shipboard sensor and weapons response involved in operations in littoral regions. Programs concerning combat identification, precision strike and information dominance will continue. The development of micro and unmanned air vehicle designs for small radar cross section platforms and the infrared countermeasures (IRCM) development and stand-off jamming work continue to be of importance.
  - (U) THREAT WARNING - The objective is to develop small and inexpensive radio frequency (RF) receivers and demodulation techniques to recognize and characterize complex modern-modulation waveforms and to exploit both active and passive technologies to provide early warning of hostile action, either surveillance or attack, to U.S. military platforms and to assist in identifying and countering the threat.
  - (U) Fabricated a miniaturized 12-bit prototype Specific Emitter Identification (SEI) system to perform within the confines of a platform such as a small unmanned air vehicle (UAV), providing specific target homing and

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Budget Item Justification  
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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

PROGRAM ELEMENT: 0602270N

PROGRAM ELEMENT TITLE: Electronic Warfare Technology

discrimination capabilities for tactical aircraft, UAVs, and portable systems and making it attractive for application in weapons systems such as High Speed Anti Radiation Missile (HARM).

- (U) Designed and demonstrated a real-time prototype unit that extracts SEI information from modern tactical military radars possessing more stable, near flat, RF sources focusing on the tactical application of SEI to the commander in the field, onboard ship, or in the air.

- (U) Developed a counterfire system based on microbolometer camera technology which is carried by the individual infantryman to detect and mark in space the location of small arms fire in real time and at ranges greater than or equal to the lethal range of the enemy weapon.

- (U) Evaluated digital signal processing using wavelets, optical processing, and electrical micro-circuit realization of the wavelet filter bank. The most promising approach was selected for demonstrating an improved signal processing capability, for detection of frequency modulated, continuous wave (FMCW) signals with a signal-to-noise ratio of zero decibels. This addresses the Advanced Integrated Electronic Warfare System (AIEWS) program requirement for detection and identification of specific signals to provide early warning and cueing of ship self-defense weapons systems.

- (U) SELF PROTECTION - The objective is to provide a fundamental technology base, from components to systems, to support the prototype development of future onboard and offboard electronic warfare (EW) systems, to enhance Naval success in Littoral Warfare, Strike, Sealift/Protection, Strategic Deterrence, and Space and Electronic Warfare (SEW) Intelligence. The entire RF band from high frequency to millimeter wave is covered under this project. It also includes the protection of U.S. Naval platforms against electro-optic and infrared (EO/IR) guided weapons by the development of new infrared (IR) materials for decoys and new deployment concepts and the development of technologies for laser based jammers.

- (U) Analyzed designs of onboard laser guided weapons detection/protection systems and field tested prototype developmental systems for the integrated onboard/offboard countermeasures solution to laser-guided threats that will challenge Navy and Marine surface vessels operating in littoral areas.

- (U) Determined most efficient jam codes against steering array sensors and transitioned most robust seductive waveforms to enhance capability of the AIEWS system against advanced IR guided anti-ship threats.

- (U) Improved antenna isolation model to represent antennas mounted on Radar Absorbent Material (RAM) coated curved surfaces for all decoy platforms and finalized isolation improvement techniques and documented analysis methods to achieve higher decoy effective radiated power through improved antenna isolation.

- (U) Performed field and at-sea tests of the Small Ship Jammer developed for physically small surface patrol crafts that have no active onboard EA self-protection capability (e.g., the PC-1 and MK V Special Operations Craft) and are currently involved in fleet littoral warfare operations.

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DATE: February 2000

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602270N

PROGRAM ELEMENT TITLE: Electronic Warfare Technology

- (U) Demonstrated effectiveness of a new Optical Augmentation technique and feasibility of EO/IR countermeasures techniques against man-in-the-loop (MIL) threats. These technology improvements will be incorporated into the Multi-Band Anti-Ship Cruise Missile Defense Tactical Electronic Warfare System (MATES) testbed to provide an integrated multi-function, multi-band laser based countermeasures system for ship defense.
  - (U) Demonstrated a high-extinction obscuration material suitable for at-sea use for the advanced development of a vertically launched imaging IR decoy system for ships, to include a new obscurant, longwave material enhancement, and a subscale deployment vehicle.
  - (U) MISSION SUPPORT - The objective is focused on improving the ability to assess EW performance ranging from individual systems/platforms through operations in Joint Mission and Support Areas such as training and the research infrastructure. A major goal of this research area is to explore development of Battle Management decision aids which fit within the established Navy command and control system deployed throughout the fleet. The focus is also on advanced surveillance techniques and jamming and deception of command and control systems and data links and the development of capabilities for strike, surveillance, electronic countermeasures (ECM) and other mission-support aircraft to improve situation awareness, to provide dependable combat identification and to determine the intent of enemy forces by passive means while disrupting their capability to obtain and disseminate tactical information.
    - (U) Demonstrated a partial payload of a Micro Air Vehicle capable of carrying avionics and a radar jamming payload, but light enough to be carried by an individual infantryman, for discreet Navy missions.
    - (U) Developed a visually rich command and control simulator capable of synthesizing realistic operations found in modern combat missions for assessing Naval operational situations, planning future operations, and evaluating system effectiveness.
    - (U) Validated the IR ship target and scene model for the cruise missile (CM) EW simulation to address the shortcomings of previous IR ship predictive codes.
    - (U) Plan and conduct tri-service field demonstration of the modified Little Monopulse Information Signal Processing Element (LMISPE) system capable of fingerprinting modern cellular radio communication systems from airborne platforms.
2. (U) FY 2000 PLAN: Work continues on shipboard sensor and weapons response involved in operations in littoral regions. Programs concerning combat identification, precision strike and information dominance will continue. The development of micro and unmanned air vehicle designs for small radar cross section platforms and the IRCM development and stand-off jamming work continue to be of importance.

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PROGRAM ELEMENT: 0602270N

PROGRAM ELEMENT TITLE: Electronic Warfare Technology

- (U) THREAT WARNING - The objective is to develop small and inexpensive RF receivers and demodulation techniques to recognize and characterize complex modern-modulation waveforms and to exploit both active and passive EO/IR technologies to provide early warning of hostile action, either surveillance or attack, to U.S. military platforms and to assist in identifying and countering the threat.
  - (U) Demonstrate and verify, in an operational test, specific target homing and discrimination capabilities with the use of extremely miniature components Analog-to-Digital (A/D) Converter, the pulse processor Application Specific Integrated Circuit (ASIC) and the Digital Signal Processor) packaged in sizes suitable for tactical aircraft, UAVs, and portable systems and making it attractive for application in weapons systems such as HARM.
  - (U) Integrate specific target homing and discrimination capabilities into a 4x4x1-inch package to create a miniature SEI system that is compact, lightweight, and power efficient. This will be accomplished using extremely miniature components packaged in sizes suitable for tactical aircraft, UAVs, and portable systems, making it attractive for application in weapons systems such as HARM.
  - (U) Optimize wavelet filterbank parameters and digital signal processing algorithms and fully demonstrate a system that extracts SEI information from modern tactical military radars possessing more stable, near flat, RF sources focusing on the tactical application of SEI to the commander in the field, onboard ship, or in the air. Transition to the AIEWS program.
  - (U) Develop and demonstrate technology building blocks to provide small, inexpensive integrated sensors to allow micro air vehicles (MAV) to detect and identify RF emitters, locate and navigate towards these emitters and deliver a sensor or countermeasure micro-payload for battlefield intelligence and situational awareness.
  - (U) Demonstrate an improved signal processing capability for detecting FMCW signals with a signal-to-noise ratio of less than zero decibels to address the AIEWS program requirement of detecting and identifying certain signals to provide early warning and cueing of ship self-defense weapons systems. Transition to the AIEWS program.
  - (U) Complete design and integration of an Compact Electronic Support (ES) System capable of being deployed on presently available remotely piloted vehicles to provide high quality threat information for strategic and tactical surveillance and reconnaissance missions.
  - (U) Develop and incorporate variable fidelity electromagnetic propagation models into the simulation providing a littoral capable force-on-force level simulator which establishes a common operating picture for the EW commander.
- (U) SELF PROTECTION - The objective is to provide a fundamental technology base, from components to systems, to support the prototype development of future onboard and offboard EW systems, to enhance Naval success in Littoral Warfare, Strike, Sealift/Protection, Strategic Deterrence, and SEW Intelligence. The entire radar frequency band

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PROGRAM ELEMENT TITLE: Electronic Warfare Technology

from high frequency to millimeter wave is covered under this project. It also includes the protection of U.S. Naval platforms against EO/IR guided weapons by the development of new IR materials for decoys and new deployment concepts and the development of technologies for laser based jammers.

- (U) Complete integration and evaluation of the onboard/offboard CM solution to laser-guided threats that will challenge Navy and Marine surface vessels operating in littoral areas.
- (U) Incorporate a new mid-infrared solid state laser into the Multi-Band Anti-Ship Cruise Missile Defense Tactical Electronic Warfare System (MATES) testbed and investigate use of a compact IR countermeasures system for small shipboard platforms to provide an integrated multi-function, multi-band laser based countermeasures system for ship defense.
- (U) Design and procure hardware/software for a surrogate command-and-control warfare (C2W) network to provide a self-adapting, spatially distributed command and control warfare and electronic attack (C2W/EA) network capable of electromagnetic battlefield dominance through target denial, obscuration, and signature alteration.
- (U) Demonstrate high intensity per unit volume in the longwave band to improve the spectral performance of the IR special materials and incorporate with the vehicle autopilot and sensor control for the development of an imaging IR decoy system for ships, to include a new obscurant, longwave material enhancement, and a subscale deployment vehicle.
- (U) MISSION SUPPORT - The objective is focused on improving the ability to assess EW performance ranging from individual system/platform through operations in Joint Mission and Support Areas such as training and the research infrastructure. A major goal of this research area is to explore development of Battle Management decision aids that fit within the established Navy command and control system deployed throughout the fleet. The focus is also on advanced surveillance techniques and jamming and deception of command and control systems and data links and the development of capabilities for strike, surveillance, electronic countermeasures and other mission-support aircraft to improve situation awareness, to provide dependable combat identification (ID) and to determine the intent of enemy forces by passive means while disrupting their capability to obtain and disseminate tactical information.
  - (U) Develop the final jamming payload, integrate it with the final Micro Air Vehicle design capable of carrying avionics and a radar jamming payload, but light enough to be carried by an individual infantryman for discreet Navy missions.
  - (U) Develop digital signal processing (DSP) hardware and algorithms to integrate with receiver/transmitter models for development of building block technologies needed for a small, lightweight, programmable Anti-Ship Missile (ASM) seeker simulator for packaging on a recoverable target drone to perform realistic at-sea threat engagement scenarios.

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PROGRAM ELEMENT TITLE: Electronic Warfare Technology

- (U) Based on results of the STARCROSS studies, develop and test a high speed analog-to-digital and DSP intercepted system to establish jamming requirements against mobile radio communications systems potentially employed by enemy forces.
- (U) Conduct an overall system level design (including Electronic Attack, Information Warfare and Artificial Intelligence) and model a coordinated Force-on-Force level engagement for deployment of distributed EW assets that can be used collaboratively in a synchronized fashion in real time.
- (U) Develop prototype set-up and control software models and establish parallelization efforts to reduce per-run execution time, simulation setup time, and post-run analysis time of the CM high-fidelity EW simulation model.
- (U) Define and fabricate RF Off-board Countermeasure (OCM) devices as part of a controlled network of OCM devices to enable any ship in the OCM network area to engage any anti-ship missile and steer it away from all ships in the OCM network protected area.

(U) FY 2001 PLAN: Work continues on shipboard sensor and weapons response involved in operations in littoral regions. Programs concerning combat identification, precision strike and information dominance will continue. The development of micro and unmanned air vehicle designs for small radar cross section platforms and the IRCM development and stand-off jamming work continue to be of importance.

- (U) THREAT WARNING - The objective is to develop small and inexpensive RF receivers and demodulation techniques to recognize and characterize complex modern-modulation waveforms and to exploit both active and passive technologies to provide early warning of hostile action, either surveillance or attack, to U.S. military platforms and to assist in identifying and countering the threat.
- (U) Develop and demonstrate receiver, direction finding and navigation technology subsystems to provide small, inexpensive integrated sensors to allow micro air vehicles to detect and identify RF emitters, locate and navigate towards these emitters and deliver a sensor or countermeasure micro-payload for battlefield intelligence and situational awareness.
- (U) Demonstrate and transition an electronic support system capable of being deployed on presently available remotely piloted vehicles to provide high quality threat information for strategic and tactical surveillance and reconnaissance missions.
- (U) Develop and incorporate adaptive radar and communications models into a littoral capable force-on-force level simulator which establishes a common operating picture for the EW commander.

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PROGRAM ELEMENT: 0602270N

PROGRAM ELEMENT TITLE: Electronic Warfare Technology

- (U) Demonstrate the feasibility of generating a coherent tactical picture of the battle scenario by employing Information Warfare Simulation technologies integrated with hardware sensor information in real-time support of the warfighter.
- (U) SELF PROTECTION - The objective is to provide a fundamental technology base, from components to systems, to support the prototype development of future onboard and offboard EW systems, to enhance Naval success in Littoral Warfare, Strike, Sealift/Protection, Strategic Deterrence, and SEW Intelligence. The entire radar frequency band from high frequency to millimeter wave is covered under this project. It also includes the protection of U.S. Naval platforms against EO/IR guided weapons by the development of new intermediate frequency (IF) materials for decoys and new deployment concepts and the development of technologies for laser based jammers.
  - (U) Based on previous Army and Navy evaluation of obscurants, optimize a material to be evaluated along with the modified special material, integrate with the vehicle technology advancements, and evaluate the effectiveness against Imaging IR Anti Ship Cruise Missile (ASCM) seekers.
  - (U) Complete system integration and demonstrate in an over-water scenario the capability of providing an integrated multi-function, multi-band laser based countermeasures system for ship defense.
  - (U) Design and demonstrate high fidelity decoys that replicate detailed temporal, spectral and phase features of platforms, thus presenting a realistic target to the threat weapons system from an expendable vehicle which can be spatially separated from the platform.
  - (U) Fabricate and test the command-and-control warfare network, and initiate integration of the C2W network with the electronic attack (EA) subsystem for a self-adapting, spatially distributed C2W/EA network capable of EM battlefield dominance through target denial, obscuration, and signature alteration.
- (U) MISSION SUPPORT - The objective is focused on improving the ability to assess EW performance ranging from individual system/platform through operations in Joint Mission and Support Areas such as training and the research infrastructure. A major goal of this research area is to explore development of Battle Management decision aids that fit within the established Navy command and control system deployed throughout the fleet. The focus is also on advanced surveillance techniques and jamming and deception of command and control systems and data links and the development of capabilities for strike, surveillance, electronic countermeasures and other mission-support aircraft to improve situation awareness, to provide dependable combat ID and to determine the intent of enemy forces by passive means while disrupting their capability to obtain and disseminate tactical information.
  - (U) Demonstrate the effectiveness of the final integrated payload/vehicle design and perform radar jamming tests of a Micro Air Vehicle capable of carrying avionics and a radar jamming payload, but light enough to be carried by an individual infantryman, for discreet Navy missions.

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- (U) Complete subsystem integration and feasibility demonstration of a small, lightweight, programmable Anti-Ship Missile (ASM) seeker simulator for packaging on a recoverable target drone to perform realistic at-sea threat engagement scenarios.
- (U) Conduct Tri-Service jamming tests to establish jamming requirements of mobile communications systems potentially employed by enemy forces.
- (U) Physically implement a coordinated electronic attack capability using available assets and conduct subsystem demonstrations in the lab to provide the capability for deployment of distributed EW assets that can be used collaboratively in a synchronized fashion in real time.
- (U) Complete parallelized full workload model and demonstrate the capacity of the overall model to reduce per-run execution time, simulation setup time, and post-run analysis time of the CM high-fidelity EW simulation model.
- (U) Design and develop algorithms and modeling concepts which allow for high fidelity user friendly models to be embedded in combat systems aboard land, sea or air platforms to provide training, scenario reconstruction, mission planning, and real time operational control.
- (U) Demonstrate RF offboard countermeasure (OCM) devices and define and fabricate infrared OCM devices as part of a controlled network of OCM devices to enable any ship in the OCM network to engage any anti-ship missile and steer it away from all ships in the OCM network protected area.

## B. (U) PROGRAM CHANGE SUMMARY:

FY 2000 President's Budget	FY 1999	FY 2000	FY 2001
Appropriated Value	22,743	24,659	25,462
Comparability Adjustment from 0602232N	1,200	36,259	
SBIR/STTR Transfer	-48	1,500	
Program Adjustment			1,582
Various Rate Adjustments			-1,001
Inflation Adjustments	-103		
Execution Adjustment	-1,393		
Congressional Rescissions		-200	
Congressional Plus Ups		11,500	
FY 2001 PRESBDG Submission	22,399	37,459	26,043

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BUDGET ACTIVITY: 2 PROGRAM ELEMENT: 0602270N  
PROGRAM ELEMENT TITLE: Electronic Warfare Technology

(U) CHANGE SUMMARY EXPLANATION:

(U) Schedule: Not applicable

(U) Technical: The Special Access High Power Microwave (HPM) Program is transferred into this P.E. from P.E. 0602232N in FY2001 at a funding level of \$1.8M per year.

C. (U) OTHER PROGRAM FUNDING SUMMARY: Not applicable.

(U) RELATED RDT&E PROGRAMS:

This PE adheres to Defense S&T Reliance Agreements on EW with oversight and coordination provided by the DDR&E and is associated with efforts that are being pursued under the following Army and Air Force PEs:

- (U) PE 0602204F (Aerospace Avionics)
- (U) PE 0603270F (Advanced Electronic Warfare Technology)
- (U) PE 0602270A (Electronic Warfare Technology)
- (U) PE 0602270F (Electronic Warfare Technology)
- (U) PE 0603270A (Advanced Electronic Warfare Technology)
- (U) PE 0605604A (Survivability and Lethality Analysis)
- (U) PE 0601153N (Defense Research Sciences)
- (U) PE 0602234N (Materials, Electronics and Computer Technology)
- (U) PE 0603270N (Advanced Electronic Warfare Technology)
- (U) PE 0603217N (Air Systems and Weapons Advanced Technology)
- (U) PE 0603792N (Advanced Technology Transition)
- (U) PE 0604270N (EW Development)

D. (U) SCHEDULE PROFILE: Not applicable.

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PROGRAM ELEMENT: 0602314N

PROGRAM ELEMENT TITLE: Undersea Warfare Surveillance Technology

(U) COST: (Dollars in Thousands)

PROJECT NUMBER & TITLE	FY 1999 ACTUAL	FY 2000 ESTIMATE	FY 2001 ESTIMATE	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	TO ESTIMATE	TOTAL COMPLETE	PROGRAM
Undersea Warfare Surveillance Technology	46,143	51,123	52,488	53,978	52,801	52,733	51,896	CONT.	CONT.	

A. (U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: All of the Navy's applied research in undersea target detection, classification, localization, and tracking is funded through this Program Element (PE). In countering the troubling proliferation of quiet diesel submarines to third world countries and Russia's continued investment in submarine technology, work within this PE provides an enabling capability for power projection and force sustainability. Associated research directly supports the Department of Defense Joint Warfighting Science and Technology Plan and the Defense Technology Area Plans. Within the Navy the effort supports the following Navy Joint Mission Areas (JMAS): Littoral Warfare; Intelligence, Surveillance, and Reconnaissance; and Strategic Mobility. The approach protects the country's capital investment in submarine, surface ship and Air Antisubmarine Warfare (ASW) assets both by developing commercial off-the-shelf (COTS) upgrade options for today's ASW suites and by exploring those high risk/high payoff technologies that promise to provide capabilities of exceptionally high military value in five to fifteen years.

(U) Intelligence, Surveillance, and Reconnaissance includes research and technology issues associated with reliable undersea target detection and tracking to enable on-command application of precision offensive military force. Programs include undersea sensors and arrays to provide robust shallow water surveillance and reconnaissance, and to detect undersea threats to the surface battleforce. This effort also includes Navy unique research and technology issues associated with creating a timely and intelligible tactical picture of the undersea battlespace.

(U) Littoral Warfare includes research and technology issues associated with dominating the undersea battlespace to enable timely execution of joint/combined operations and to ensure joint force sustainability. Programs include advanced sensors and arrays for both improved ASW surveillance and enhanced battleforce self-defense, ASW data fusion for better tactical control, and low frequency active sonar and rapidly deployable surveillance systems for covert/non-covert indication and warning.

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PROGRAM ELEMENT TITLE: Undersea Warfare Surveillance Technology

(U) Strategic Mobility includes research and technology issues associated with reliable undersea target detection and tracking, enabling joint battleforce sustainability. Programs include the entire spectrum of technology development undertaken in support of other JMAs.

(U) These efforts support the naval portion of the Joint Warfare Strategy as expressed in "Forward...From the Sea". Programs in this PE are primarily service (Navy) unique.

(U) Applied research funded by this PE in many cases transitions to advanced development projects in undersea warfare advanced technology (PE 0603747N).

(U) Due to the sheer volume of efforts included in this PE the programs described in the Accomplishments and Plans sections are representative selections of the work included in this PE.

(U) The Navy Science and Technology program includes projects that focus on or have attributes that enhance the affordability of warfighting systems.

(U) JUSTIFICATION FOR BUDGET ACTIVITY: This program is budgeted within the APPLIED RESEARCH Budget Activity because it investigates technological advances with possible applications toward solution of specific Naval problems, short of an advanced development effort.

(U) PROGRAM ACCOMPLISHMENTS AND PLANS:

1. (U) FY 1999 ACCOMPLISHMENTS:

- (U) ACOUSTIC SENSOR TECHNOLOGY:

- (U) Initiated:

- (U) Development of low frequency, three-axis, acoustic velocity sensors aimed at dramatically improving the ability to passively detect quiet submarines. The basis for this effort is a comprehensive analysis that indicates that this technology will enable a significant improvement of detection ranges for some of the most challenging targets.

- (U) Development of an affordable, high-pulse power, high-energy density, ambient temperature battery for use in A-size active sonobuoys and in off-board and deployable sensors and sources intended for wide-

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PROGRAM ELEMENT TITLE: Undersea Warfare Surveillance Technology

- area surveillance operations. The goal of this effort is to extend the lifetime of active sonobuoys by 50% and to power future autonomous surveillance arrays for up to 90 days.
- (U) Development of an ultra-lightweight, ultra-low power air-, surface ship- or submarine-deployable, Autonomous Drifting Line Array (ADLA) to be used in conjunction with or in place of conventional towed arrays when additional sensing resources are needed in forward areas. These arrays will make maximum use of in-sensor passive and active signal processing and will communicate with tactical support centers via low-bandwidth RF paths such as commercial cellular channels.
  - (U) Development of active and passive acoustic signal processing detection, localization and classification techniques that can be executed in battery-powered, drifting and fixed autonomous air ASW and undersea surveillance sensors and arrays. Two separate Broad Agency Announcements (BAAs) were published to address this topic.
  - (U) Development of a family of ultra-lightweight, ultra-low power air-, surface ship- or submarine-deployable, Matched Field Tracking Arrays to be used for barrier (Hydra) or area (Kelp) surveillance or as organic off-board sensors for submarines. These arrays will classify on depth from matched field tracking as well as other means, will have telesemar communications and be compatible with the overall Deployable Array Technology (DAT) system concept.
  - (U) Development of a broadband acoustic projector array using electroactive polymer as the driver. This development utilized existing copolymer material available. Future planning includes the use of a new class of high strain irradiated electrostrictive polymer currently in 6.1 development.
- (U) Continued:
- (U) Development of a large aperture, bottom-mounted array and associated signal processing aimed at exploring the feasibility of achieving the very large gains promised by matched field signal processing.
  - (U) Development of a signal processing method that enables rapid and accurate differentiation between transient noises that come from man-made sources and those that emanate from biologic sources. The method reduces the high false alarm rate and performs at a level that is very near the theoretical optimum.
  - (U) Development of an affordable, high-pulse power, high-energy density, thermal battery for A-size active sonobuoys. The goal is to increase energy density and lifetime to meet requirements of Air Deployed Low Frequency Projector (ADLFP) program. Began a related 24-month Small Business Innovation Research Phase II effort.

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PROGRAM ELEMENT TITLE: Undersea Warfare Surveillance Technology

- (U) The assessment and report on the role of Air ASW Surveillance in plausible FY 2015 regional and global conflicts. Began a similar assessment of bottom-moored shallow water acoustic and non-acoustic surveillance methods.
- (U) Development of signal processing algorithms which, when used in conjunction with a volumetric towed array, can provide improved localization estimates. This technology will transition to PE 0603504N, Advanced Processing Build Block for integration and delivery to hull two of the Virginia class submarine.
- (U) Development of a first-generation brassboard version of an off-board, acoustic, multi-static source and associated on-board signal processing techniques. FY 1999 work focused on conducting an over-the-side engineering test of a brassboard, off-board source transducers and electronics utilizing low frequency, slotted cylinder projectors, and a sea test to obtain target-in-the environment data. The sea-tested and engineering test of the off-board source transducers and electronics were successfully completed. Following analysis of the data, development of multi-static processing and shallow water classification algorithms will be initiated.
- (U) Development of critical sensor and signal processing technologies required to autonomously detect and classify submarines with a family of deployed systems. The focus of the FY 1999 work is on integrating acoustic communications links into an uncabled network of undersea sensors and subsequently demonstrating an ability to pass a series of preprogrammed communications in a shallow water environment.
- (U) Development of a capability to exploit unique classification clues provided by coherently processing active sonar data collected by two widely spaced, relatively moving sensors. The focus of the FY 1999 work is on analyzing at-sea data and computer simulations to evaluate the payoffs and limitations of this approach.
- (U) Development of technical approaches for automating the configuration of a sonar system in response to a real-time analysis of the acoustic field and relevant (measured) environmental parameters. The FY 1999 work is focused on an exploration of alternative adaptive signal processing/modeling techniques.
- (U) Development of electrostrictive relaxor ceramics for use in high power, low frequency projector arrays. Continue engineering and manufacturing efforts to complete development of a class of lead magnesium niobate (PMN) relaxor materials.

(U) Demonstrated:

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PROGRAM ELEMENT TITLE: Undersea Warfare Surveillance Technology

- (U) That forward-scattered acoustic energy is detectable at tactically useful ranges in a tactically significant acoustic environment at sea as part of the Littoral Warfare Advanced Development (LWAD) 99-3 Sea Test (P.E. 0603747N).
- (U) Performance of a Bragg grating-based optical towed array. This is a risk reduction effort that was initiated in FY 1996. The intent is to provide an alternative optical technology in the event the approach selected in the Affordable Array Technology Advanced Technology Demonstration (PE 0603792N) does not work as hypothesized.

(U) Completed:

- (U) Development of a signal processing algorithm that, based on in-situ environmental information and the tactical scenario, automatically selects the appropriate advanced tracking method for improved detection and classification of stationary or slowly-moving submarines. This effort was initiated in FY 1998.
- (U) Development of common signal processing algorithms for a surface ship's SQS-53C and the SH-60R helicopter's Airborne Low Frequency Sonar (ALFS). This effort, which was initiated in FY 1997, is aimed at significantly reducing the false alarm rate, especially when operating in shallow water. The technologies will transition via software upgrades to ALFS and the SQS-53C.

• (U) NON-ACOUSTIC SENSOR TECHNOLOGY:

- (U) Initiated:
  - (U) Design and construction of two laser based, sensor Exploratory Development Models. This development is in support of a joint US/UK program that will significantly expand the utility of a Laser Induced Differential Absorption Radar (LIDAR) system as a standoff sensor.
- (U) Extremely Low Frequency Electromagnetic (ELFE) sensor installation and associated sensor algorithm development in support of the next generation Magnetic Anomaly Detection (MAD) system.
  - (U) Completed:
- (U) Development and laboratory evaluation of a miniature, low cost, low power, magnetometer together with electromagnetic feature extraction and tracking algorithms. This effort is in support of a deployable autonomous distributed system. Transition to Advanced Deployable System, P.E. 0604784N.

• (U) DATA FUSION TECHNOLOGY:

- (U) Demonstrated:

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PROGRAM ELEMENT TITLE: Undersea Warfare Surveillance Technology

- (U) The capability of the Deployable Autonomous Distributed System to autonomously detect, classify, and track a threat target and, using data fusion techniques, to develop a fire control quality track suitable for weapon employment.

(U) Completed:

- (U) Development of the multi-sensor, acoustic and non-acoustic Data Fusion algorithm. Transition this technology to Program Executive Officer, Undersea Warfare Advanced Systems Technology Office and Naval Sea Systems Command PMS-400.

2. (U) FY 2000 PLAN:

- (U) ACOUSTIC SENSOR TECHNOLOGY:

(U) Initiate:

- (U) Development of active acoustic arrays that will conform to the shape of the hull for follow-on surface ship programs and for inclusion into the Virginia class Integrated Bow Conformal (IBC) effort for high frequency use. The objective is to explore system issues that could lead to the elimination of large spherical bow arrays on these ships. Affordability, reliability and service life considerations will drive this development.
- (U) Development of an advanced version (Super ADAR) of the Advanced Deployable Acoustic Receiver (ADAR) sonobuoy that includes the Global Positioning System (GPS), in-buoy active, passive and transient signal processing, satellite data and command telemetry, and has a 5 day semi-autonomous lifetime.
- (U) Development of single crystal materials suitable for use in a high power, broadband, acoustic projector. This is a high risk/high pay-off effort that leverages a massive investment in this technology by Defense Advanced Research Projects Agency. The initiative is applicable to surface ships and submarines. It could lead to a common ASW and mine avoidance system.
- (U) Development of all-optical heading, depth, and temperature sensors (engineering sensors) for use with all-optical towed arrays. The focus of the FY 2000 work will be on developing an approach for an all-optical heading sensor with sufficient sensitivity to replace conventional magnetic sensors

(U) Continue:

- (U) Development of critical sensor and signal processing technologies required to autonomously detect and classify submarines with a family of deployed systems. The focus of the FY 2000 work will be on integrating the technologies required to link a series of fully functional, autonomously

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PROGRAM ELEMENT: 0602314N

PROGRAM ELEMENT TITLE: Undersea Warfare Surveillance Technology

- deployable sensors to each other with acoustic communications and to the shore via low profile gateway buoys employing radio frequency communications.
- (U) Development of low frequency, three-axis, acoustic velocity sensors to dramatically improve the ability to passively detect quiet submarines. The FY 2000 work will focus on preparations for an in-water test at Lake Seneca to validate performance.
- (U) Development of an electroactive polymer broadband acoustic source. The aim of this initiative is to enable the under-ice and mine avoidance sonar on an attack submarine to be embedded in the submarine bow or sonar dome as a conformal array.
- (U) Development of a high-energy density, ambient temperature battery for use in A-size active sonobuoys and in off-board and deployable sensors and sources intended for wide-area surveillance operations. The focus of the FY 2000 work will be on testing a prototype battery in the laboratory.
- (U) Development of an ultra-lightweight, deployable, ADLA to be used in conjunction with, or in place of, conventional towed arrays. An over-the-side hydrodynamic and acoustic test of a 300-meter long array will occur in FY 2000.
- (U) Development of active and passive acoustic signal processing detection, localization and classification techniques that can be executed in battery-powered, drifting and fixed autonomous air ASW and undersea surveillance sensors and arrays.
- (U) Development of technical approaches for automating the configuration of a sonar system in response to a real-time analysis of the acoustic field and relevant (measured) environmental parameters. The FY 2000 work is focused on application of adaptive signal processing/modeling techniques.
- (U) Development of a first-generation, brassboard version of an off-board, acoustic, multi-static source and associated on-board signal processing techniques. The focus of the FY 2000 work will be on a more advanced demonstration utilizing an integrated version of the brassboard source and at-sea testing of multi-static processing algorithms in two other littoral areas. Development of multistatic processing algorithms will be continued.
- (U) Development of a family of ultra-lightweight, ultra-low power air-, surface ship- or submarine-deployable, Matched Field Tracking Arrays to be used for barrier (Hydra) or area (Kelp) surveillance or as organic off-board sensors for submarines. An acoustic feasibility test of both array concepts, Hydra and Kelp, will occur in FY 2000.
- (U) Development of a signal processing method that will enable rapid and accurate differentiation between transient noises that come from man-made sources and those that emanate from biologic sources. These works will transition to the Advanced Processing Build program in PE 0603504N.

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PROGRAM ELEMENT TITLE: Undersea Warfare Surveillance Technology

(U) Development of signal processing algorithms which, when used in conjunction with a volumetric towed array, can provide improved localization estimates. The work in this project has been redirected from volumetric towed array processing to single line towed array processing at the request of the Advanced Systems and Technology Office. This technology will transition to PE 0603504N, Advanced Processing Build Block for integration and delivery into the Acoustic Rapid COTS Insertion Program.

(U) Conduct:

(U) Report analysis of sea test for Acoustic Ray Anomaly. Initiate transition planning with PMA-264 and the NAVAIR Advanced Extended Echo Ranging (AEER) Program Office.

(U) Demonstrate:

(U) The performance of a large aperture, bottom-mounted array and associated signal processing aimed at exploring the feasibility of achieving the very large signal processing gains promised by matched field signal processing.

(U) The capability to exploit unique classification clues provided by coherently processing active sonar data collected by two widely spaced, relatively moving sensors using at-sea data. This demonstration will be conducted using data collected at-sea in an acoustically challenging environment.

(U) The advantages of employing novel feedback control techniques in powering transduction array concepts. An offshoot will be to initiate the integration of efficient power amplifiers directly into the transducer array. This initiative is specifically aimed at reducing the life-cycle cost of active acoustic systems.

(U) Complete:

(U) Development of innovative, low frequency, multi-static signal processing algorithms. These technologies will transition to PE 0603747N Project X1933 for evaluation in an end-to-end Low Frequency Active/Surveillance Towed Array Search System testbed.

(U) Assessment and report on the role of bottom-moored shallow water acoustic and non-acoustic surveillance methods. Begin and complete a similar assessment of the role of submarine-deployed off-board sensors.

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PROGRAM ELEMENT TITLE: Undersea Warfare Surveillance Technology

(U) Development of an affordable, high-pulse power, high-energy density, thermal battery for A-size active sonobuoys. The goal is to increase energy density and lifetime to meet requirements of the ADLFP program. Complete a related 24-month Small Business Innovation Research Phase II effort.

• (U) NON-ACOUSTIC SENSOR TECHNOLOGY:

(U) Conduct:

(U) An airborne demonstration of an uncompensated, Extremely Low Frequency MAD system. The goal is to show that the new development system will perform as well as a compensated MAD system.

(U) Complete:

(U) Construction of LOTUS and Emerald Exploratory Development Model hardware and initiate at-sea shakedown testing.

• (U) DATA FUSION TECHNOLOGY:

(U) Initiate:

(U) Development of advanced concepts for inter-platform/system data fusion.

(U) Conduct:

(U) An advanced simulation of intra-field data fusion and field level control of a Deployable Autonomous Distributed System.

3. (U) FY 2001 PLAN:

• (U) ACOUSTIC SENSOR TECHNOLOGY:

(U) Initiate:

(U) Development of a new "fishline" fiber optic acoustic sensor technology for future application to towed and deployed sonar arrays. The objective is to explore sensing and interrogation concepts for a very small diameter, single fiber, multiplexed acoustic sensor system. Acoustic sensitivity and noise issues of "fishline" will be assessed.

(U) Continue:

(U) Development of active acoustic arrays that will conform to the shape of the hull for folbw-on submarine and surface ship programs. The work in FY 2001 will focus on nested and sparse array

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PROGRAM ELEMENT TITLE: Undersea Warfare Surveillance Technology

concepts for both mid and high frequency application requirements and on approaches for integrating projector arrays with large passive arrays and with submarines coatings.

- (U) Development of an electroactive polymer, broadband, acoustic source. The focus of the work in FY 2001 will be on testing prototype broadband partial arrays encompassing multi-octave operation and broadband signal transmissions. This effort will include a validation of array models and an assessment of the interactions between array elements.
- (U) Development of the air-deployable Super-ADAR sonobuoy that includes GPS, in-buoy active and passive signal processing, satellite data and command telemetry, and has a 5 day, semi-autonomous lifetime. Deploy a testable unit in FY01.
- (U) Development of high-energy density, extended operation, ambient chemical battery for wide area air ASW drifting and fixed surveillance operations. Transition the technology to PE 0603747N Project R2142 for an advanced development demonstration of integrated deployable system technologies.
- (U) Development of critical sensor and signal processing technologies required to autonomously detect and classify submarines with a family of deployed systems. The focus of the FY 2001 work will be on signal processing associated with a short vertical line array sensor.
- (U) Development of all-optical heading, depth, and temperature sensors (engineering sensors) for use with all-optical towed arrays. The focus of the FY 2001 work will be on demonstrating all-optical heading sensor performance and developing an approach for multiplexing all engineering sensors on a single fiber.
- (U) Development of a family of ultra-lightweight, ultra-low power air-, surface ship- or submarine-deployable, Matched Field Tracking Arrays to be used for barrier (Hydra) or area (Kelp) surveillance or as organic off-board sensors for submarines. Advanced array construction methods, engineering sensors for self location, and improved processing will occur in FY2001.
- (U) Development of a first-generation, brassboard version of an off-board, acoustic, multi-static source and associated on-board signal processing techniques. FY 2001 work will focus on further analysis of sea test data, development of robust multistatic processing algorithms for use in difficult littoral areas and improvements to multistatic performance prediction models.
- (U) Development of acoustic arrays that conform to the shape of the hull for follow-on submarine and surface ship programs. The FY 2001 focus is to design and evaluate conformal sensor designs of double-curvature arrays. Acoustic performance of the conformal acoustic arrays will be assessed relative to ship design implications.

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PROGRAM ELEMENT TITLE: Undersea Warfare Surveillance Technology

- (U) Evaluation of performance of low frequency, three-axis, acoustic velocity sensors and scalar pressure sensors through in-water tests at Lake Seneca. In addition, develop plans for full-scale evaluation on a 688-I class submarine.
- (U) Demonstrate:
  - (U) Capability of automated active signal processing techniques for detection and classification of diesel electric submarines in littoral environments. These techniques will allow reduced manning of future sonar systems.

(U) Complete:

- (U) Development of technical approaches for automating the configuration of a sonar system in response to a real-time analysis of the acoustic field and relevant (measured) environmental parameters. Transition environmentally adaptive sonar technology signal processing techniques, concepts of operation and measures of effectiveness to an advanced development demonstration effort in PE 0603747N Project R2142.

- (U) NON-ACOUSTIC SENSOR TECHNOLOGY:

- (U) Conduct sea tests of LOTUS and Emerald standoff sensor system.
- (U) Complete ELFE algorithm development and data analysis from flight tests. Develop and publish a final report. These technologies will transition to the Shallow Water Localization and Attack System, P.E. 0603254N, Project H1292.

- (U) DATA FUSION TECHNOLOGY:

- (U) Develop inter-platform/sensor data fusion algorithms to produce a Common Tactical Picture and perform a Situation Assessment.

(U) Complete:

- (U) Analysis of results from simulation tests and publish final report. Transition to PD-18.
- (U) Analysis of results from the FY 00 sea test and publish final report. Transition to PD-18.

B. (U) PROGRAM CHANGE SUMMARY:

FY 1999      FY 2000      FY 2001

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PROGRAM ELEMENT: 0602314N

PROGRAM ELEMENT TITLE: Undersea Warfare Surveillance Technology

(U) FY 2000 President's Budget:	49,710	51,406	51,213
(U) Appropriated Value:	-	51,406	-
(U) SBIR/STTR Transfer:	-593	0	0
(U) Minor Program Adjustments	0	0	686
(U) Execution Adjustment:	-2974	0	0
(U) Congressional Rescissions	0	-283	0
(U) Various Rate Adjustments	0	0	589
(U) FY 2001 OSD/OMB Submission:	46,143	51,123	52,488

(U) CHANGE SUMMARY EXPLANATION:

(U) Schedule: Not Applicable.

(U) Technical: Not Applicable.

C. (U) OTHER PROGRAM FUNDING SUMMARY:

(U) RELATED RDT&E:

- (U) PE 0601153N (Defense Research Sciences)
- (U) PE 0602315N (Mine Countermeasures, Mining and Special Warfare Technology)
- (U) PE 0602435N (Ocean and Atmospheric Technology)
- (U) PE 0603254N (Anti-Submarine Warfare Systems Development)
- (U) PE 0603504N (Advanced Submarine Combat Systems Development)
- (U) PE 0603747N (Undersea Warfare Advanced Technology)
- (U) PE 0603792N (Advanced Technology Transition)
- (U) PE 0604212N (Anti-Submarine Warfare and Other Helicopter Development)
- (U) PE 0604784N (Advanced Deployable System)

D. (U) SCHEDULE PROFILE: Not applicable.

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PROGRAM ELEMENT: 0602315N

PROGRAM ELEMENT TITLE: Mine Countermeasures, Mining and Special Warfare Technology

(U) COST: (Dollars in Thousands)

PROJECT NUMBER & TITLE	FY 1999 ESTIMATE	FY 2000 ESTIMATE	FY 2001 ESTIMATE	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	TO COMPLETE	TOTAL PROGRAM
N/A Mine Countermeasures, Mining and Special Warfare Technology	48,084	44,773	50,864	51,708	52,027	50,091	51,320	CONT.	CONT.

A. (U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: This Navy program element (PE) provides technologies for naval Mine Countermeasures (MCM), U.S. Naval sea mines, Naval Special Warfare, and Department of Defense (DOD) Explosive Ordnance Disposal (EOD). It is strongly aligned with the Joint Chiefs of Staff Joint Warfighting Capabilities through the development of technologies to achieve military objectives (Power Projection from the Sea) with minimal casualties and collateral damage. The PE supports the Joint Littoral Warfare Mission Area 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. The MCM component concentrates on the development and transition of technologies for organic mine countermeasures and Future Naval Capabilities supporting Ship to Objective Maneuver. These include technologies for clandestine minefield surveillance and reconnaissance, organic self-protection, organic minehunting, neutralization/breaching and clearance. The sea mining component emphasizes offensive sea mining capabilities. The Naval Special Warfare and EOD technology components concentrate on the development of technologies for near-shore mine/obstacle detection and clearance, mobility and survivability, as well as explosive ordnance disposal.

(U) MCM Technology: 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. "Desert Storm" demonstrated the U.S. Navy's needs to counter the projected third-world mine threat. Advanced technologies are required to rapidly detect and neutralize all mine types, from deep water to the beach. This task has two major thrusts: (1) Mine/obstacle detection and (2) mine/obstacle neutralization. The detection thrust includes: remote sensing techniques to survey threat mining activities and mine/obstacle field locations; advanced acoustic/non-acoustic sensors and processing technologies for rapid minefield reconnaissance and determination of the location of individual mines and obstacles. The majority of these sensors and techniques were demonstrated in FY 1997 and FY 1998 as part of the Joint Countermine Advanced Concepts Technology Demonstration (JCM ACTD). The neutralization thrust includes influence sweeping

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technologies for influence minefield clearance, explosive and non-explosive technologies for surf zone (SZ) mine/obstacle field breaching, and advanced technologies to rapidly neutralize shallow water (SW) sea mines.

(U) Mine Technology: The requirements for improved sea mine technologies has changed due to the reduced threat of the traditional modern submarines and surface ships. The elevated threats today are the third-world submarines and surface ships which may be encountered in the littoral waters of regional conflicts. Despite the diminished sophisticated threat, it is imperative that the US Navy maintain a broad-based and robust sea mining capability through advanced mine sensors, environmental characterization, and systems performance analysis technologies. Emphasis is placed on potentially high payoff advanced sensors for target detection and discrimination and on low cost, wide area sea mine system concepts, including positive command/control mechanisms and expanded weapon effectiveness for regional warfare.

(U) Special Warfare Technology: Naval Special Warfare (NSW) missions primarily support covert naval operations. The goal is to develop technology required to increase the combat range and effectiveness of Special Warfare units. A major current focus is to develop technologies to enhance the Sea-Air-Land mission of pre-invasion detection for clearance/avoidance of mines and obstacles in the very shallow water (VSW) and SZ approaches to the amphibious landing areas. Improvements to mission support equipment are needed to increase the probability of mission success, endurance and SEAL swimmer survivability.

(U) EOD Technology: Technology development for EOD needs addresses the DOD Joint Service and interagency responsibilities in EOD, including that required to counter and neutralize Weapons of Mass Destruction (WMD). The technologies developed are required for locating, rendering safe and disposing of Unexploded Explosive Ordnance (UXO). These operations typically occur in deep, poor-visibility water, in areas of high background noise, and in strategic operating areas contaminated by a variety of UXO. Advanced technologies are needed for gaining access to areas contaminated by sophisticated area-denial sensors and/or booby traps and for contending with WMD. These technologies are expected to transition to the Joint Service EOD Program, the Naval EOD Program or the DOD Technical Response Group.

(U) The Navy Science and Technology program includes projects that focus on or have attributes that enhance the affordability of warfighting systems.

(U) Due to the sheer volume of efforts included in this PE, the programs described in the Accomplishments and Plans sections are representative selections of the work included in this PE.

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(U) JUSTIFICATION FOR BUDGET ACTIVITY: This program is budgeted within the APPLIED RESEARCH Budget Activity because it investigates technological advances with possible applications toward solution of specific Naval problems, short of a major development effort.

## (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

### 1. (U) FY 1999 ACCOMPLISHMENTS:

#### • (U) MINE/OBSTACLE DETECTION:

- (U) Acoustic Sensors: Completed analysis of performance and effectiveness of Toroidal Volume Search Sonar (TVSS), demonstrated during JCM ACTD. Demonstrated Synthetic Aperture Sonar (SAS) technology during Fleet Battle Experiment (FBE) Echo (Kernal Blitz), Mine Readiness and Effectiveness Measurement (MIREM) 9, and GOMEX99 (Gulf of Mexico Experiment). Initiated development of broadband sonar transmitter for SAS application to enhance detection/classification probabilities, area search rate, and environmental adaptability.
- (U) Electro-Optic Sensors: Demonstrated laser line scan electro-optic identification sensor during FBE-Echo (Kernal Blitz), MIREM9, and GOMEX99. Initiated development of scene classification algorithms based on target optical properties. Begin feasibility studies to define the characteristics of an advanced electro-optic identification sensor that measures the spectral properties of mine-like objects and the surrounding scene.
- (U) Electro-Magnetic Sensors: Completed development of thin film, High Tc superconducting gradiometer for field demonstration to investigate motion induced noise characteristics.
- (U) Image Processing and Classification Algorithms: Completed assessment of effectiveness of multi-sensor data fusion techniques demonstrated during JCM ACTD and initiated development of improvements indicated by the assessment. Initiated development of broadband acoustic signal processing algorithms and techniques for SAS application to provide increased coverage rate, increased target image resolution, and extended sonar range. Initiated environmentally adaptive processing techniques to maintain high detection probabilities under varying and adverse environmental conditions.

#### • (U) MINE/OBSTACLE NEUTRALIZATION:

- (U) Shallow Water (SW) Mine Neutralization: Initiated effort to develop technology to sweep pressure influence mines by focusing on the characterization of pressure signatures of surface ships in ocean swell.
- (U) Surf Zone (SZ) Mine Neutralization: Expanded mine vulnerability data base to include neutralization criteria for recently developed threat mines with potential for use in the SZ and beach environments. Investigated innovative concepts for energetic neutralization of SZ mines.

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PROGRAM ELEMENT: 0602315N

PROGRAM ELEMENT TITLE: Mine Countermeasures, Mining and Special Warfare Technology

- (U) Obstacle Breaching: Determined effects of directed energy warheads against light/medium obstacles in water and air. Investigated innovative concepts for clearance or burial of SZ obstacles.

• (U) SEA MINING:

- (U) Intelligent Mine Network: Developed hardware/software to demonstrate feasibility of Distributed Autonomous Deployed System (DADS) -weapon concept.
- (U) Sea Mine Sensors: Completed testing of guidance sensors and signal processing for DADS-weapon in the laboratory.
- (U) Minefield Command and Control: Completed assessment of concept for command and control of DADS weapons through simulation.
- (U) SW Bottom Mines: Completed assessment of applicability of command and control concepts developed in prior years to SW bottom mines.

• (U) SPECIAL WARFARE/EOD:

- (U) Mission Mobility Technology: Transitioned low signature diver propulsion technology. Develop NSW signature reduction technologies. Continued development of NSW life support equipment technologies.
- (U) Mission Support Technology: Began integration of sensors into a diver-portable multi-sensor buried minehunter prototype. Initiated development of advanced portable real-time intelligence/sensor/marker technologies.
- (U) Clearance of UXO: Investigated the use of broad band transmissions to jam or neutralize the electronic components of electronic safe and armed fuses. Expanded inverse scattering sensing capability of time domain electro-magnetic induction sensors to allow identification of individual buried UXO. Demonstrated a 10,000 element acoustic array that provides a 1 centimeter resolution image of an underwater target at 20 frames per second.
- (U) Response to WMD incidents: Conducted testing of a catalyst/sensor array technique for the detection and localization of a WMD in a marine environment.
- (U) Extending the Littoral Battlespace (ELB): Initiated development of modeling and simulation of ELB component technologies. Developed ELB Measures of Effectiveness and Measures of Performance supporting military utility assessment. Conducted integrated feasibility demonstrations.

2. (U) FY 2000 PLAN

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PROGRAM ELEMENT TITLE: Mine Countermeasures, Mining and Special Warfare Technology

- (U) MINE/OBSTACLE DETECTION:
  - (U) Acoustic Sensors: Complete development of broadband sonar projector for synthetic aperture sonar to enhance detection/classification probabilities, area search rate and environmental adaptability. Integrate broadband source on existing SAS testbed for field testing. Begin field test of broadband synthetic aperture technology. Begin development of small acoustic sensors for integration on small autonomous vehicles.
  - (U) Electro-optic Sensors: Continue development of scene classification algorithms based on target optical properties. Complete feasibility studies defining characteristics of advanced, multi-spectral mine identification sensor. Initiate development of advanced electro-optic mine identification sensor.
  - (U) Electro-magnetic Sensors: Initiate field testing of thin film, high temperature superconducting gradiometer focusing on motion induced noise characterization.
  - (U) Image Processing, Classification Algorithms, and Data Fusion: Continue development of broad band processing techniques/algorithm development efforts. Continue development of environmentally adaptive processing techniques to extend detection/classification range of existing and emerging sensor systems. Initiate data fusion effort focusing on fusion of multi-platform, multi-sensor data (with initial emphasis on fusion of in-service and developmental organic sensors).
  
- (U) MINE/OBSTACLE NEUTRALIZATION:
  - (U) SZ Mine Neutralization: Continue development and evaluation of High Energy Low Pressure (HELP) explosive technology to promote pressure-impulse characteristics of explosives for more efficient coupling into tilt-rod mines. Transition completed mine kill criteria for new threat mines to PMS-407 in support of Distributed Explosive Technology/Shallow Water Breaching (DET/SABRE) programs. Initiate nondeterministic modeling of mine vulnerability. Initial efforts will be development of a nondeterministic model for a single mine.
  - (U) Obstacle Breaching: Initiate development of linear shaped charge array anti-obstacle technology for breaching of obstacles on the beach and in the surf. Continue development and evaluation of small unmanned bottom robotic platforms to provide reconnaissance and targeting data for mine and obstacle clearance systems. Continue developing data base for damage characteristics of obstacles on land and in the water when subjected to simultaneous and sequenced multiple bomb detonations.
  
- (U) SEA MINING:
  - (U) Intelligent Mine Network: Complete development of hardware/software to demonstrate feasibility of DADS weapon concept. Begin demonstration of mine network concept.
  - (U) Sea Mine Sensors: Initiate field tests of guidance sensors and signal processing for DADS weapon.

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- (U) Minefield Command and Control: Initiate development of command and control hardware/software for feasibility demonstration of minefield command and control.
- (U) SPECIAL WARFARE/EOD
  - (U) Mission Mobility: Continue development of life-support equipment technologies. Major focus will be thermal protection for extremities. Initiate effort to increase Stirling engine performance from 500 to 2000 watts. Investigate materials and methodologies to enable non-magnetic valve and actuator systems on NSW diver propulsion vehicle systems.
  - (U) Mission Support: Continue development of unmanned underwater vehicle (UUV) technologies to support VSW reconnaissance missions. Initiate development of broadband sonar technology for diver and UUV deployment. Initiate development of scannerless range imaging system for underwater applications. Continue development of underwater adhesive technologies. Initiate development of deployable virtual environment based training aid and tactical decision aid for NSW missions.
  - (U) Clearance of UXO: Initiate underwater vehicle coordination task to provide enabling technologies for heterogeneous systems of small UUVs to provide detection, classification, and identification of underwater explosive ordnance. Initiate development of robotic actuators and manipulators based on artificial muscle materials. Investigate and implement neural techniques for visual image processing and object recognition.
  - (U) Response to WMD Incidents: Evaluate concepts for detecting radiation interaction with water as a means of detecting the primary source of radiation.
  - (U) ELB: Conduct and assess integrated feasibility demonstrations of ELB technologies. Develop enhancements to battlespace network to enable real-time, seamless sensor to shooter functions. Initiate development of technologies to support near real-time operations/intelligence integration.

3. (U) FY 2001 PLAN

- (U) MINE/OBSTACLE DETECTION
  - (U) Acoustic Sensor: Complete field testing of broadband SAS technology. Document results and begin transition to PE 0603502N (Remote Minehunting System). Complete development of small acoustic sensors for integration on small autonomous vehicles. Complete laboratory testing of small acoustic sensors. Begin integration of acoustic sensors on small autonomous underwater vehicles, focusing on networking and adaptive sampling.
  - (U) Electro-Optic Sensors: Complete development of advanced, multi-spectral mine identification sensor. Initiate field testing of advanced mine identification sensor.

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PROGRAM ELEMENT: 0602315N

PROGRAM ELEMENT TITLE: Mine Countermeasures, Mining and Special Warfare Technology

- (U) Electro-magnetic Sensors: Complete field testing of thin film, low temperature superconducting gradiometer. Complete documentation of test results and begin transition of PE 0603502N (Shallow Water Mine Countermeasures).
- (U) Image Processing, Classification Algorithms, and Data Fusion: Complete development of broad band processing techniques/algorithm development efforts. Complete development of environmentally adaptive processing techniques to extend detection/classification range of existing and emerging sensor systems. Assess performance of environmentally adaptive processing techniques during mine training exercise and document results. Begin transition of environmentally adaptive techniques/algorithms to PE 0603502N (Remote Minehunting System) and AQS-20/X airborne minehunting acquisition program. Continue development of data fusion techniques/algorithms focusing on fusion of multi-platform, multi-sensor data.

- (U) MINE/OBSTACLE NEUTRALIZATION

- (U) SZ Mine Neutralization: Demonstrate performance of HELP charge against tilt rod mines. Initiate study of vulnerability of magnetic influence mines obtained from Program Manager Naval Sea Command code SEA 407(PMS-407). Develop estimates of these mines interactions with shock and bubble loading and provide pre-test predictions in support of DET/SABRE tests. Continue nondeterministic modeling of mine vulnerability. Transition completed mine kill criteria for new threat mines to PE 0603502N in support of DET/SABRE programs.
- (U) Obstacle Breaching: Investigate innovative concepts for clearance and burial of SZ and beach obstacles. Develop supporting technologies that are critical to accurate and affordable delivery of high explosive packages from over the horizon. Develop a methodology that will provide a reliable prediction of explosive channeling effects produced by using arrays of bombs to provide a clear path in the surf and beach and craft landing zones.

- (U) SEA MINING

- (U) Intelligent Mine Network: Complete demonstration of mine network concept for DADS weapon
- (U) Sea Mine Sensors: Complete field testing of guidance sensors and signal processing algorithms. Complete documentation of field test results.
- (U) Minefield Command and Control: Conduct field test of command and control of DADS weapon.

- (U) SPECIAL WARFARE/EOD

- (U) Mission Mobility: Continue development of life support equipment technologies. Transition enhanced Stirling cycle engine technology to PMS-EOD for use in VSWMCM DET. Initiate efforts to develop Diver Propulsion Vehicle subsystems with lower magnetic signature.
- (U) Mission Support: Continue development of UUV technologies to support NSW reconnaissance and mine clearance missions. Transition underwater adhesive technology to PMS-EOD. Continue development of broadband sonar

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PROGRAM ELEMENT TITLE: Mine Countermeasures, Mining and Special Warfare Technology

technologies for diver and UUV deployment. Initiate development of advanced conformal side-looking acoustic sensors for diver and UUV deployment.

- (U) Clearance of UXO: Continue development of technologies to enable coordinated behavior and mission execution by unmanned underwater vehicles. Continue development of robotic manipulators and actuators based on artificial muscle materials. Initiate development of technologies to remotely jam or disable the functioning of Electronic Safed Armed fused devices.

- (U) Response to WMD Incidents: Evaluate promising techniques for detection of underwater radiation in a laboratory setting.

B. (U) PROGRAM CHANGE SUMMARY:

	FY 1999	FY 2000	FY 2001
(U) FY 2000 President's Budget:	45,496	45,022	51,008
(U) Appropriated Value:		45,022	
(U) Adjustments from FY00 PRESBUDG:			
(U) Congressional Recissions:		-249	
(U) SBIR/STTR Transfer:	-716		-144
(U) Various Rate Adjustments:			
(U) Inflation Adjustments:	-208		
(U) Execution Adjustments:	3,512		
(U) FY 2001 PRESBUDG Submission:	48,084	44,773	50,864

(U) Schedule: Not applicable.

(U) Technical: Not Applicable.

C. (U) OTHER PROGRAM FUNDING SUMMARY: Not applicable.

(U) RELATED RDT&E:

(U) This program has strong ties to the PE's listed below:

(U) PE 0601153N (Defense Research Sciences)

(U) PE 0602131M (Marine Corps Landing Force Technology)

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET      DATE: February 2000

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602315N

PROGRAM ELEMENT TITLE: Mine Countermeasures, Mining and Special Warfare Technology

(U) PE 0602233N	(Human Systems Technology)
(U) PE 0602314N	(Undersea Warfare Surveillance Technology)
(U) PE 0602435N	(Oceanographic and Atmospheric Technology)
(U) PE 0602633N	(Undersea Warfare Weapons Technology)
(U) PE 0603502N	(Undersea Warfare and MCM Development)
(U) PE 0603555N	(Sea Control and Littoral Warfare Technology Demonstration)
(U) PE 0603654N	(Joint Service EOD Development)
(U) PE 0603782N	(Mine and Expeditionary Warfare Advanced Technology)
(U) PE 0604654N	(Joint Service EOD Development)
(U) PE 0603640M	(Marine Corps Advanced Technology Demo)
(U) PE 0602712A	(Countermine Systems)
(U) PE 0603606A	(Landmine WF and Barrier Advanced Technology)
(U) PE 1160401BB	(Special Operation Technology Development)
(U) PE 1160402BB	(Special Operation Advanced Technology Development)

(U) This program adheres to Tri-Service Reliance Agreements on EOD with coordination provided by the Joint Directors of Laboratories.

D. (U) SCHEDULE PROFILE: Not applicable.

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2000

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602435N

PROGRAM ELEMENT TITLE: Oceanographic and Atmospheric Technology

(U) COST (Dollars in thousands)

PROJECT NUMBER & TITLE	FY 1999 ACTUAL	FY 2000 ESTIMATE	FY 2001 ESTIMATE	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	TO COMPLETE	TOTAL PROGRAM
N/A Oceanographic and Atmospheric Technology	69,411	72,681	60,320	63,764	61,674	61,178	60,134	CONT.	CONT.

A. (U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: This Program Element (PE) provides the fundamental programmatic instrument by which basic research on the natural environment is transformed into technology developments that provide new or enhanced warfare capabilities. This PE also provides technologies that form the natural-environment technical base on which all systems development and advanced technology depend. This PE contains the National Oceanographic Partnership Program (NOPP)(Title II, subtitle E, of Public Law 104-201) enacted into law for FY 1997. A major component of the program supports Organic Mine Countermeasures.

(U) Due to the sheer volume of efforts included in this PE, the programs described in the Accomplishments and Plans sections are representative selections of the work included in this PE.

(U) This PE provides for ocean and atmospheric technology developments that contribute to meeting top joint warfare capabilities established by the Joint Chiefs of Staff. Major efforts of this PE are devoted to (1) gaining real-time knowledge of the battlefield's natural environment, (2) determining the natural-environment needs of regional warfare, (3) providing the on-scene commander the capability to exploit the environment to tactical advantage, and (4) developing atmospheric research related to detection of sea-skimming missiles and strike warfare.

(U) This PE provides natural-environment applied research for all fleet operations and for current or emerging systems. This PE supports virtually all the Joint Mission Areas/Support Areas with primary emphasis on Joint Littoral Warfare and Joint Strike Warfare. Specifically:

(U) Joint Littoral Warfare efforts address issues in undersea, surface, and air battlespace. Programs include ocean and atmospheric prediction for real-time description of the operational environment, shallow water (SW) acoustics and multiple-influence sensors for undersea surveillance and weapon systems, and influences of the natural environment on mine countermeasure (MCM) systems.

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2000

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602435N

PROGRAM ELEMENT TITLE: Oceanographic and Atmospheric Technology

(U) Joint Strike Warfare efforts address issues in air battlespace dominance. Programs include influences of the natural environment on electromagnetic (EM)/electro-optic (EO) systems used in the targeting and detection of missile weapon systems as well as improvements in tactical information management about the natural environment.

(U) These efforts support the Joint Warfare Strategy "Forward From the Sea." This program 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 PE is related to and fully coordinated with efforts in accordance with the ongoing Reliance joint planning process. There is close coordination with the US Air Force and US Army under the Reliance program in the Battlespace Environment categories of Lower Atmosphere, Ocean Environments, Space & Upper Atmosphere, and Terrestrial Environments.

(U) The Navy program includes projects that focus on, or have attributes that enhance, the affordability of warfighting systems.

(U) JUSTIFICATION FOR BUDGET ACTIVITY: This program is budgeted within the APPLIED RESEARCH Budget Activity because it investigates technological advances with possible applications toward solution of specific Naval problems, short of a major development effort.

(U) PROGRAM ACCOMPLISHMENTS AND PLANS:

1. (U) FY 1999 ACCOMPLISHMENTS:

- (U) NATURAL-ENVIRONMENT ISSUES IN UNDERSEA SURVEILLANCE AND WEAPONS:
  - (U) Demonstrated techniques for adapting to the natural environment for in-situ, near-real-time reverberation assessment and clutter control, optimizing sonar operation in complex, shallow water natural environments so as to further advance active techniques for detection of the quiet submarine threat.
  - (U) Analyzed FY 98 test data to address potential exploitation of internal waves in shallow water under surface-duct conditions for mid-water surveillance by hull-mounted sonar.
  - (U) Developed predictive capability for optimum placement and fusion of acoustic/nonacoustic sensors in strongly range-dependent natural environments such as straits and gulfs.
  - (U) Completed validation of high frequency underwater acoustic noise models and conduct experimental evaluations of the false-alarm/classification-error performance of newly developed noise exploitation algorithms.

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2000

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602435N

PROGRAM ELEMENT TITLE: Oceanographic and Atmospheric Technology

- (U) Demonstrated performance improvements of natural-environment enhanced signal processing algorithms using geo-acoustical inversion techniques.
- (U) Performed detailed analyses of high-frequency acoustic data obtained in several shallow water locales with the purpose of creating an adaptive basis for undersea weapon performance prediction in shallow water.
- (U) Continued participation with PE 0603792N in development of underwater acoustic communications to establish communications capability between submarine/submarine and other platforms.
- (U) NATURAL-ENVIRONMENT INFLUENCES ON MCM SYSTEMS, INCLUDING LITTORAL OCEANOGRAPHY:
  - (U) Continued development of autonomous ocean vehicle technology (and related natural-environment sensor technology) with selective field work aimed at demonstrating increasing levels of capability in this technology area which offers great promise for virtually all naval missions in the littoral zone.
  - (U) Continued development of the Naval Surface Warfare Center Test Facility in conjunction with allied universities and government agencies to provide for monitoring and measurement of the ocean environment to contribute to marine vehicle research, especially in the context of mine countermeasures.
  - (U) Continued efforts in hyperspectral remote sensing technology to build a capability for detailed resolution of littoral ocean characteristics; this work, in collaboration with developments in PE 0602232N and PE 0603794N, supports the Naval Earth Map Observer (NEMO) satellite planned for launch in FY 00 with products aimed for the Warfighter Support Center at Naval Oceanographic Office (NAVOCEANO) and the Marine Corps Intelligence Agency.
  - (U) Provided an initial spatial variability model (low-grazing angle bottom reverberation backscattering, bottom penetration/sediment scattering) and data bases to Naval Surface Warfare Center (NSWC), Coastal Systems Station (NSWC-CSS) for MCM system development.
  - (U) Processed Sea-Viewing-Wide-Field-of-View Sensor data and other satellite data in near real time using new algorithms to extract coastal optical absorption and scattering. Utilized these new algorithms to create a regional data base for forward strategic area.
  - (U) Initiated efforts on ocean color algorithms and ocean process models to develop the capability for inferring aspects of ocean vertical structure from remotely-sensed ocean color, especially in the littoral ocean where this technology will impact use of optical devices in MCM and aid in the resolution of complex ocean processes that affect other warfare missions.
  - (U) Transitioned algorithms for extracting real-time seafloor data from toroidal volume sonar system (TVSS) and side look sonar (SLS) sonars to NSWC-CSS.
  - (U) Conducted final test for algorithms for extracting real-time sound speed and surface reverberation data from TVSS sonar.

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2000

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602435N

PROGRAM ELEMENT TITLE: Oceanographic and Atmospheric Technology

- (U) Initiated development of algorithms to extract real-time data on the natural environment in denied areas using Synthetic Aperture Sonar (SAS) and Laser Line Scanner System.
- (U) Integrated micro-scale modeling of fluid/gas flow into data base predictive model incorporating oceanographic forcing functions for use by the explosive mine neutralization community.
- (U) Initiated effort to extend geoaoustic data base algorithms to geotechnical data base algorithms.
- (U) Conducted a field study of mine migration and burial behavior in low energy/muddy beach natural environments.
- (U) Evaluated the Predictive Visibility Model in terms of performance in various natural environments and determine the feasibility of improvements to the model to provide the natural-environment basis for optical MCM systems.
- (U) Conducted final and comprehensive experiment on influence of bubbles in shallow water on sonar performance, especially in terms of MCM systems.
- (U) Began applying and validating final models of bubble distributions and high-frequency acoustic propagation in a shallow-water bubbly medium.
- (U) Planned and conducted a full-band spatial/temporal coherence measurement in a very-shallow water site and utilized these data to test predictions/hypotheses regarding the oceanographic factors which affect the phase stability of the waterborne paths involved in real aperture and SAS systems for MCM; analyzed data from the high-clutter natural environment to provide an upper bound for the statistical characterization of bottom clutter which will be utilized in the clutter model.
- (U) Biosensor technology for MCM was developed, especially in terms of a bioluminescence sensor for the Navy Special Warfare forces to provide vulnerability assessment to detection through "bioluminescence trails."
- (U) OCEAN AND ATMOSPHERIC PREDICTION:
  - (U) Continued testing other high-order advection schemes. Compared with older schemes and test in the California Current region.
  - (U) Investigated the effect of higher-order schemes on passive tracer dispersion.
  - (U) Delivered Very High Resolution (VHR) Coastal Model with improved advection.
  - (U) Delivered Global Layered Model with improved advection and subduction/ventilation capability.
  - (U) Initiated eddy-resolving global ocean model development including data assimilation.
  - (U) Developed and transition to 6.4 a shipboard tactical ocean nowcast/forecast model that allows for VHR (to 100 m).
  - (U) Transitioned Asian Seas Shallow Water Assimilation/Forecast System (SWAFS) including data assimilation to 6.4. Developed relocatable baroclinic tide model.

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Budget Item Justification  
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FY 2001 RDT&E, N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2000

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602435N

PROGRAM ELEMENT TITLE: Oceanographic and Atmospheric Technology

- (U) Continued efforts in critical evaluation of new predictive schemes as a means of achieving more effective models.
- (U) Demonstrated the over-water clear-air weather detection capability of the operational system SPY-1 on-board the USS O'Kane.
- (U) Demonstrated and Deployed a nonhydrostatic tactical scale prediction system in Bahrain for use in forecasting weather effects for operational planning; system transitioned to operations and scheduled for full deployment in FY 00/01.
- (U) ATMOSPHERIC INFLUENCES ON EM/EO SYSTEMS:
  - (U) Demonstrated a global aerosol transport prediction capability through prediction of the transport of an Asian dust event across the Pacific Ocean.
  - (U) Completed a series of surf/coastal aerosol characterization experiments to enable development of a surf aerosol model for EO propagation prediction.
  - (U) Interfaced the coastal aerosol model with the EO Tactical Decision Aid and with the coastal aerosol data assimilation system to provide a more complete basis for EO systems, especially those used in detection of sea-skimmer missiles.
  - (U) Transitioned improved EM propagation effects decision aids incorporating terrain, surface clutter, airborne platforms, etc, thus expanding the capability to assess effects of the natural environment on radar systems.
  - (U) Transitioned to Naval Sea Systems Command and Space and Naval Warfare Systems Command a small Global Positioning System receiver based system for measuring atmospheric refractivity structure.
  - (U) Continued efforts in characterizing PM-10 in the atmosphere of southern California, especially as it relates to operations and testing at naval bases in the area.
- (U) National Oceanographic Partnership Program:
  - (U) Used a Broad Agency Announcement to solicit new ideas and efforts in Data Assimilation and Modeling as well as in Ocean Observation Capabilities: in Data Assimilation and Modeling, recent workshops indicated the need for a new structural paradigm under which a community-wide effort would build a linked system of resources and collaborations leading to new scientific insight and synthesis of new results with broad utility for the ocean community; in Ocean Observation the focus is on establishing the means for continuous, high resolution of oceanic processes.
  - (U) Continued evolution of efforts in "virtual" ocean data and remote sensing centers/facilities to capitalize on existing centers by developing broad community access/exchange of Navy, National Oceanic and Atmospheric, and other data bases together with data display and assimilation techniques.

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2000

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602435N

PROGRAM ELEMENT TITLE: Oceanographic and Atmospheric Technology

- (U) Continued evolution of efforts aimed at a National Littoral "Laboratory" with the long-term aim of portable coastal ocean/atmosphere forecasting capabilities.
  - (U) Continued partnership efforts in oceanography to optimize resources, intellectual talent, and facilities in ocean sciences focused upon ocean observing technologies.
  - (U) Continued with selected aspects of efforts that develop and/or demonstrate Coastal and Open Ocean Observational Techniques; Observational Systems; Sensors and Sensing; and Modeling/Data Assimilation.
  - (U) Utilized Secretary of the Navy/Chief of Naval Operations (SECNAV/CNO) Oceanographic Research chairs to further promote the collaboration of distinguished university scientists with Navy/Marine Corps activities; a primary aim is to achieve a synthesis of results and understanding in key oceanographic areas important to Navy/Marine Corps operations.
2. (U) FY 2000 PLAN
- (U) NATURAL-ENVIRONMENT ISSUES IN UNDERSEA SURVEILLANCE AND WEAPONS:
    - (U) Earlier work on low frequency active acoustics successfully demonstrated capabilities to discriminate against clutter from environmental features in a deep ocean setting (algorithms have transitioned and been implemented in the Low Frequency Active Fleet System); further development will continue in active acoustics to provide capabilities for detection of the "quiet" submarine with special emphasis on shallow water regions; acoustic field measurements, modeling, and data analysis will be employed as well as joint efforts with fleet activities, The Technical Cooperation Program, and the North Atlantic Treaty Organization Supreme Allied Commander Atlantic (NATO SACLANT) Centre; validation and refinement of mid-frequency bistatic bottom, surface, and volume scattering models will be a main focus.
    - (U) Continue developments in shallow water acoustics to advance capabilities to exploit the natural environment for optimal submarine detection, especially in the littoral zone where oceanographic conditions can be highly variable both spatially and temporally; advances will come from theoretical modeling to describe sound interaction with the ocean surface, the ocean bottom, and with variable ocean processes (ocean fronts and internal waves); further quantification will be found for the result that acoustic propagation in shallow water regions can be greatly influenced by the presence of internal solitary waves.
    - (U) Continue developments in undersea noise characterization to enable acoustic detection/processor systems (distributed systems; focused and adaptive beamforming; matched-field processing) to reject false alarms; coupled hydrodynamic-acoustic noise source models from propeller cavitation and surf-generated breaking wave noise will be the focus of effort; noise properties are of major importance to efforts in PE 0602314N.

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FY 2001 RDT&E, N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2000

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602435N

PROGRAM ELEMENT TITLE: Oceanographic and Atmospheric Technology

- (U) Continue developments in natural-environment enhanced signal processing, including methods for estimating characteristics of the natural environment from acoustic measurements; develop techniques that exploit key qualitative features of acoustic signals and thus offer near real-time localization.
- (U) Use a science/technology team to ensure application of the latest developments in oceanography and acoustics in the planning and assessment of fleet Ship Anti Surface Warfare Readiness Effectiveness and Measuring Program (SHAREM) exercises; apply computer simulation/warfare effectiveness tools to SHAREM; aim is to reveal how oceanographic/acoustic properties affect system performance and help focus future basic/applied research.
- (U) Continue development of high-frequency acoustics, including underwater acoustics communications, based on assessment of the area as of FY 99.
- (U) NATURAL-ENVIRONMENT INFLUENCES ON MCM SYSTEMS, INCLUDING LITTORAL OCEANOGRAPHY:
  - (U) Continue development of the technologies that will contribute toward the long-term goals of determining influences of the natural environment on MCM systems and tactics and enabling real-time characteristics of the natural environment to be known to the on-scene commander; this goal will be achieved through developments in several technologies (coastal ocean prediction, with waves and currents; ocean sampling; remote sensing; acoustics; optics; magnetics; hydrodynamics; chemistry; geology/sediment dynamics; biosensor technology; etc.) and the "network-centric" approach by which the component technologies will be applied for use by the on-scene commander.
  - (U) Develop high-resolution littoral ocean models, including waves and currents, for use in predicting oceanographic characteristics in the littoral zone significant to MCM operations; the aim is to transition the capability to NAVOCEANO; indirect use of wave properties to infer bottom bathymetry will also be developed.
  - (U) Autonomous Ocean Sampling Network technology for MCM will continue development, primarily using commercial-off-the-shelf technology; a series of field experiments featuring increasing levels of difficulty; the revolutionary nature of this ocean technology will continue to be demonstrated through collaboration with NAVOCEANO and other participants.
  - (U) Continue development of remote sensing techniques to gain information about the littoral ocean, especially ocean bathymetry which has a significant impact on mine countermeasure operations as well as amphibious operations; the aim is to provide NAVOCEANO with a worldwide capability for inferring bottom depths and other characteristics of the littoral ocean; Precise Time/Time Interval technology will be developed for precise position capability, especially critical for Mine Warfare and MCM operations.

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FY 2001 RDT&E, N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2000

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602435N

PROGRAM ELEMENT TITLE: Oceanographic and Atmospheric Technology

- (U) Continue development, in collaboration with developments in PE 0602232N and PE 0603794N, of algorithms to employ with the NEMO satellite planned for launch in FY 00 with products aimed for the Warfighter Support Center at NAVOCEANO and the Marine Corps Intelligence Agency.
- (U) Place increasing emphasis on the development of physics-based littoral ocean color models to enable remotely-sensed hyperspectral data to infer physical processes in the ocean; these models will enable the most effective exploitation of hyperspectral satellite imagery, which promises to be a major advance in the ability to probe the littoral ocean vertical structure for the purposes of littoral warfare; algorithms will transition to NAVOCEANO.
- (U) Continue development of impact of the natural environment on high-frequency acoustics in terms of synthetic aperture sonar and other high-resolution acoustic methods of mine detection/classification; results in this area are important to developments underway in PE 0602315N.
- (U) Continue development in characterization of gas content of wet sands as a critical aspect of the natural environment that affects the effectiveness of explosive mine neutralization techniques.
- (U) Continue development of hydrodynamic interactions with mines, including hydro-sedimentological aspects, to gain more accurate ability to predict the behavior of mines in SW, such as their possible movement and burial; this capability will provide the mine warfare community significant aid in terms of types of operations needed to clear an area.
- (U) Continue bioluminescence sensor work aimed for transition to Navy Special Warfare Forces; this work will enable the Navy Special Warfare Forces to assess vulnerability of their operations to detection via "bioluminescence trails," which is a high priority with Commander, Navy Special Warfare Command.
- (U) Computer simulation/sensitivity analyses of operations in the littoral zone will continue development for the evaluation of optimum tactical effectiveness, given the variable characteristics of the natural environment.
- (U) OCEAN AND ATMOSPHERIC PREDICTION:
  - (U) Continue to develop ocean model nowcast/forecast capabilities at a variety of scales (global and basin, regional and semi-enclosed seas, and local), including relocateable and nested models, with the aim of providing for transition through PE 0603207N to fleet operational users.
  - (U) Continue development efforts for advanced on-board oceanographic models that utilize real-time data; aim is to ultimately merge several models to enable the on-board model to provide a full suite (oceanographic, acoustic, biologic, optical, visibility, etc.) of predictive capabilities for the on-scene user in the FY 05 timeframe.
  - (U) Perform ocean data assimilation, model intercomparisons, testing and validation with oceanographic models under development and do so in close collaboration with the Oceanographer of the Navy.

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2000

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602435N

PROGRAM ELEMENT TITLE: Oceanographic and Atmospheric Technology

- (U) Continue developments in the area of coupled ocean/atmosphere models to achieve more accurate incorporation of the effects of interactions between the two media.
  - (U) Continue development of atmospheric models with the goal of providing Fleet Numerical Meteorological and Oceanographic Command (FNMO) with global prediction capabilities that use a nested procedure to go from global to regional to local descriptions; adaptation of models to massive parallel computers will continue as a means of achieving greater speed and efficiencies.
  - (U) On-scene weather prediction capability has been under development and has demonstrated some degree of maturity; a preliminary prediction capability has been established in Bahrain at the request of U. S. Central Command to provide real-time, on-scene weather prediction for operations in the Persian Gulf.
  - (U) With the advent of more capable prediction procedures data assimilation techniques for the atmospheric models will receive increased attention; in particular, the SPY-1 operational tactical radar will undergo continued testing for use of the radar returns to infer detailed local atmospheric conditions, which in turn may be used to remove weather "clutter" from the radar display.
  - (U) The remarkable accomplishment of deriving vector wind fields from satellite data dramatically increased the number of weather stations (by orders of magnitude) and led to a substantial increase in daily wind observations; this achievement lays the basis for further developments in satellite applications to meteorology; application of wind-derived information to tropical cyclone structure, to severe storms, and to rain-rate will be developed; artificial intelligence procedures will continue to be developed for automated inference of significant atmospheric characteristics.
  - (U) Build on the past work on aerosols and transport models to start the process of constructing an end-to-end observation, analysis, and prediction system for use at FNMO and with on-scene forecast systems; continue field work on coastal aerosols and dust.
- (U) ATMOSPHERIC INFLUENCES ON EM/EO SYSTEMS:
    - (U) As a consequence of previous work on EM propagation in the atmosphere, much knowledge has been gained on the nature and magnitude of variability in EM propagation caused by the natural environment; developments will yield models that more thoroughly incorporate atmospheric effects of refraction, extinction, turbulence, and rough boundaries; models are made available to the entire EM user community through transition to NAVOCEANO; a specific focus for airborne and ship platforms will be the Advanced Propagation Model that combines previous component models for terrain and range-dependence.
    - (U) Continue field measurements to quantify atmospheric effects on EM propagation; an experiment in the summer of FY 00 is to focus on a "rough" evaporation duct and the anomalous properties that result.

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2000

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602435N

PROGRAM ELEMENT TITLE: Oceanographic and Atmospheric Technology

- (U) Continue development of tactical decision aids to enable the fleet user of EM systems to more fully exploit system capabilities and/or anomalous conditions of propagation in the atmosphere which are often of significant magnitude in terms of range and altitude modifications.
- (U) EO sensors are important in surface warfare and strike warfare, as demonstrated in the Persian Gulf conflict; improvements in EO propagation models will be developed in terms of atmospheric effects such as background radiance, transmittance, refractivity, aerosols, and clouds; the Advanced Navy Aerosol Model (incorporating near surface effects over the open ocean important for detection of sea-skimming missiles) is expected to be completed in this timeframe; models are made available to the entire EO user community through transition to NAVOCEANO.
- (U) Continue the international program Electro-Optical Propagation Assessment and Coastal Environment (EOPACE) as an effective means of gathering field measurements to test and verify atmospheric effects on electro-optic propagation, especially in coastal environments.
- (U) Continue efforts toward making the Electro-Optical Tactical Decision Aid and Electro-Magnetic Tactical Decision Aid (EOTDA/EMTDA) more inclusive of atmospheric effects and more useful to the fleet operators.
- (U) Continue efforts in characterizing PM-10 in the atmosphere of southern California, especially as to operations and testing at naval bases in the area, with the focus on field studies and emission studies.
- (U) NOPP:
  - (U) Continue evolution of efforts in "virtual" ocean data and remote sensing centers/facilities to capitalize on existing centers by developing broad community access/exchange of Navy, NOAA, and other data bases together with data display and assimilation techniques.
  - (U) Continue evolution of efforts aimed at a National Littoral "Laboratory" with the long-term aim of "portable" coastal ocean/atmosphere forecasting capabilities.
  - (U) Continue partnership efforts in oceanography to optimize resources, intellectual talent, and facilities in ocean sciences focused upon ocean observing technologies, goal is to advance national ocean capability.
  - (U) Continue with selected aspects of efforts that develop and/or demonstrate Coastal and Open Ocean Observational Techniques; Observational Systems; Sensors and Sensing; and Modeling/Data Assimilation.
  - (U) Utilize SECNAV/CNO Oceanographic Research Chairs to further promote the collaboration of distinguished university scientists with Navy/Marine Corps activities; a primary aim is to achieve a synthesis of results and understanding in key oceanographic areas important to Navy/Marine Corps operations.

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2000

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602435N

PROGRAM ELEMENT TITLE: Oceanographic and Atmospheric Technology

## 3. (U) FY 2001 PLAN

- (U) NATURAL-ENVIRONMENT ISSUES IN UNDERSEA SURVEILLANCE AND WEAPONS:
  - (U) Continue development in active acoustics to provide capabilities for detection of the "quiet" submarine with special emphasis on shallow water regions; acoustic field measurements, modeling, and data analysis will be employed as well as joint efforts with fleet activities, The Technical Cooperation Program, and the NATO SACLANC Centre; complete and transition to NAVOCEANO and Warfare Centers statistical models for characterizing the probabilities of false alarms due to broadband clutter.
  - (U) Continue developments in shallow water acoustics to advance capabilities to exploit the natural environment for optimal submarine detection, especially in the littoral zone where oceanographic conditions can be highly variable both spatially and temporally; advances will come from theoretical modeling to describe sound interaction with the ocean surface, the ocean bottom, and with variable ocean processes (ocean fronts and internal waves); further quantification will be found for the result that acoustic propagation in shallow water regions can be greatly influenced by the presence of internal solitary waves.
  - (U) Continue developments in undersea noise characterization to enable acoustic detection/processor systems (distributed systems; focused and adaptive beamforming; matched-field processing) to reject false alarms; conduct initial demonstration of false-target rejection algorithms based on biological and ship-radiated noise discriminants; noise properties are of major importance to developments in PE 0602314N.
  - (U) Continue developments in natural-environment enhanced signal processing, including methods for estimating characteristics of the natural environment from acoustic measurements; attention will be given to the active acoustics case in which great advantage may be gained in choosing the propagating signal, perhaps sufficient to discriminate object echoes from natural boundary reverberation.
  - (U) Continue with interactions with the fleet SHAREM exercises to maximize use of "cutting-edge" basic/applied research in the interpretation and analysis of fleet exercise results; aim is to reveal how oceanographic/acoustic properties affect system performance and help focus future basic/applied research.
  - (U) Continue development of high-frequency acoustics, including underwater acoustics communications, with new focus established by assessment of the area as of FY 99.
- (U) NATURAL-ENVIRONMENT INFLUENCES ON MCM SYSTEMS, INCLUDING LITTORAL OCEANOGRAPHY:
  - (U) Continue development of the technologies that contribute toward establishment of a "network-centric" capability to provide the on-scene commander with real-time knowledge of the environment, knowledge of systems sensitivities, and knowledge of their optimum operational effectiveness, all made useable through appropriate tactical decision aids.

R-1 Line Item 14

Budget Item Justification  
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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2000

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602435N

PROGRAM ELEMENT TITLE: Oceanographic and Atmospheric Technology

- (U) Continue development of high-resolution littoral ocean models, including waves and currents, for use in predicting oceanographic characteristics in the littoral zone significant to MCM operations; the aim is to transition the capability to NAVOCEANO; indirect use of wave properties to infer bottom bathymetry will also be developed to a higher degree of precision.
- (U) Continue development of Autonomous Ocean Sampling Network technology for MCM, primarily through the use of commercial-off-the-shelf components and collaboration with NAVOCEANO and other participants.
- (U) Continue development of remote sensing techniques to gain information about the littoral ocean, especially ocean bathymetry which has a significant impact on mine countermeasure operations as well as amphibious operations; continue developments in Precise Time/Time Interval technology to provide greater precision in position determination, especially in mine Warfare and MCM operations.
- (U) Continue development of physics-based littoral ocean color models for the effective exploitation of hyperspectral satellite imagery to probe littoral ocean vertical structure for the purposes of littoral warfare; algorithms will transition to NAVOCEANO.
- (U) Continue development, in collaboration with developments in PE 0602232N and PE 0603794N, of algorithms to employ with the NEMO satellite planned for launch in FY 00 with products aimed for the Warfighter Support Center at NAVOCEANO and the Marine Corps Intelligence Agency; post-launch focus will be on calibration with known features and validation.
- (U) Continue development of impact of the natural environment on high-frequency acoustics relevant to synthetic aperture sonar and other high-resolution acoustic methods of mine detection/classification; results in this area are important to developments underway in PE 0602315N.
- (U) Continue development in characterization of gas content of wet sands as a critical aspect of the natural environment that affects the effectiveness of explosive mine neutralization techniques.
- (U) Continue development of hydrodynamic interactions with mines, including hydro-sedimentological aspects, to gain more accurate predictive ability for the behavior of mines in shallow water (mine drift/burial).
- (U) Continue developments in bioluminescence sensors focused on transition of an Autonomous Underwater Vehicle capable sensor to the Navy Special Warfare forces and on development of an expendable and affordable bioluminescence sensor for NAVOCEANO.
- (U) Continue development of computer simulation/sensitivity studies of operations in the littoral zone to determine optimum tactical effectiveness under the difficult conditions of the littoral region.

- (U) OCEAN AND ATMOSPHERIC PREDICTION:

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Budget Item Justification  
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# UNCLASSIFIED

FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2000

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602435N

PROGRAM ELEMENT TITLE: Oceanographic and Atmospheric Technology

- (U) Continue development of ocean model nowcast/forecast capabilities at a variety of scales (global and basin, regional and semi-enclosed seas, and local), including relocateable and nested models; aim is to transition an initial version of the Eddy-Resolving Global Oceanographic Prediction System.
- (U) Continue development efforts for advanced on-board oceanographic models that utilize real-time data for providing the on-scene commander with a virtually real-time predictive capability of all natural environmental factors of operational significance.
- (U) Perform ocean data assimilation, model intercomparisons, testing and validation with oceanographic models under development and do so in close collaboration with the Oceanographer of the Navy.
- (U) Continue development in the area of coupled ocean/atmosphere models to achieve more accurate incorporation of the effects of interactions between the two media.
- (U) Continue development of atmospheric models with the goal of providing FNMOC with global prediction capabilities that use a nested procedure to go from global to regional to local descriptions; adaptation of models to massive parallel computers will continue as a means of achieving greater speed and efficiencies.
- (U) Continue development of an on-scene weather prediction capability as a means of providing real-time forecast capability to the on-scene commander.
- (U) Continue development of data assimilation techniques for the atmospheric models under development; a decision point as to further testing of the utility of the SPY-1 operational tactical radar to infer detailed local atmospheric characteristics will be reached.
- (U) Continue development of remote sensing techniques as a means of obtaining weather observations; artificial intelligence procedures will continue development for automated inference of significant atmospheric characteristics.
- (U) Continue work to construct an end-to-end aerosol observation, analysis, and prediction system for use at FNMOC and with the on-scene forecast system; continue field work on coastal aerosols and dust; the aim is to achieve an operational capability in about the FY 05 timeframe.
- (U) ATMOSPHERIC INFLUENCES ON EM/EO SYSTEMS:
  - (U) Continue development of EM propagation models for the atmosphere to more thoroughly incorporate the atmospheric effects of refraction, extinction, turbulence and rough boundaries; models are required for effects over water, across coastlines, and over varying terrain for both land-based and sea-based systems.
  - (U) Continue field measurements to quantify atmospheric effects on EM propagation and test models under development with the goal of providing more capable radar systems to the fleet.

R-1 Line Item 14

Budget Item Justification  
(Exhibit R-2, page 13 of 16)

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FY 2001 RDT&E, N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2000

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602435N

PROGRAM ELEMENT TITLE: Oceanographic and Atmospheric Technology

- (U) Continue development of tactical decision aids to enable the fleet user of EM systems to more fully exploit system capabilities and/or anomalous conditions of propagation, thus gaining tactical advantage.
- (U) Continue developments in electro-optic propagation models to increase the utility and effectiveness of electro-optic sensors in surface warfare and strike warfare; a Coastal Aerosol Model will be a specific product to take account of aerosol properties in the coastal region.
- (U) Continue the international program EOPACE as an effective means of gathering field measurements to test and verify atmospheric effects on electro-optic propagation, especially in coastal environments.
- (U) Continue efforts toward making EOTDA/EMTDA more inclusive of atmospheric effects and more useful to the fleet operators.

• (U) NOPP:

- (U) Continue to emphasize and develop major oceanographic themes that require multi-agency participation as well as broad oceanographic partnerships among academic/government agencies/private industry to advance the aims of NOPP, specifically to place emphasis on the ocean as a significant natural resource important to national security as well as the nation's economic well-being.
- (U) Continue evolution of efforts in "virtual" ocean data and remote sensing centers/facilities to capitalize on existing centers by developing broad community access/exchange of Navy, NOAA, and other data bases together with data display and assimilation techniques.
- (U) Continue evolution of efforts aimed at a National Littoral "Laboratory" with the long-term aim of "portable" coastal ocean/atmosphere forecasting capabilities.
- (U) Continue partnership efforts in oceanography to optimize resources, intellectual talent, and facilities in ocean sciences focused upon ocean observing technologies; goal is to advance national ocean capability.
- (U) Continue with selected aspects of efforts that develop and/or demonstrate Coastal and Open Ocean Observational Techniques; Observational Systems; Sensors and Sensing; and Modeling/Data Assimilation.
- (U) Continue SECNAV/CNO Oceanographic Research Chairs to further promote the collaboration of distinguished university scientists with Navy/Marine Corps activities; a primary aim is to achieve a synthesis of results and understanding in key oceanographic areas important to Navy/Marine Corps operations.

R-1 Line Item 14

Budget Item Justification  
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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2000

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602435N

PROGRAM ELEMENT TITLE: Oceanographic and Atmospheric Technology

B. (U) PROGRAM CHANGE SUMMARY:

	<u>FY 1999</u>	<u>FY 2000</u>	<u>FY 2001</u>
(U) FY 2000 President's Budget:	68,726	60,334	62,084
(U) Appropriated Value:		73,084	
(U) Adjustments from FY 00 PRESBUFG:			
(U) SBIR/STTR Transfer	-787		
(U) Inflation Adjustment	-313		
(U) SSP Adjustments			-8
(U) Congressional Plus Ups			
(U) Distributed Marine		2,000	
(U) Autonomous UUV		10,000	
(U) PM-10 Air Quality Study		750	
(U) Various Rate Adjustments			-1,436
(U) Execution Adjustments	1,785	-403	
(U) Congressional Rescissions			-320
(U) Minor Program Adjustment			
(U) FY 2001 PRESBUFG Submission	69,411	72,681	60,320

(U) Schedule: Not applicable.

(U) Technical: Not applicable.

C. (U) OTHER PROGRAM FUNDING SUMMARY: Not applicable

(U) RELATED RDT&E:

- (U) PE 0601153N (Defense Research Sciences)
- (U) PE 0602232N (SEW Technology)
- (U) PE 0602314N (Undersea Warfare Surveillance Technology)
- (U) PE 0602315N (Mine Countermeasures, Mining and Special Warfare Technology)
- (U) PE 0602633N (Undersea Warfare Weapons Technology)
- (U) PE 0603207N (Air/Ocean Tactical Applications)
- (U) PE 0603785N (Combat Systems Oceanographic Performance Assessment)

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Budget Item Justification  
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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2000

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602435N

PROGRAM ELEMENT TITLE: Oceanographic and Atmospheric Technology

- (U) PE 0603792N (Advanced Technology Transition)
- (U) PE 0603794N (C3 Advanced Technology)
- (U) PE 0604218N (TESS ENG)
- (U) PE 0602101F (Geophysics)
- (U) PE 0602601F (Phillips Lab Exploratory Development)
- (U) PE 0602784A (Military Engineering Technology)
- (U) PE 0603410F (Space Systems Environmental Interactions Technology)
- (U) PE 0603707F (Weather Systems Technology)

D. (U) SCHEDULE PROFILE: Not applicable.

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Budget Item Justification  
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## FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602633N

DATE: February 2000

PROGRAM ELEMENT TITLE: UNDERSEA WARFARE WEAPONS TECHNOLOGY

(U) COST: (Dollars in Thousands)

PROJECT NUMBER & TITLE	FY 1999 ACTUAL	FY 2000 ESTIMATE	FY 2001 ESTIMATE	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	TO COMPLETE	TOTAL PROGRAM
UNDERSEA WARFARE WEAPONS TECHNOLOGY	37,197	40,839	35,028	35,781	34,901	34,985	34,384	CONT.	CONT.

A. (U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: This program focuses on undersea warfare in support of Future Naval Capabilities in Littoral ASW, Platform Protection, and Time Critical Strike. Specific objectives endorsed by the Joint Chiefs of Staff include: (1) developing a range of tactical Anti-Submarine Warfare (ASW) capabilities that could be employed at the lower end of the full range of military operations with minimum risk of casualties or collateral damage to friendly forces, and (2) developing a robust world-wide capability for neutralizing undersea threats in decisive conflict, also with minimal casualties or collateral damage. Projects support the development of technologies associated with undersea target neutralization, force unit survival and undersea tactical control. Specifically:

(U) Littoral ASW is concerned with detection, classification, localization, and neutralization of enemy submarines and torpedoes in adverse acoustic environments. The objective is to dominate the undersea battlespace to enable timely execution of joint/combined operations and to ensure joint force sustainability. Programs address improved shallow-water operation, tactical control, torpedoes, torpedo countermeasures and hard-kill devices for surface battleforce and submarine self defense.

(U) Time Critical Strike addresses the application of precision offensive military force. Programs address new explosives for enhanced target damage effectiveness, and sensors and countermeasures to detect and neutralize undersea threats to the surface battleforce.

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Budget Item Justification  
(Exhibit R-2, Page 1 of 10)

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602633N

DATE: February 2000

PROGRAM ELEMENT TITLE: UNDERSEA WARFARE WEAPONS TECHNOLOGY

(U) Platform protection is concerned with surface ship self defense against incoming torpedoes. This program addresses this concern through development of technology supporting counterweapons and countermeasures including the Anti Torpedo Torpedo.

(U) Success in neutralizing undersea threats to both submarines and surface ships not only requires successful detection, classification, localization and tracking, but also must culminate in an effective weapon which removes the threat and denies use of the battlespace to the enemy.

(U) Due to the sheer volume of efforts included in this Program Element, the programs described in the Accomplishments and Plans sections are representative selections of work included in this Program Element.

(U) The Navy S&T Program includes projects that focus on or have attributes that enhance the affordability of warfighting systems.

(U) JUSTIFICATION FOR BUDGET ACTIVITY: This program is budgeted within the APPLIED RESEARCH Budget Activity because it investigates technological advances with possible applications toward solution of specific Naval problems, short of a major development effort.

## (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

### 1. (U) FY 1999 ACCOMPLISHMENTS:

- (U) GUIDANCE & CONTROL (G&C):
  - (U) Tested and evaluated multi-frequency and frequency agile processing for broadband G&C.
  - (U) Evaluated conformal array applications for improved G&C in shallow water.

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Budget Item Justification  
(Exhibit R-2, Page 2 of 10)

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602633N

DATE: February 2000

PROGRAM ELEMENT TITLE: UNDERSEA WARFARE WEAPONS TECHNOLOGY

--(U) Designed single crystal material capabilities for future broadband array transduction.  
--(U) Developed cooperative engagement and coordinated attack tactical methodologies.

- (U) PROPULSION:

--(U) Tested lab prototype cells for high performance, low-cost rechargeable battery.  
--(U) Demonstrated pilot scale and brassboard components for 21 inch HYDROX high energy/power density thermal system.  
--(U) Designed and tested improved fuel utilization concepts for aluminum-seawater pilot scale vortex combustor.  
--(U) Continued Stirling engine development for use with wick combustor.  
--(U) Conducted laboratory testing of liquid catholyte semi-fuel cells with high efficiency design.

- (U) UNMANNED UNDERWATER VEHICLES (UUVs):

--(U) Fabricated compact integrated Motor/Rotor propulsor for a 21 inch diameter UUV for increased volume (payload).  
--(U) Developed a model/simulation, for design and test purposes, of the affordable maximum volume covert submarine UUV launch and recovery subsystem, which minimizes the impact on the submarine modifications and operations.  
--(U) Developed a computer model for the design of an affordable precision gravity based navigation system for stealth and energy savings.  
--(U) Transitioned advanced underwater communications algorithms to the Tactical Acoustic Communications ATD (PE 0603792N) for enhanced performance in shallow water.

- (U) SILENCING:

--(U) Tested and optimized MK48 ADCAP torpedo quiet exhaust system in water tunnel.  
--(U) Developed finite element noise model to predict and simulate torpedo noise sources.

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Budget Item Justification  
(Exhibit R-2, Page 3 of 10)

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602633N

DATE: February 2000

PROGRAM ELEMENT TITLE: UNDERSEA WARFARE WEAPONS TECHNOLOGY

- (U) COUNTERWEAPON AND COUNTERMEASURES:
  - (U) Demonstrated homing and fuzing performance of counterweapon in the bubbly wake.
  - (U) Continued air dropped salvo simulation efforts.
  - (U) Incorporated hydrophone technology into smart, adaptive countermeasures (SACM) and conducted in-water tests.
  - (U) Conducted in-water test of micro electromechanical systems (MEMS)-based safe and arming device in 6.25 inch diameter weapon.
  - (U) Initiated terminal defense effort to develop technologies to defeat torpedoes in terminal layer.
- (U) WARHEADS:
  - (U) Developed validated second generation hydrocode with parallelized architecture resulting in order of magnitude reduction in solution time.
  - (U) Developed new high shock underwater formulations based upon novel fuel and oxidizers concept.
  - (U) Demonstrated burn through capability for neutralization of double-hull submarines in smaller warheads.
  - (U) Demonstrated effectiveness enhancement of reactive material shaped charges against undersea targets.
  - (U) Conducted in-water test of MEMS safety and arming device for torpedo applications.
  - (U) Conducted in-water demonstration of reduced volume electromagnetic (EM) fuze in support of reduced length torpedo concept.
  - (U) Evaluated multiple warhead concepts with the potential to provide 3-5X current capability for half length torpedo and other undersea applications.
  - (U) Developed capability to perform MEMS component design, test, and evaluation for undersea warhead applications
- (U) COMPUTATIONAL ENGINEERING
  - Developed Computational Fluid Dynamics (CFD) engineering tools required to support the design of maritime vehicles.

R-1 Line Item 15

Budget Item Justification  
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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602633N

DATE: February 2000

PROGRAM ELEMENT TITLE: UNDERSEA WARFARE WEAPONS TECHNOLOGY

- (U) COUNTERMEASURE AFFORDABILITY
  - (U) Developed affordable countermeasure technology by incorporating modular, common components with reduced life cycle costs including longer stowage life.
  
- 2. (U) FY 2000 PLAN:
  - (U) G & C:
    - (U) Test and evaluate coherent broadband and simultaneous tones broadband processing techniques with in-water data.
    - (U) Integrate and evaluate use of simultaneous tones for improved countermeasures(CCM) performance.
    - (U) Design, fabricate and test integrated multiplexor chip for High Resolution Array.
    - (U) Perform a joint cooperative engagement experiment with the high frequency submarine sonar program.
  
  - (U) PROPULSION:
    - (U) Conduct laboratory testing of alternative high energy density aerogel cathode materials and morphologies for affordable rechargeable batteries.
    - (U) Complete brassboard testing of components for 21 inch HYDROX.
    - (U) Investigate advanced metal fuels for aluminum seawater vortex combustor.
    - (U) Evaluate high efficiency semi-fuel cell with alternate metal anode and liquid catholyte.
    - (U) Integrate wick combustor with Stirling engine for laboratory system tests.
    - (U) Evaluate UUV propulsion concepts that incorporate commercial fuel cell technologies.
  
  - (U) TORPEDO STEALTH:
    - (U) Validate physics-based noise model and transition to Simulation Based Design (SBD).
    - (U) Demonstrate active control on torpedo hull to reduce radiated noise in-water.
    - (U) Develop hybrid active-passive noise damping and mounts on torpedo.

R-1 Line Item 15

Budget Item Justification  
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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602633N

DATE: February 2000

PROGRAM ELEMENT TITLE: UNDERSEA WARFARE WEAPONS TECHNOLOGY

- (U) Initiate sensor self noise modeling and reduction.
- (U) Transition submarine propulsor technology to torpedo.
- (U) Develop coating and composite shell for torpedo afterbody.
- (U) TORPEDO DEFENSE:
  - (U) Continue most promising terminal defense efforts.
  - (U) Continue salvo and air dropped torpedo defense technology development.
  - (U) Transition SACM technology to PMS-415 (Submarine Regional Warfare Systems).
  - (U) Continue Detection, Classification, and Localization algorithm development.
- (U) WARHEADS:
  - (U) Transition validated second generation hydrocode with parallelized architecture resulting in order of magnitude reduction in solution time.
  - (U) Demonstrate robust in-wake electromagnetic fuzing concept for Lightweight Hybrid Torpedo.
  - (U) Establish feasibility, through numerical calculations and laboratory experiments, of the multiple bubble concept.
- (U) WEAPON DESIGN OPTIMIZATION
  - (U) Develop and implement design tools to perform trade-off analysis in support of the Common Broadband Advanced Sonar System (CBASS) for MK48 ADCAP upgrade.
  - (U) Develop multi-disciplinary design optimization schemes for torpedo design and analysis.
- (U) HIGH SPEED WEAPONS
  - (u) Develop supercavitating technologies for incorporation into a high speed test bed

3. FY 2001 PLAN:

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602633N

DATE: February 2000

PROGRAM ELEMENT TITLE: UNDERSEA WARFARE WEAPONS TECHNOLOGY

- (U) G & C:
  - (U) Develop broadband monostatic and bi-static models for foreign diesel targets and compare with in-water data.
  - (U) Test and evaluate a coherent broadband Beam Space Canceler.
  - (U) Integrate and test Prototype Intelligent Controller (PIC) technologies for optimum waveform selection and shallow water countermeasure scenarios.
  - (U) Demonstrate 3D image processing, learning and data fusion in the context of an expanded intelligent controller architecture.
- (U) PROPULSION:
  - (U) Test laboratory prototype cells with high energy density aerogel cathodes for affordable rechargeable batteries.
  - (U) Demonstrate integrated HYDROX energy system.
  - (U) Design and develop brassboard aluminum seawater vortex combustor using advance metal fuels.
  - (U) Design and develop brassboard high efficiency semi-fuel energy system.
  - (U) Complete laboratory system tests on integrated wick combustor with Stirling engine.
  - (U) Design and test modified commercial lab-scale fuel cell units for undersea vehicles.
- (U) TORPEDO STEALTH:
  - (U) Implement self noise model on torpedo sensor design.
  - (U) Complete active control of radiated noise demonstration in water.
  - (U) Demonstrate active control technique on turbine noise.
  - (U) Demonstrate hybrid active-passive mounts on machinery noise suppression.
  - (U) Transition quiet exhaust system to MK48 ADCAP torpedo.
  - (U) Continue energy reclamation concept on torpedo vibration.
  - (U) Implement active fiber concept to control torpedo hull acoustic radiation and vibration.

R-1 Line Item 15

Budget Item Justification  
(Exhibit R-2, Page 7 of 10)

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602633N

DATE: February 2000

PROGRAM ELEMENT TITLE: UNDERSEA WARFARE WEAPONS TECHNOLOGY

- (U) TORPEDO DEFENSE
- (U) Continue most promising terminal defense efforts.
- (U) Continue salvo and air dropped torpedo defense technology development.
- (U) Continue Detection, Classification, and Localization algorithm development.
- (U) WARHEADS:
- (U) Initiate large scale validation of coupled hydrocode for explosive prediction.
- (U) Initiate flip chip technology development for reduces size MEMS-based Safety and Arming device.
- (U) Demonstrate tunnel blast concept to increase warhead performance by at least 2x.
- (U) WEAPON DESIGN OPTIMIZATION:
- (U) Implement collaborative design and simulation tools for torpedo optimization and trade off analysis.
- (U) Implement design and optimization for weapon tactics development.
- (U) Transition Computer Automated Virtual Environment (CAVE) for weapons simulation.
- (U) HIGH SPEED WEAPONS
- (u) Continue development of supercavitating technologies for incorporation into high speed test bed.

R-1 Line Item 15

Budget Item Justification  
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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602633N

DATE: February 2000

PROGRAM ELEMENT TITLE: UNDERSEA WARFARE WEAPONS TECHNOLOGY

## B. (U) PROGRAM CHANGE SUMMARY

	FY 1999	FY 2000	FY 2001
(U) FY 2000 President's Budget:	39,717	34,066	33,255
(U) Appropriated Value:	-	41,066	-
(U) Adjustments from FY 2000 PRESBUDG:			
Program Adjustment	0	0	+1,618
SBIR/STTR Transfer	-608	0	0
Various Rate Adjustment	0	0	+297
Congressional Plus ups	0	+7,000	0
Strategic Sourcing	0	0	-142
Congressional Rescission	0	-227	0
Inflation Adjustment	-185	0	0
Execution Adjustment	-1,727	0	0
(U) FY 2001 PRESBUDG Submission:	37,197	40,839	35,028

## (U) CHANGE SUMMARY EXPLANATION:

(U) SCHEDULE: Not applicable.

(U) TECHNICAL: In FY 2000 the Silencing and Long Range Vehicle Technologies projects will be combined into a single project named Torpedo Stealth to meet the emerging U.S. Navy requirement in torpedo quieting and performance. The Weapon Design Optimization effort was transferred from the Undersea Warfare Advanced Technology Program Element to better align with the technology development objectives.

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Budget Item Justification  
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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602633N

DATE: February 2000

PROGRAM ELEMENT TITLE: UNDERSEA WARFARE WEAPONS TECHNOLOGY

C. (U) OTHER PROGRAM FUNDING SUMMARY:

(U) OTHER APPROPRIATION FUNDS: Not applicable.

(U) RELATED RDT&E:

- (U) PE 0101224N (SSBN Security and Survivability Program)
- (U) PE 0601153N (Defense Research Sciences)
- (U) PE 0602111N (Air and surface Launched Weapons Technology)
- (U) PE 0602121N (Ship, Submarine & Logistics Technology)
- (U) PE 0602314N (Undersea Warfare Surveillance Technology)
- (U) PE 0602315N (Mine Countermeasures, Mining and Special Warfare Technology)
- (U) PE 0602435N (Ocean and Atmospheric Technology)
- (U) PE 0603609N (Conventional Munitions)
- (U) PE 0603747N (Undersea Warfare Advanced Technology)
- (U) PE 0603763E (Marine Technology)
- (U) PE 0603739E (Advanced Electronics Technologies)
- (U) PE 0602702E (Tactical Technology)
- (U) PE 0602173C (Support Technologies-Applied Research)
- (U) PE 0603792N (Advanced Technology Transition)

(U) This program adheres to Defense Science and Technology Reliance Agreements on Conventional Weaponry with oversight provided by the Director Defense Research and Engineering.

(U) SCHEDULE PROFILE: Not applicable.

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Budget Item Justification  
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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2000

BUDGET ACTIVITY: 2 PROGRAM ELEMENT: 0602805N  
PROGRAM ELEMENT TITLE: Dual Use Science and Technology Program

(U) COST: (Dollars in Thousands)

PROJECT NUMBER & TITLE	FY 1999 ACTUAL	FY 2000 ESTIMATE	FY 2001 ESTIMATE	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	TO COMPLETE	TOTAL PROGRAM
Dual Use Science and Technology Program	8,539	9,945	10,067	10,218	10,409	10,622	10,837	CONT.	CONT.

A. (U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: The mission of the Dual Use Science and Technology (DUS&T) Program is to prototype and demonstrate new approaches for leveraging commercial research, technology, products, and processes for military benefit. These new approaches to working with industry, many of which were prototyped at DARPA, must become common throughout the Navy in order to take full advantage of the technological dynamism of the commercial sector. While acquisition reform has helped clear the path, and experience has shown leveraging can work; it has also shown that leveraging is still unfamiliar and not widely adopted. The challenge is to spread leveraging of the commercial sector into the Navy and make it a normal way of doing business throughout the entire acquisition spectrum. Specifically, DUS&T encourages the Navy to leverage commercial research and development to improve the performance, cost and/or readiness of military systems. Under this effort, the Navy solicits, evaluates, ranks, and nominates dual use S&T projects for Dual Use S&T funds. Each project is 50% cost shared with industry. 25% is cost shared with the Navy project funds and Dual Use S&T provides the remaining 25%. All projects are awarded using either Cooperative Agreements or Other Transactions. This is essentially learning by doing approach to Dual Use S&T in the Navy, with Dual Use S&T funds providing an incentive.

(U) JUSTIFICATION FOR BUDGET ACTIVITY: This program is funded under APPLIED RESEARCH because it investigates technological advances with possible applications toward solution of specific Naval problems, short of a major development effort.

(U) PROGRAM ACCOMPLISHMENTS AND PLANS:

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PROGRAM ELEMENT TITLE: Dual Use Science and Technology Program

2. (U) FY 1999 ACCOMPLISHMENTS:

(U) Below are the various areas of interest for this program with the individual awards topics following:

(U) Affordable Sensor Technology - Develop the sensor hardware, software, and system architecture needed to meet the needs and lower cost of Naval and commercial systems. Sensor technologies included are acoustic sensor arrays, electric/magnetic field sensors, seismic sensors, radiowave frequency sensors, electro-optic/infrared sensors, laser radars, sensor fusion, and location/navigation sensors. Initiated following awards:

- qualification of Ausform finishing Process for the Manufacturing of Aerospace Gearing.
- very large two-color 'water fused' IR array technology.
- 100 W, 4-20 GHz AlGaIn/SiC Modulation Doped Field Effect Transistor Amplifier Development.
- optical correlator.
- seafloor cable burial systems for small diameter fiber-optic cable.

(U) Sustainment - Develop robust and reliable designs, parts obsolescence decision tools and simulation models, and advanced industrial sustainment practices capable of fully supporting Naval weapon and commercial system life cycle requirements. These requirements include low-cost, low volume manufacturing, shorter time to low risk production and cost-effective support; rapid quality repair and remanufacturing throughput; and increased readiness support. Initiated following awards:

- reduced cost manufacturing for blade disks.
- power electronics teaching factory.
- teaching factory for Advanced Turbine Engine Welding and Inspection Processes.
- resin injection recirculation molding of large components: process optimization and processing-structure-property relations.

(U) Fuel Efficiency and Advanced Propulsion Technology - Develop technologies for the total propulsion system for increased and efficient speed and thrust, reduced amounts of fuel and power required and reduced emissions. Aspects include power electronic building blocks. Initiated following awards:

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PROGRAM ELEMENT TITLE: Dual Use Science and Technology Program

- development and demonstration of a standard cell approach to power electronic building blocks.
- very high power PEBB demonstration.
- advanced propulsion technology-hydrogen dense fuels stabilized aluminum hydride or alane.
- development of a high density, high efficiency, advanced programmable point-of-use power supply.
- modular power building block for multifunctional aircraft/shipboard avionics and radar power applications.
- multi-function, low weight, and compact power converters for aircraft power system applications.

(U) Advanced High Speed Vessels and Structural Systems for Large Sea-Based Structures - This focus area addresses those requirements needed by the Navy and commercial sector to build high performance and yet affordable platforms over the life cycle. Technologies of particular interest include high speed and excellent seakeeping vessels, structural health monitoring systems for large sea-based structures, control of large structural systems, and reliability of composite structures. Initiated following awards:

- advanced slender hull development.
- a comprehensive assessment of the hydrofoil concept for fast ships.
- application to improved design tools to demonstration craft incorporating hybrid hydrofoil and integrated propulsion technologies which are scalable to large, high-speed ships.
- surface effective vessel.
- open system architecture - condition based monitoring.

(U) Information Systems & Technology - Develop information technologies that improve the capability of both Navy command and control, and commercial communications and awareness. Areas of research include intelligent information systems, communication systems, information fusion, and collaborative environment development. Initiated following awards:

- a secure, covert, survivable network for wideband tactical communications.
- seafloor cable burial system for small diameter fiber-optic cable.

3. (U) FY 2000 PLAN:

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PROGRAM ELEMENT: 0602805N

PROGRAM ELEMENT TITLE: Dual Use Science and Technology Program

(U) Selected topics address Navy needs identified in the Science and Technology Requirements Guide and Navy projects will be expected to provide at least 25% of the total proposed effort with industry providing at least 50%. Below are the various areas of interest for this program with the individual awards topics following:

(U) Affordable Sensor Technology - Develop the sensor hardware, software, and system architecture needed to meet the needs and lower cost of Naval and commercial systems. Sensor technologies included are acoustic sensor arrays, electric/magnetic field sensors, seismic sensors, radiowave frequency sensors, electro-optic/infrared sensors, laser radars, sensor fusion, and location/navigation sensors. The following are planned awards:

- linear wide-band vacuum electronic power amplifier.
- development and validation of multi-frequency design codes for linear high power amplifiers.
- high power silicon carbide transmitter.
- affordable modular digital receiver.
- low defect density GaN Substrates from GaN Boules.
- phased array weather radar technology.
- ferrites for radar applications.

(U) Sustainment - Develop robust and reliable designs, parts obsolescence decision tools and simulation models, and advanced industrial sustainment practices capable of fully supporting Naval weapon and commercial system life cycle requirements. These requirements include low-cost, low volume manufacturing, shorter time to low risk production and cost-effective support; rapid quality repair and remanufacturing throughput; and increased readiness support. The following are planned awards:

- solid state pseudo-hydraulic systems for naval desk operations.
- high rate fiber placement for affordable composite structures.
- friction stir welding technology commercialization for high strength structural alloys.
- scaled-up production of nanostructured ceramic powders.
- thermal barrier coatings for molybdenum refractory alloys.
- integrated engine prognostics and health-management system.
- reconfigurable control and fault identification system.

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PROGRAM ELEMENT: 0602805N

PROGRAM ELEMENT TITLE: Dual Use Science and Technology Program

(U) Advanced Propulsion, Power and Fuel Efficiency Technology - Develop technologies for the total propulsion system for increased and efficient speed and thrust, reduced amounts of fuel and power required and reduced emissions. Aspects include power electronic building blocks, turbine engine propulsion, aircraft power distribution and storage. The following are planned awards:

- active control of combustion processes.
- magnetostriuctive actuators for marine propeller pitch and flow control.
- metal matrix composite reinforced magnetic thrust disk.
- robust, high-DN bearing.
- turbine engine propulsion.
- nickel-metal hydride aircraft battery.

(U) Information Systems & Technology - Develop information technologies that improve the capability of both Navy command and control, and commercial communications and awareness. Areas of research include intelligent information systems, communication systems, information fusion, and collaborative environment development. The following are planned awards:

- a system for distributed registration for mobile augmented reality in urban environment.
- k/ka-band phased array antennas for mobile platforms.

(U) Bioengineering and Medical Technologies - Develop technologies to improve areas of Automatic Pattern Recognition-Neural model-based sensor/processor networks for dynamic scene assessment, target detection/classification, and machinery fault diagnosis and Birobotics-Biomimetic, Autonomous Vehicles and Mobile Robots. The following are planned awards:

- Intelligent Inference Systems bio-bots.
- simulation based intelligent tutoring for maintenance.

4. (U) FY 2001 PLAN:

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BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602805N

PROGRAM ELEMENT TITLE: Dual Use Science and Technology Program

(U) ONR issued a call to Navy activities in November 1998 for FY 2000 and 2001 topics to be included in a single Joint Army, Navy, and Air Force solicitation to industry for dual use SET proposals. Selected topics will address Navy needs identified in the Science and Technology Requirements Guide and Navy projects will be expected to provide at least 25% of the total proposed effort with industry providing at least 50%. The FY 2000/2001 solicitation was issued in January 1999. An additional Joint solicitation for FY 2001 proposals will be issued in January 2000. Agreements for FY 2001 will be awarded in October 2000. Topic areas include:

(U) Affordable Sensor Technology - Develop the sensor hardware, software, and system architecture needed to meet the needs and lower cost of Naval and commercial systems. Sensor technologies included are acoustic sensor arrays, electric/magnetic field sensors, seismic sensors, radiowave frequency sensors, electro-optic/infrared sensors, laser radars, sensor fusion, and location/navigation sensors.

(U) Sustainment - Develop robust and reliable designs, parts obsolescence decision tools and simulation models, and advanced industrial sustainment practices capable of fully supporting Naval weapon and commercial system life cycle requirements. These requirements include low-cost, low volume manufacturing, shorter time to low risk production and cost-effective support; rapid quality repair and remanufacturing throughput; and increased readiness support.

(U) Distributed Mission Training - Develop network of training assets, including live, simulated and computer-generation, which allows multiple players at multiple sites to engage in complex, scalable andtailorable synthetic training environments that mirror the real, modern battlefield. Including Interconnection technology, Information technology, Representation technology, and Pervasive technologies.

(U) Advanced Propulsion, Power and Fuel Efficiency Technology - Develop technologies for the total propulsion system for increased and efficient speed and thrust, reduced amounts of fuel and power required and reduced emissions. Aspects include power electronic building blocks, turbine engine propulsion, aircraft power distribution and storage.

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PROGRAM ELEMENT TITLE: Dual Use Science and Technology Program

- (U) High Speed Ships - Conceptualize, analyze, and demonstrate the feasibility of high speed ships for both commercial and military transport. The broad goals at full scale are: speeds in excess of 70 knots, ranges in excess of 6,000 miles, payload (cargo) in excess of 5,000 tons, shallow draft for small port entry, offloading under adverse weather conditions, and reasonable power requirements.
- (U) Information Systems & Technology - Develop information technologies that improve the capability of both Navy command and control, and commercial communications and awareness. Areas of research include intelligent information systems, communication systems, information fusion, and collaborative environment development.
- (U) Bioengineering and Medical Technologies - Develop technologies to improve areas of Automatic Pattern Recognition-Neural model-based sensor/processor networks for dynamic scene assessment, target detection/classification, and machinery fault diagnosis and Biorobotics-Biomimetic, Autonomous Vehicles and Mobile Robots.

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BUDGET ACTIVITY: 2 PROGRAM ELEMENT: 0602805N  
PROGRAM ELEMENT TITLE: Dual Use Science and Technology Program

	FY 1999	FY 2000	FY 2001
B. (U) PROGRAM CHANGE SUMMARY:			
(U) FY 2000 President's Budget:		18,390	18,126
(U) Appropriated Value:	9,977	10,000	-
(U) SBIR/STTR Transfers:	-274	-	-
(U) Program Adjustments:	-	-	518
(U) Outsourcing Adjustments:	-	-	182
(U) Execution Adjustments:	-1,119	-	-
(U) Congressional Rescissions:	-	-55	-
(U) Congressional Reduction:	-	-8,390	-
(U) Various Rate Adjustments:	-45	-	-8,759
(U) FY 2001 PRESBU DG Submission:	8,539	9,945	10,067

(U) CHANGE SUMMARY EXPLANATION:

(U) Schedule: Not applicable.

(U) Technical: Not applicable.

C. (U) OTHER PROGRAM FUNDING SUMMARY: Not applicable.

(U) RELATED RDT&E:

(U) PE 0602805A (Dual Use Applications Program)

(U) PE 0602805F (Dual Use Science and Technology Program)

D. (U) SCHEDULE PROFILE: Not applicable.

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

PROGRAM ELEMENT: 0603217N  
PROGRAM ELEMENT TITLE: Air Systems and Weapons Advanced Technology

BUDGET ACTIVITY: 3

(U) COST: (Dollars in Thousands) PROJECT	FY 1999 ESTIMATE	FY 2000 ESTIMATE	FY 2001 ESTIMATE	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	TO COMPLETE	TOTAL ESTIMATE
R0446 Advanced Avionics Subsystems	4,674	3,430	3,493	3,586	3,397	3,373	3,314	CONT.	CONT.
R0447 Weapons Advanced Technology	30,833	26,801	25,249	25,807	26,005	23,680	23,444	CONT.	CONT.
W2014 Integrated High Performance Turbine Engine Technology (IHPTET)	6,946	7,171	6,803	7,534	6,871	6,822	6,716	CONT.	CONT.
R2455 Vectoring Extremely Short Take-off and Landing (BSTOL) Control Reduced Tail Operation Research (VECTOR)	4,832	4,411	4,122	0	0	0	0	0	13,365
R2487 DP-2 Thrust Vectoring System Proof of concept demonstration	1,942	3,978	0	0	0	0	0	0	5,920
R2700 RAMJET Propulstion Technologies	0	2,984	0	0	0	0	0	0	2,984
<b>TOTAL</b>	<b>49,227</b>	<b>48,775</b>	<b>39,667</b>	<b>36,927</b>	<b>36,273</b>	<b>33,875</b>	<b>33,474</b>	<b>CONT.</b>	<b>CONT.</b>

A. (U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: This program element (PE) demonstrates concepts for future air platforms and surface/air weapons employed in Naval Warfare. The demonstrated concepts support the Joint Warfare Strategy Forward...from the Sea" and relate to the Joint Mission Areas of Strike, Littoral Warfare, and Intelligence Surveillance and Reconnaissance. Projects in this PE are jointly planned in the Defense Science and Technology Reliance process with the Air Force and Army through panels of the Director Defense Research and Engineering.

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PROGRAM ELEMENT: 0603217N

PROGRAM ELEMENT TITLE: Air Systems and Weapons Advanced Technology

(U) Strike technology issues relevant to this PE include surgical lethality, platform survivability, affordability and increased Naval gunfire range and accuracy. Littoral Warfare technology issues relevant to this PE include air battlespace dominance, expeditionary forces air support, ship self-defense and increased Naval gunfire range and accuracy. Intelligence Surveillance and Reconnaissance technology issues relevant to this PE include platform mission endurance and survivability. Seven projects are executed within the PE:

(U) Advanced Avionics Subsystems (AAS): The AAS program has as its goal the demonstration in real-time on an embedded avionics processor of an annotated, geo-referenced, 3D perspective out-the-window scene of the terrain and target/threat environment external to the aircraft. The program will provide the following functional capabilities: a) the ability to perform in-flight mission preview; b) the ability to ingest, view and obtain precision targeting solutions from off-board sensor image updates; c) the ability to perform in-flight mission replanning; and d) the ability to share a Common Tactical Picture among multiple platforms

(U) Weapons Advanced Technology: Demonstrates emerging sub-system/component level weapons concepts which promise affordable and significant performance improvements to both existing and next generation Naval Air and Surface launched weapons. These efforts in this area will demonstrate the achievement of the time-phased Air and Surface Weapons Technology (ASWT) goals, which will maintain and increase the Naval Air and Surface Weapons capability edge through the 21st century.

(U) Integrated High Performance Turbine Engine Technology (IHPTET): Provides experimental engine testing of new gas turbine engine technologies to demonstrate readiness and reduce technical risk for entering engineering development. IHPTET is a Tri-Service program in which each Service contributes established shares of 6.2 and 6.3 funding and laboratory resources to meet specified goals of doubling thrust-to-weight ratio, halving fuel consumption by the year 2003 (relative to a 1987 baseline) and reducing acquisition and maintenance costs. Additional emphasis has been incorporated to address High Cycle Fatigue issues, which may be associated with propulsion system design deficiencies.

(U) Vectoring ESTOL Control Reduced Tail Operation Research (VECTOR) Program: An international cooperative program with Germany. VECTOR will utilize the X-31 aircraft to develop, flight demonstrate, provide quality metrics and operational concept formulation and validation of ESTOL and supporting thrust vectoring technologies. The program will also develop an

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BUDGET ACTIVITY: 3  
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PROGRAM ELEMENT TITLE: Air Systems and Weapons Advanced Technology

Advanced Air Data System (AADS) (specifically and uniquely designed to operate even at extreme angles of attack) and will explore reduced vertical tail/directional controls.

(U) The DP2 Thrust Vectoring System: A this program is a demonstration of a proof-of-concept of a reduced-scale flight test vehicle. The vehicle concept is a vertical take-off and landing (VTOL) aircraft of advanced composite construction, utilizing thrust vector control.

(U) The Navy Science and Technology (S&T) program includes projects that focus on or have attributes that enhance the affordability of warfighting systems.

(U) JUSTIFICATION FOR BUDGET ACTIVITY: This program is budgeted within the ADVANCED TECHNOLOGY DEVELOPMENT Budget Activity because it encompasses design, development, simulation, experimental testing or prototype hardware. It is also necessary to validate technological feasibility and concept of operations to reduce technological risk prior to initiation of a new acquisition program or transition to an ongoing acquisition program.

## B. (U) PROGRAM CHANGE SUMMARY FOR TOTAL P.E.:

	FY 1999	FY 2000	FY 2001
FY 2000 President's Budget	47,398	42,046	37,969
Appropriated Value	-	49,046	-
Adjustments from FY 2000 PRESBUDDG:			
SBIR/STTR Transfer	-607	0	0
Execution Adjustment	2,654	0	0
Program Adjustment	0	0	1,971
Inflation Rate Adjustment	-218	0	0
Various Rate Adjustments	0	0	-291

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BUDGET ACTIVITY: 3      PROGRAM ELEMENT: 0603217N  
PROGRAM ELEMENT TITLE: Air Systems and Weapons Advanced Technology

Congressional Rescissions	0	-271	0
Mil/Civ Pay Rates	0	0	18
Congressional Adds			
DP-2 Thrust Vectoring	0	4,000	0
RAMJET Propulsion	0	3,000	0
FY 2001 President's Budget	49,277	48,775	39,667

(U) CHANGE SUMMARY EXPLANATION:

(U) Schedule: Not Applicable.  
(U) Technical: Not Applicable.

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BUDGET ACTIVITY: 3      PROGRAM ELEMENT: 0603217N  
 PROGRAM ELEMENT TITLE: Air Systems and Weapons Advanced Technology

U) COST: (Dollars in Thousands)

PROJECT NUMBER & TITLE	FY 1999 ACTUAL	FY 2000 ESTIMATE	FY 2001 ESTIMATE	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	TO COMPLETE	TOTAL PROGRAM
0446 Advanced Avionics Subsystems (AAS)	4,674	3,430	3,493	3,586	3,397	3,373	3,314	CONT.	CONT.

MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: This project demonstrates commercial-off-the-shelf (COTS) technology systems that will facilitate the introduction of new functionality (e.g., 3 dimensional (3-D) perspective scene visualization, pilot/crew workload reduction, on/off-board sensor data fusion, mission replanning, etc.) into existing Navy aircraft and future platforms in a cost-effective manner. The project includes: (a) Advanced Visualization and Data Fusion software (AVDFS); (b) scalable open architecture project (SOAP); (c) advanced interconnect technology; and (d) the design and build of an Advanced Mission Computer and Display (AMC&D)-like processor. Individual performers and tasks are selected to maximize the probability of transfer of successful results to Navy and other systems. This project addresses the Joint Mission 2010, Navy Science and Technology (S&T) Requirements Guidance, ... Forward From The Sea, and theoutyear plans of several naval aviation programs (e.g., F/A-18, Air Combat Electronics, Tactical Aircraft Mission Planning, AV-8B, Joint strike Fighter (JSF) and others). Key objectives include providing better technology transparency, reducing software costs pending currently closed avionics architectures, protocol-independent high-speed/high-bandwidth databases, and ability to introduce new functionality for effective joint warfighting.

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BUDGET ACTIVITY: 3 PROGRAM ELEMENT: 0603217N  
PROGRAM ELEMENT TITLE: Air Systems and Weapons Advanced Technology

PROJECT NUMBER: R0446  
PROJECT TITLE: Advanced Avionics Subsystems (AAS)

## (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

### 1. (U) FY 1999 ACCOMPLISHMENTS:

- (U) Initiated:
- (U) Developed a baseline capability to incorporate and display infrared sensor imagery with AVDFS 3-D visualization software.
- (U) Integrate AVDFS with the Tactical Aircraft Mission Planning System (TAMPS) and Joint Mission Planning Segment (JMPS) mission planning systems to provide mission rehearsal and preview capability. Prototype versions of AVDFS were used to support Operation Allied Force.
- (U) Initial investigations on high efficiency interface protocols to improve network bandwidth efficiency.
- (U) Implementation of 3-D perspective scene generation into embedded hardware architecturally consistent with AMC&D technology insertion Architecture.
- (U) Initial software portability across processors, operating systems network types and object request brokers.
- (U) Continued:
- (U) To develop the capability to execute 3-D perspective scene generation software in real-time on embedded avionics hardware. The development methodology will involve the iterative use of software simulation techniques in conjunction with the progressive use of proposed Advanced Mission Computer and Display (AMC&D) hardware.
- (U) Geo-registered image mosaicing techniques and data compression technology required to fuse imagery from multiple sources and bring in information from off-board.
- (U) Refining image generation software for portability to multiple commercial-off-the-shelf (COTS) graphics engines. Migration of AVDFS to multiple platforms including the entire Silicon Graphics Inc. (SGI) product line and Windows New Technology (NT) INTEL-based processors.
- (U) Performance analysis and development of Common Object Request Broker Architecture (CORBA) in a real-time deterministic system.
- (U) Performance analysis and development of CORBA in a real-time deterministic system.

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PROGRAM ELEMENT: 0603217N

PROGRAM ELEMENT TITLE: Air Systems and  
Weapons Advanced Technology

PROJECT NUMBER: R0446

PROJECT TITLE: Advanced Avionics  
Subsystems (AAS)

- (U) Incorporation of Real-time Database Management System.
  - (U) Definition of network requirements and capabilities for an information intensive unified system
  - (U) Completed:
    - (U) Demonstration showing the revised AVDFS software (called PowerScene II) to: 1) Execute across multiple platforms (SGI/IRIX, PC/WindowsNT, PC/Windows 98, SUN/Solaris); and 2) incorporate/exploit image and terrain databases from the National Imagery and Mapping Agency (NIMA).
    - (U) Integration of AVDFS with TAMPS 6.2 mission planning software.
    - (U) Demo which shows a baseline capability to incorporate and display infrared (IR) sensor imagery with AVDFS 3-D visualization software.
    - (U) Integration of signal processing node into the SOAP architecture based on COTS technology.
    - (U) Investigation of using processing resources on the Optical Backplane Interconnect System (OBIS) backplane as the embedded resource for visualization algorithms.
    - (U) Fault tolerant/dynamic reconfiguration in a Real-time CORBA environment.
    - (U) Performance modeling process development to be used throughout project life.
  - (U) Advanced Avionics Interconnect Technology
    - (U) Continued:
      - (U) Development of extremely high-speed and high-bandwidth protocol independent optical data network based on COTS technologies and techniques. Technology leverages fiber optic technologies developed by the commercial telecommunications industry. This effort seeks to replace the current MIL-STD-1553 bus technology.
      - (U) Evaluation of optical interconnect components for ships and aircraft under joint Naval Sea Systems Command (NAVSEA)/Naval Air Systems Command (NAVAIR) Dual-Use Science and Technology (S&T) project agreement.
      - (U) Integration of key components for High Speed Optical Networks.
- (U) FY 2000 PLAN:  
(U) Initiate:

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BUDGET ACTIVITY: 3 PROGRAM ELEMENT: 0603217N  
PROGRAM ELEMENT TITLE: Air Systems and Weapons Advanced Technology

PROJECT NUMBER: R0446  
PROJECT TITLE: Advanced Avionics Subsystems (AAS)

- (U) Development of the baseline capability to execute AVDFS software in near real-time on the Navy's next generation embedded mission computer - AMC&D (target AMC&D build 2).
- (U) Definition and development of AVDFS functionality to showcase the ability to perform a Time Critical Strike (TCS) mission scenario in conjunction with real-time execution on AMC&D.
- (U) Continue:
  - (U) Development and demonstration of interoperability with operational avionics hardware.
  - (U) Development of the capability to execute 3-D perspective scene generation software in real-time on embedded avionics hardware.
  - (U) Geo-registered image mosaicing techniques and data compression technology (required to fuse imagery from multiple sources and bring in information from off-board)
  - (U) Real-time CORBA evaluation
  - (U) Evaluation of high efficiency interconnect protocols.
- (U) Complete:
  - (U) Off-board interface definition.
  - (U) Performance analysis and development of CORBA in a real-time deterministic system
  - (U) Real-time Database Management System and Mass Memory trade study.
  - (U) Definition of network requirements and capabilities for an information intensive unified system.
  - (U) System design for FY 2001 demonstration hardware and software architectures.
  - (U) Prototype pilot interface for visualization software.
- (U) FY 2001 PLAN:
  - (U) Complete:
    - (U) Demonstration showing the capability to execute AVDFS software in real-time on the Navy's next generation embedded mission computer - AMC&D processor.

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BUDGET ACTIVITY: 3 PROGRAM ELEMENT: 0603217N  
PROGRAM ELEMENT TITLE: Air Systems and Weapons Advanced Technology

PROJECT NUMBER: R0446  
PROJECT TITLE: Advanced Avionics Subsystems (AAS)

- (U) Demonstration showing the tactical utility of AVDFS in performing a TCS mission scenario in conjunction with real-time execution on AMC&D.
- (U) Hardware, operating system prototype based on AMC&D hardware. Prototype may require supplemental processing elements for some image fusion computations.
- (U) 3-D visualization in embedded hardware.
- (U) Integration into demonstration environment.
- (U) Characterization of system performance and transition into engineering, manufacturing and development (EM&D) products.

(U) PROGRAM CHANGE SUMMARY: See total program change summary for P.E.

(U) OTHER PROGRAM FUNDING SUMMARY: Not applicable.

(U) RELATED RDT&E: This program adheres to Defense Reliance Agreements for Sensors, Electronics and Battlespace Environment (Integrated Platform Electronics).

(U) Work in this Program Element (PE) is related to and fully coordinated with efforts in the following PEs:

- (U) PE 0601152N (In-House Lab Independent Research)
- (U) PE 0601153N (Defense Research Sciences)
- (U) PE 0602111N (Air and Surface Launched Weapons Technology)
- (U) PE 0602122N (Aircraft Technology)
- (U) PE 0602202F (Human Systems Technology)
- (U) PE 0602204F (Aerospace Avionics)
- (U) PE 0602234N (Materials, Electronic and Computer Technology)
- (U) PE 0602708E (Cockpit Autonomous Landing)
- (U) PE 0603231F (Crew Systems and Personnel)
- (U) PE 0603238N (Precision Strike and Air Defense Technology)

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Budget Item Justification  
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# UNCLASSIFIED



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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2000

BUDGET ACTIVITY: 3 PROGRAM ELEMENT: 0603217N PROJECT NUMBER: R0446  
PROGRAM ELEMENT TITLE: Air Systems and Weapons Advanced Technology PROJECT TITLE: Advanced Avionics Subsystems (AAS)

- (U) PE 0603792N & 0603792F (Advanced Technology Demonstrations)
- (U) PE 0603800N & 0603800F (Joint Strike Fighter (JSF) DEM/VAL)
- (U) PE 0603253F (Advanced Avionics Integration)

(U) SCHEDULE PROFILE: Not applicable.

R-1 Line Item 17

Budget Item Justification  
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# UNCLASSIFIED

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: PROGRAM ELEMENT: 0603217N  
PROGRAM ELEMENT TITLE: Air Systems and Weapons Advanced Technology

U) COST: (Dollars in Thousands)

PROJECT NUMBER & TITLE	FY 1999 ESTIMATE	FY 2000 ESTIMATE	FY 2001 ESTIMATE	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	TO COMPLETE	TOTAL PROGRAM
0447 Weapons Advanced Technology	30,833	26,801	25,249	25,807	26,005	23,680	23,444	CONT.	CONT.

. (U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: This project will reduce technical risky performing technology demonstrations in guidance and control, ordnance, Guns and Launchers, fire control air breathing propulsion and airframe aeromechanics sub-system/component concepts. It builds on the foundation of research emerging from Navy and Industry Applied Research projects funded by PE 0602111N programs which promise affordable performance improvements to existing an ext generation Naval air and surface launched weapons. The elements of the project addresses Joint Mission Area (JMA) requirements for increased capabilities in surgical lethality of weaponry (Strike JMA), increased ship self defense capabilities (Littoral Warfare JMA) and increased accuracy and range for Naval Surface Fire Support (Strike and Littoral MAS).

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Budget Item Justification  
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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: PROGRAM ELEMENT: 0603217N

PROGRAM ELEMENT TITLE: Air Systems and

Weapons Advanced Technology

PROJECT NUMBER: R0447

PROJECT TITLE: Weapons Advanced Technology

## (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

### 1. (U) FY 1999 ACCOMPLISHMENTS:

- (U) Cruise Missile Real Time Retargeting Demonstration (CMRTR):
  - (U) Demonstrated the Build 1 Laser Detecting and Ranging Seeker (LADAR) in the lab which includes the adaptive strike planning and fixed/mobile target automatic target recognition software, and Tomahawk 6 DOF simulation.
  - (U) Finished modification of the T-39 test aircraft to accept the Build 1 LADAR sensor. This task included design and fabrication of the mechanical/electrical interface assemblies, wiring harnesses, and interface boards to the lab.
  - (U) Conducted successful Flight testing of the Build 1 solid state LADAR on the T-39 aircraft. 17 out of 17 successful runs with automatic target recognition (ATR) functioning correctly. Operated multiple successful LADAR targetting runs against urban targets in conjunction with Marine Corps training in Yuma Arizona.
  - (U) Continued fabrication of Build 2 sensor for delivery in FY 2000.
  - (U) Modified the T-39 test aircraft to accept the Build 2 LADAR sensor. This task includes designing and fabricating the mechanical/electrical interface assemblies, wiring harnesses, and interface boards to the lab.
- (U) Surgical Strike Adaptive Video Control and Data Communication System:
  - (U) This task develops and demonstrates advanced video compression and Radio Frequency (RF) modulation/coding technology for a podless digital weapon control data link system for use in joint strike operations
  - (U) Began flight test planning for FY 2000 system verification and testing.
  - (U) Integrated terminals into ground test platforms.
  - (U) Ground tested multiple terminals.
  - (U) Integrated terminals into flight test platforms.
  - (U) Refined system level performance requirements.
  - (U) Continued Performance prediction analysis of weapon control data link system.
  - (U) Performed laboratory integration testing of terminals.

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Budget Item Justification  
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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET      DATE: February 2000

BUDGET ACTIVITY:      PROGRAM ELEMENT: 0603217N      PROJECT NUMBER: R0447  
PROGRAM ELEMENT TITLE: Air Systems and Weapons Advanced Technology      PROJECT TITLE: Weapons Advanced Technology

- (U) Finished design, development, and fabrication of RF, modem, network control, processor, and central processor submodules.
- (U) Completed platform integration approach/design.
- (U) Defined electrical and mechanical terminal interfaces.
- (U) Concentric Canister Launcher (CCL):
  - (U) Continued Tomahawk Computational Fluid Dynamics (CFD) model validation.
  - (U) Proceeded with hatch design and fabrication.
  - (U) Maintained efforts for fabrication of prototype launch system hardware.
  - (U) Continued design and fabrication of canister interface electronics unit.
  - (U) Completed demonstration of all up distributed control system.
  - (U) Continued development of fiber optical Local Area Network (LAN) architecture.
  - (U) Conducted SM2 Blk IV restrained firing.
  - (U) Conducted Tomahawk Land Attack Missile (TLAM) Land/Sea flyout test via LAN and CCL electronics.
  - (U) Conducted Evolve Seasparrow Missile (ESSM) and decoy electronic development.
- (U) Concurrently Engineered (CE) Ball-Joint Gimbal for Joint Strike Weapon:
  - (U) Started CE seeker flight tests and demonstration.
  - (U) Conducted CE seeker integration and test, ground, rooftop, Hardware In The Loop (HITL) tests.
  - (U) Finished integration of CE gimbal hardware and flight test pod.
  - (U) Completed ground, rooftop, HITL, flight tests, and program documentation.
- (U) Shared Aperture: This task enables the development and demonstration of wideband multifunction RF systems with shared apertures and electronics to perform the functions currently performed by multiple RF systems, in particular radar, communications and Electronic Warfare (EW) systems.
  - (U) Constructed test prototype.
  - (U) Finished final design for open architecture multifunction RF system.

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Budget Item Justification  
(Exhibit R-2, page 13 of 32)

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET      DATE: February 2000

BUDGET ACTIVITY:      PROGRAM ELEMENT: 0603217N      PROJECT NUMBER: R0447

                            PROGRAM ELEMENT TITLE: Air Systems and      PROJECT TITLE: Weapons Advanced Technology

  Weapons Advanced Technology

- (U) High Speed Missile Technology (Formerly Hypersonics): This task will demonstrate airframe propulsion guidance & control and ordnance technologies of the dual combustion ramjet for potential next generation Navy high speed strike missiles.
  - (U) Began initial design of dual combustion ramjet test vehicle.
  - (U) Developed test plan for free jet testing of the ramjet.
  - (U) Developed preliminary design of the test stand.
  
- (U) Land Attack and Deep Strike (LADS) Weapon Technology: This task will demonstrate the capability to substantially improve the mission planning and execution times for land attack and deep strike missions for both surface and submarine launched tactical strike weapons such as Tactical Tomahawk, Fasthawk, Navy Tactical Missile System (NTACMS), and the Land Attack Standard Missile (LASM). The demonstration uses the following technology developed in the 6.2 Weapons program (PE 0602111N): Weapon/target pairing, Bomb Damage Identification (BDI) from Synthetic Aperture Radar (SAR) processing, Global Positioning System (GPS)/Inertial Measurement Unit (IMU) attitude accuracy for 3 dimensional (3-D) precision targeting, algorithms for rapid Tomahawk mission planning, and rapid tactical area mapping.
  - (U) Defined preliminary operational concept for the LADS weapon demonstration
  - (U) Produced an initial top level architecture for the mission planning system
  - (U) Identified components of the previous 6.2 program products that will be transitioned to the LADS weapon demonstration.
  - (U) Reviewed software and hardware components of 6.2 elements (e.g. GPS/IMU, BDI SAR, etc) transitioning to the LADS demonstration. Identify the modifications required to integrate the components into the demonstration.
  
- (U) Integrated High Payoff Rocket Propulsion Technology (IHPRPT): This task will demonstrate high kinetic performance air launched rocket motor technologies. These technologies will be integrated into a 5'-8' diameter flight weight rocket motor and demonstrated in ground tracking. Technologies demonstrated will include

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Budget Item Justification  
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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET      DATE: February 2000

BUDGET ACTIVITY:      PROGRAM ELEMENT: 0603217N  
PROGRAM ELEMENT TITLE: Air Systems and      PROJECT NUMBER: R0447  
Weapons Advanced Technology      PROJECT TITLE: Weapons Advanced Technology

aluminized and non-aluminized reduced smoke propellants; light weight, high strength/stiffness component case; high pressure combustion; thrust vector control (TVC)(integrated aero/TVC and aft mounted jet reaction control); and a light weight, low erosion nozzle.

- (U) Optimized reduced smoke solid propellant grain geometry and burn rate characteristics.
- (U) Conducted static firing of subscale rocket motors at increasing chamber pressures to verify propellant specific impulse.
- (U) Analytically evaluated composite case strength.
  
- (U) Precision Strike Navigator (PSN):
  - (U) Continued test preparation and integration.
  - (U) Continued Inertial Measurement Unit (IMU) fabrication.
  - (U) Completed wafer material & structure development and characterization.
  - (U) Continued wafer fabrication

(U) FY 2000 Plan:

- (U) CMRTR:
  - (U) Complete flight testing of Build 1 LADAR
  - (U) Finish development of critical mobile target algorithm.
  - (U) Conduct synthetic scene generation work for hardware in the loop testing.
  - (U) Demonstrate adaptive strike planner executive allocator.
  - (U) Conduct ground test of Build 2 LADAR
  - (U) Begin flight testing of Build 2 LADAR
  
- (U) Surgical Strike Adaptive Video Control and Data Communication System:
  - (U) Finish F/A-18 system integration studies.

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: PROGRAM ELEMENT: 0603217N

PROGRAM ELEMENT TITLE: Air Systems and

PROJECT NUMBER: R0447

Weapons Advanced Technology

PROJECT TITLE: Weapons Advanced Technology

- (U) Complete Flight testing of Surgical Strike system. Demonstrate real time video and high bandwidth capacity in F/A-18 flight test aircraft.

• (U) CCL:

- (U) Complete Standard Missile II, Block IV restrained firing test.
- (U) Finish CCL conceptual design for ship integration
- (U) Conclude CCL life cycle cost study.
- (U) Performed integration/testing of TLAM, SM-2, Torpedo, and complex node electronics.
- (U) Produce final report.

• (U) High Speed Missile Technology

- (U) Perform component and subsystem integration for dual combustion ramjet propulsion system testing
- (U) Fabricate test stand for free jet testing
- (U) Conduct subsystem verification testing for dual combustion ramjet free jet testing
- (U) Develop final design of dual combustion ramjet test vehicle.

• (U) LADS weapon demonstration:

- (U) Develop a detailed architecture and system design for the mission planning system configuration
- (U) Define the interface requirements between the software interfaces of the rapid mission planning, tactical area mapping, and weapon/target pairing components.
- (U) Test the coupled GPS/IMU attitude accuracy for 3-D precision targeting
- (U) Begin implementation of planning system in testbed.
- (U) Demonstrate an affordable strike weapon seeker and data link system in a captive carry flight test.

- (U) Ship Based Defense Demonstration: This task will demonstrate the technologies for increasing the effectiveness of ship based defense systems in tracking and killing supersonic, maneuvering cruise missiles. The task builds on the following PE 0602111N tasks: interactive adaptation of fire control to the environment,

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Budget Item Justification  
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DATE: February 2000

BUDGET ACTIVITY: PROGRAM ELEMENT: 0603217N  
PROGRAM ELEMENT TITLE: Air Systems and  
Weapons Advanced Technology

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PROJECT TITLE: Weapons Advanced Technology

Non-Uniformity Compensated Focal Plane Array (NUCFPA), and clutter processing. Three technology demonstrations will be comprised of two components. The adaptive weapon control demonstration will demonstrate the feasibility of increasing weapon performance by improving the ability of the weapon to adapt to changing propagation environments. The other component will improve the performance of the weapon warhead against maneuvering targets by implementing alternative warhead concepts.

- (U) Evaluate and analyze the effectiveness of two alternative warhead designs, the reactive material warhead and the miniature aimed warhead. These warhead designs were developed in the PE 0602111N Air and Surface Weapons Technology (ASWT) program. A down select will be made to select the best alternative for a kill mechanism against a maneuvering threat.

- (U) Conduct weapon system integration study of shipboard electro-Optic (EO) trackers, weapons control systems, and miniature command/link receivers. This will result in a down select between command guidance and command waypoint guidance.

• (U) IHPRPT:

- (U) Develop high strength, light weight, high pressure composite case rocket motor
- (U) Develop and test low/no erosion nozzle throat insert materials and test to determine suitability
- (U) Static test subscale low erosion nozzles at high pressure to determine erosion characteristics

• (U) PSN:

- (U) Complete wafer fabrication
- (U) Complete IMU fabrication and testing.
- (U) Document results of demonstration

• (U) Advanced Common Electronic Modules (ACEMs):

- (U) Complete:
  - (U) Development and testing of ACEMs that will be smaller, and have less power consumption and higher performance than their analog counterparts, while accomplishing all the requisite acquisition, transmission and

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Budget Item Justification  
(Exhibit R-2, page 17 of 32)

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: PROGRAM ELEMENT: 0603217N  
PROGRAM ELEMENT TITLE: Air Systems and  
Weapons Advanced Technology

PROJECT NUMBER: R0447  
PROJECT TITLE: Weapons Advanced Technology

digital processing of Radio Frequency (RF) signals over a very wide frequency range (50 MHz to 45GHz). The family of ACEMs consists of advanced analog-to-digital technology and will be integrated to create systems capable of performing multiple functions. This enhances affordability through a 10-fold projected decrease in systems weight and power consumption, a 15-fold increase in systems performance, and substantial Life Cycle Cost savings. This program and technology transitioned from PE 0602122N at the end of FY99.

(U) FY 2001 Plan:

- (U) CMRTR:
  - (U) Conduct flight testing of Build 2 LADAR using T-39 test aircraft.
  - (U) Test and verify in flight the performance of the Automatic Target Recognition (ATR) capability of the CMRTR system,
  - (U) Complete effort by conducting flight test and demonstration of the Adaptive Strike Planning and auto routing capabilities of the CMRTR system.
  
- (U) High Speed Missile Technology
  - (U) Begin advanced airframe testing activities to evaluate performance of different design alternatives in the Mach 4+ environment.
  - (U) Conduct component and subsystem integration of advanced airframe design components.
  - (U) Test the ordnance operation and performance in the Mach 6+ environment. Evaluate and test multiple ordnance configurations such as Unitary warheads, kinetic penetrator structures, and multiple submunition configurations.
  - (U) Develop Safe-arm and fuzing technologies that are effective at the terminal speeds of a high speed missile.
  
- (U) LADS strike weapon demonstration
  - (U) Finalize design of mission planning system

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Budget Item Justification  
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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: PROGRAM ELEMENT: 0603217N  
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Weapons Advanced Technology

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PROJECT TITLE: Weapons Advanced Technology

- (U) Initiate modifications required to integrate the components into the LADS demonstration (i.e. the development of enhanced mission planning capability and open systems avionics architecture for "smart" loitering weapon system.).
- (U) Incorporate and test algorithms for responsive Tactical Tomahawk loiter/retargeting planning into testbed.
- (U) Modify tactical area mapping and BDI assessment components to interface with the mission planning components. Test and refine interfaces between mapping and BDI elements.
- (U) Provide a preliminary design for fire control applications for additional strike weapons such as Fasthawk and Land Attack Standard Missile (LASM).
- (U) Refine and test Tacair targeting capability.
- (U) Conduct a flight demonstration of an affordable strike weapon carrying a seeker and Data Link system.
- (U) Ship Based Defense Demonstration:
  - (U) Evaluate the integration interaction of shipboard meteorological sensors with weapon control components and weapon doctrine systems. Define rules for radar sensitivity variations in different propagation environments and identify and optimize AM/SPY-1 Sensitivity Time Control (STC) notch setting for maximum performance in a wide range of propagation environments. Begin preliminary design of a decision aide to assist operator in adapting radar sensitivity settings for optimum performance based on a changing propagation environment.
  - (U) Using warhead configuration selected in prior year, design and build a prototype warhead that provides a significantly improved kill capabilities against the maneuvering cruise missile threat and can be adapted to current self defense missile systems.
  - (U) Design and prototype the airframe control components that are necessary to provide the endgame maneuverability for a higher probability of kill (Pk) against the maneuvering threat.
- (U) Multi-Target Air-to-Air Missile Demonstration: This project will demonstrate an inexpensive RF seeker that can locate and track multiple targets in an air-to-air engagement involving a lead aircraft, his wingman, and an enemy aircraft. The RF seeker will be conformal (i.e. mounted on the missile body) thereby freeing up the nose section of the missile to accommodate a second seeker. The second seeker can be configured to provide a higher

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Budget Item Justification  
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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: PROGRAM ELEMENT: 0603217N

PROGRAM ELEMENT TITLE: Air Systems and  
Weapons Advanced Technology

PROJECT NUMBER: R0447

PROJECT TITLE: Weapons Advanced Technology

level of precision tracking in the end game of the missile engagement and thereby significantly increasing missile Pk and improving the exchange ratio in the post merge air to air engagement. This demonstration transitions the ASWT Surface Wave Antenna advanced seeker project in PE 0602111N.

- (U) Develop detailed seeker performance requirements
- (U) Modify processor design and algorithm to support greater RF angular precision
- (U) Develop preliminary seeker transmitter/receiver packaging and commercial off the shelf (COTS) electronic design.

- (U) IHPRT Technology:

- (U) Evaluate high performance/low loss thrust vector control concepts for air launch
- (U) Downselect to the most promising thrust vector control concept and static fire at low pressure.
- (U) Combine propellant, case, nozzle, and case technology into full scale (7''-8'' diameter) motor. Static fire the motor to determine the performance characteristics.

- (U) Shape Memory Alloy (SMA) Actuator: This effort will demonstrate the proof of concept for a reconfigurable rotor system that can be applied to improve range and weapon carrying capacity forUCAVs during precision strike and close air support operations. This program will build upon prior sub-scale, shape memory alloy technology efforts sponsored by Defense Advanced Research Projects Agency (DARPA).
  - (U) Refinement and re-scaling of a sub-scale actuator design concept.
  - (U) Integration of a large scale, shape memory alloy actuator into the rotor blade of a test aircraft.

• (U) PROGRAM CHANGE SUMMARY: See total program change summary for P.E.

• (U) OTHER PROGRAM FUNDING SUMMARY: Not Applicable

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET      DATE: February 2000

BUDGET ACTIVITY:      PROGRAM ELEMENT: 0603217N      PROJECT NUMBER: R0447

PROGRAM ELEMENT TITLE: Air Systems and      PROJECT TITLE: Weapons Advanced Technology

Weapons Advanced Technology

- (U) RELATED RDT&E:
- (U) PE 0601152N (In House Lab Independent Research)
  - (U) PE 0601153N (Defense Research Sciences)
  - (U) PE 0602111N (Air and Surface Launched Weapons Technology)
  - (U) PE 0602122N (Aircraft Technology)
  - (U) PE 0602234N (Materials, Electronic, and Computer Technology)
  - (U) PE 0602602F (Conventional Munitions)
  - (U) PE 0603238N (Precision Strike and Air Defense Technology)
  - (U) PE 0603609N (Conventional Munitions)
  - (U) PE 0603601F (Advanced Weapons)
  - (U) PE 0207133F (F-16 Squadrons)
  - (U) PE 0203730A (Chaparral Missile)

(U) SCHEDULE PROFILE: Not applicable.

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Budget Item Justification  
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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET      DATE: February 2000

PROGRAM ELEMENT: 0603217N  
PROGRAM ELEMENT TITLE: Air Systems and Weapons Advanced Technology

UDGET ACTIVITY: 3

(U) COST: (Dollars in Thousands)

PROJECT NUMBER & TITLE	FY 1999 ESTIMATE	FY 2000 ESTIMATE	FY 2001 ESTIMATE	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	TO COMPLETE	TOTAL PROGRAM	CONT.
2014 Integrated High Performance Turbine Engine Technology (IHPTET)	6,946	7,171	6,803	7,534	6,871	6,822	6,716	CONT.	CONT.	CONT.

(U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: This project covers the Navy's share of the demonstrator engine efforts under the Department of Defense (DoD)/National Aeronautics and Space Administration (NASA) Industry IHPTET program ensuring that Navy unique design and operational requirements are met. Full scale integrated technology demonstration is essential to validate and transition technologies from applied research through advanced development and into system demonstration/validation, engineering and manufacturing development or product lines. Without technology demonstrators, system acquisition cost and schedule risk would increase to unacceptable levels or weapons systems would have degraded operational performance. The lack of technology demonstrator efforts could result in system development schedule increase of five or more years along with the associated increase in cost. The technology sets integrated into and demonstrated in the IHPTET demonstrator engines are closely related to the system requirements for the Joint Strike Fighter (JSF), F-18E/F Common Support Aircraft (CSA), Multi-mission Maritime Aircraft (MMA), Tactical Tomahawk, SH-60R, and other future Navy platforms, so that the transition of these high risk and high payload technologies may be effectively accomplished. In addition, IHPTET technologies can transition to current legacy systems via engine Component Improvement Programs (CIP). A strong and viable U.S. propulsion program also provides a dual-use benefit to our country by enhancing our competitiveness in the international commercial engine market. This long term project, coordinated through Reliance, will provide for the future needs in air battlespace dominance and expeditionary forces support (Littoral Warfare Joint Mission Area (JMA)),

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DATE: February 2000

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603217N

PROGRAM ELEMENT TITLE: Air Systems and

Weapons Advanced Technology

PROJECT NUMBER: W2014

PROJECT TITLE: Integrated High Performance

Turbine Engine Technology

increased platform mission endurance (Intelligence, Surveillance, and Reconnaissance JMA) and provide technology for increased affordability and platform survivability and increased mission effectiveness (Strike JMA). The program funds three demonstrator engine classes. Each engine class has specific performance goals that are divided into multiple phases. Phase I has been completed and demonstrated for each of the three classes of demonstrators. Phase II is currently progressing to the engine demonstration phase, for all of the advanced component technologies, in the current fiscal year. Phase III concepts were developed and have been initiated. The phase goals of each engine class are listed as follows and are referenced to a 1987 baseline (additional affordability goals have been developed for fighter/attack and turboprop/shaft classes):

- (U) Fighter/attack (Joint Technology Demonstrator Engine (JTDE)):
  - Phase I - 1991: +30% thrust/weight (Fn/Wt), +100°F combustor inlet temperature (CIT), +300°F turbine inlet temperature (TIT), -20% fuel burn.
  - Phase II - 1997: +60% Fn/Wt, +200°F CIT, +600°F TIT, -20% acquisition cost, -20% maintenance cost, -30% fuel burn.
  - Phase III - 2003: +100% Fn/Wt, +400°F CIT, +900°F TIT, -35% acquisition cost, -35% maintenance cost, -40% fuel burn.
- (U) Turboprop/shaft (Joint Turbine Advanced Gas Generator (JTAGG)):
  - Phase I - 1991: +40% shaft horsepower/weight (SHP/Wt), -20% specific fuel consumption (SFC), +300°F TIT.
  - Phase II - 1997: +80% SHP/Wt, -30% SFC, +600°F TIT, -20% acquisition cost, -20% maintenance cost.
  - Phase III - 2003: +120% SHP/Wt, -40% SFC, +1000°F TIT, -35% acquisition cost, -35% maintenance cost.
- (U) Missile/expendable engines (Joint Expendable Turbine Engine Concepts (JETEC)):
  - Phase I - 1991: +35% thrust/airflow (Fn/Wa), -20% SFC, +1100°F CIT, +500°F TIT, -30% Cost.
  - Phase II - 1997: +70% Fn/Wt, -30% SFC, +1200°F CIT, +900°F TIT, -45% Cost.
  - (U) Phase III - 2003: +100% Fn/Wa, -40% SFC, +1400°F CIT, +1400°F TIT, -60% Cost.
- (U) Each engine company (Allison Advanced Development Company (AADC) (IN) Honeywell International Engines and Systems (formerly AlliedSignal Engines) (AZ), General Electric (GE) (OH & MA), Pratt & Whitney (P&W) (CT & FL), Teledyne Continental Motors Engine Division (formerly Teledyne Ryan Aeronautical) (OH) and Williams International (WI) (MI)) attempts to utilize at least two engine builds or demonstrator tests within each Phase to demonstrate the performance

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DATE: February 2000

UDGET ACTIVITY: 3      PROGRAM ELEMENT: 0603217N      PROJECT NUMBER: W2014  
PROGRAM ELEMENT TITLE: Air Systems and Weapons Advanced Technology      PROJECT TITLE: Integrated High Performance Turbine Engine Technology

goals. The JETEC goals are divided into demonstrating SFC and Cost for a subsonic demonstrator and Fn/Wa, CIT, TIT and Cost for a supersonic demonstrator.

## U) PROGRAM ACCOMPLISHMENTS AND PLANS:

- (U) FY 1999 ACCOMPLISHMENTS:
  - (U) Continued:
  - (U) Phase II JTDE: Completed Pratt & Whitney (P&W) Phase II demonstrator engine testing, achieving +41%Fn/Wt (XTE66/1).
  - (U) Phase II JTAGG: Completed fabrication, assembly and instrumentation of initial Honeywell (formerlyAllied Signal Engines (ASE) demonstrator engine.
  - (U) Phase II JETEC: Completed assembly and instrumentation of both Williams International (WI) and Allison Advanced Development Company (AADC) supersonic demonstrator engines.
  - (U) Phase III JTDE: Completed source selections with P&W and General Electric (GE/AADC) and initiated designs.
  - (U) Phase III JTAGG: Initiated design of (GE/AADC) demonstrator engine.
  - (U) Phase III JETEC: Completed source selection with WI and initiated design. Continued design and fabrication of ASE demonstrator engine.
- (U) FY 2000 PLAN:
  - (U) Continue:
  - (U) Phase II JTDE: Complete fabrication, assembly, and instrumentation of AADC demonstrator engine
  - (U) Phase II JTAGG: Initial demonstrator engine test. Component optimization and second build of demonstrator engine to meet Phase II goals
  - (U) Phase II JETEC: Complete demonstrator engine test at WI and AADC to achieve Fn/Wa and cost goals.
  - (U) Phase III JTDE: Design of Phase III demonstrator engines
  - (U) Phase III JTAGG: Design of Phase III demonstrator engines

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Budget Item Justification  
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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603217N

PROGRAM ELEMENT TITLE: Air Systems and

Weapons Advanced Technology

PROJECT NUMBER: W2014

PROJECT TITLE: Integrated High Performance Turbine Engine Technology

- (U) Phase III JETEC: Design and fabrication of Phase III demonstrator engines

(U) FY 2001 PLAN:

• (U) Continue:

- (U) Phase II JTDE: Demonstration of Phase II goals with GE/AADC demonstration engine.
- (U) Phase III JTAGE: Demonstration of Phase II goals with Honeywell demonstration engine.
- (U) Phase III JTDE: Fabrication, assembly and instrumentation of GE/AADC and P&W demonstrator engines and demonstration of Pratt & Whitney progress toward Phase III goals.
- (U) Phase III JTAGE: Design, component development and fabrication of demonstrator to meet Phase III goals.
- (U) Phase III JETEC: Design, component development and fabrication of demonstrator engines to meet Phase III goals.

(U) PROGRAM CHANGE SUMMARY: See total program change summary for P.E.

(U) Schedule: Not applicable.

(U) Technical: Not applicable.

(U) OTHER PROGRAM FUNDING SUMMARY: Not applicable.

(U) RELATED RDT&E:

- (U) PE 0601152N (In-House Lab Independent Research)
- (U) PE 0601153N (Defense Research Sciences)
- (U) PE 0601102F (Defense Research Sciences)
- (U) PE 0601102A (Defense Research Sciences)
- (U) PE 0602122N (Aircraft Technology)
- (U) PE 0602234N (Materials, Electronic and Computer Technology)
- (U) PE 0602203F (Aerospace Propulsion)
- (U) PE 0602211A (Aviation Technology)
- (U) PE 0603202F (Aircraft Propulsion Subsystem Integration)

R-1 Line Item 17

Budget Item Justification  
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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET      DATE: February 2000

UDGET ACTIVITY: 3      PROGRAM ELEMENT: 0603217N      PROJECT NUMBER: W2014

PROGRAM ELEMENT TITLE: Air Systems and Weapons Advanced Technology      PROJECT TITLE: Integrated High Performance Turbine Engine Technology

(U) PE 0603216F (Advanced Turbine Engine Gas Generator)

(U) PE 0603003A (Aviation Advanced Technology)

(U) SCHEDULE PROFILE: Not applicable.

R-1 Line Item 17

Budget Item Justification  
(Exhibit R-2, page 26 of 32)

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FY 2001 RDT&E, N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 3 PROGRAM ELEMENT: 0603217N

PROGRAM ELEMENT TITLE: Air Systems and Weapons Advanced Technology

U) COSTS: (Dollars in Thousands)

NUMBER & TITLE	FY 1999 ESTIMATE	FY 2000 ESTIMATE	FY 2001 ESTIMATE	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	TO COMPLETE	TOTAL PROGRAM
2455 Vectoring Extremely Short Take-off and Landing (ESTOL) Control Reduced Tail Operation Research (VECTOR)	4,832	4,411	4,122	0	0	0	0	0	9,778

. (U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION The Vectoring ESTOL Control Reduced Tail Operation Research (VECTOR) effort is an international cooperative program with Germany. This task is a follow-on to a previous X-31 thrust vectoring light demonstration, also with Germany as our partner. That effort utilized engine exhaust thrust vectoring vanes (TVV) to reduce thrust vectoring and was limited to medium and high altitude fighter maneuvering. ESTOL and Reduced tail/directional control were not addressed in the previous program. VECTOR rejoins Germany as a partner, who brings vectored thrust, vectored thrust flight control, and Advanced Air Data System (AADS) (flush port) expertise. VECTOR will utilize the X-31 aircraft to develop, flight demonstrate, and provide quality metrics and operational concept formulation and validation of ESTOL and supporting thrust vectoring technologies. The program will also develop an AADS (specifically and uniquely designed to operate even at extreme angles of attack) and will explore reduced vertical tail/directional controls using thrust vectoring with a first-ever fully integrated flight, engine and thrust vectoring control and an AADS. Pay-offs for such technologies and concepts include reductions in requirements for runways for expeditionary operations, reductions of catapult and arresting gear and wind-over-the-deck requirements, decreased aircraft catapult and arresting loads (decreased airframe fatigue), increased flight controls complexity, lower development and acquisition costs, and decreased aircraft weight, observability, and maintenance costs. Other benefits include significantly higher take-off and lower landing energy (which would reduce aircraft fatigue), and increased safety of flight (due to significantly reduced out-of-control flight incidents). VECTOR results will be applicable to tactical aircraft and unmanned aerial vehicles.

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Budget Item Justification  
(Exhibit R-2, page 27 of 32)

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FY 2001 RDT&E, N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 3 PROGRAM ELEMENT: 0603217N  
PROGRAM ELEMENT TITLE: Air Systems and Weapons Advanced Technology

PROJECT NUMBER: R2455  
PROJECT TITLE: Vectoring  
ESTOL Control Tailless  
Operation Research  
(VECTOR)

## (U) FY 1999 ACCOMPLISHMENTS:

- (U) Initiated:
  - (U) Aircraft reactivation.
  - (U) ESTOL concept and requirements definition.
  - (U) Initial ESTOL pilot displays and pilot in-the-loop simulation.
  - (U) ESTOL modeling and simulation.
  - (U) Wind tunnel testing, supporting concept and requirements definition.
  - (U) Update of ESTOL aerodynamics data set.
  - (U) System design for installation and integration of X-31 flight controls, engine controls and thrust vectoring controls.
  - (U) Wind tunnel testing of X-31 integrated systems (in both the U.S. and Germany).
  - (U) Requirements definition for X-31 flight control modifications.
  - (U) Requirements definition and planning for modifications to X-31 thrust vectoring controls.
  - (U) Requirements definition and planning for modifications to X-31 engine controls.
  - (U) Design and fabrication of an Advanced Air Data System (AADS) (flush port).
  - (U) Ground test of an AADS (conducted in Germany).
  - (U) Development of ESTOL and reduced vertical tail/directional stability simulation and ground tests, including wind tunnel testing.
  - (U) ESTOL and reduced vertical tail/directional stability simulation and ground tests, including wind tunnel testing.
  - (U) Flight-hardware-in-the-loop simulation development.
  - (U) Flight control computer reactivation.
  - (U) Initial real-time simulation activation.

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Budget Item Justification  
(Exhibit R-2, page 28 of 32)

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603217N

PROGRAM ELEMENT TITLE: Air Systems and Weapons Advanced Technology

PROJECT NUMBER: R2455  
PROJECT TITLE: Vectoring  
ESTOL Control Tailless  
Operation Research  
(VECTOR)

(U) FY 2000 PLAN

- (U) Initiate:
  - (U) Flight control law development
  - (U) Analysis and reporting requirements definition.
  - (U) Analysis and reporting methodologies and systems.
  - (U) Aircraft integration of an Advanced Air Data System (AADS).
  - (U) Design and fabrication of a final design (miniaturized) AADS (flush port).
  - (U) Requirements analysis, design and integration requirements for reduced verticaltail/directional control.
  - (U) Modifications to X-31 flight control software.
  - (U) Modifications to X-31 thrust vectoring controls.
  - (U) Modifications to X-31 engine controls.
  - (U) Advanced ESTOL flight control software (Operational Flight Program (OFP)) development validation and verification (V&V).
  - (U) Flight development and demonstration of ESTOL technologies.
  - (U) Flight development and demonstration of AADS.
- (U) Continue: (additional work funded in previous years in PE 0603790N):
  - (U) Development and ground test of an AADS.
- (U) Continue:
  - (U) ESTOL and vertical tail/directional control reduction concept and requirements definition.
  - (U) ESTOL and reduced vertical tail/directional control reduction concept simulation and ground tests.

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Budget Item Justification  
(Exhibit R-2, page 29 of 32)

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FY 2001 RDT&E, N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603217N

PROGRAM ELEMENT TITLE: Air Systems and Weapons Advanced Technology

PROJECT NUMBER: R2455

PROJECT TITLE: Vectoring  
ESTOL Control Tailless  
Operation Research  
(VECTOR)

- (U) ESTOL and reduced vertical tail/directional control concept and requirements definition wind tunnel testing.
- (U) ESTOL modeling and simulation and aerodynamic data set update.
- (U) Requirements definition for X-31 flight control software validation and modification.
- (U) Requirements definition and planning for modifications to X-31 thrust vectoring controls and engine controls.
- (U) System design for installation and integration of X-31 flight controls, engine controls and thrust vectoring controls.
- (U) Flight control law development.
- (U) Extensive wind tunnel testing of X-31 integrated systems (in both the U.S. and Germany).
- (U) Design and fabrication of an Advanced Air Data System (AADS) (flush port).
- (U) Ground test of an AADS (conducted in Germany).
- (U) Flight-hardware-in-the-loop simulation development.
- (U) Complete (additional work funded in previous years in PE 0603790N):
  - (U) Initial design, fabrication and installation of the initial AADS.
  - (U) First AADS development flights.
- (U) Complete:
  - (U) Aircraft reactivation.
  - (U) Reactivation functional check flights.
  - (U) Initial ESTOL cockpit display development.
  - (U) Initial ESTOL development flights.
  - (U) Initial aircraft modifications for thrust vectoring technology development.
  - (U) Initial ESTOL flight software (OFP) development and validation and verification.

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Budget Item Justification  
(Exhibit R-2, page 30 of 32)

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FY 2001 RDT&E, N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603217N

PROGRAM ELEMENT TITLE: Air Systems and Weapons Advanced Technology

PROJECT NUMBER: R2455  
PROJECT TITLE: Vectoring  
ESTOL Control Tailless  
Operation Research  
(VECTOR)

- (U) Flight control computer reactivation.
- (U) Real-time simulation activation.
- (U) Initial ESTOL Aero Data Set.

FY 2001 PLAN:

- (U) Initiate:
  - (U) Advanced ESTOL flight software (OPF) development, validation and verification
  - (U) Flight demonstration of miniaturized AADS
- (U) Continue:
  - System design installation and integration of X-31 flight controls, engine controls and thrustvectoring controls.
  - (U) Ground and flight test of ESTOL system.
  - (U) Extensive wind tunnel testing of X-31 integrated systems.
  - (U) ESTOL pilot displays and pilot in-the-loop simulation.
  - (U) ESTOL Aero Data Set.
- (U) Continue (additional work funded in previous years in PE 0603790N):
  - (U) Requirements analysis, design and integration of a final design (miniaturized) AADS (flush port).
- (U) PROGRAM CHANGE SUMMARY: See total program change summary for P.E.
- (U) OTHER PROGRAM FUNDING SUMMARY: Not applicable.

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603217N

PROGRAM ELEMENT TITLE: Air Systems and Weapons Advanced Technology

PROJECT NUMBER: R2455  
PROJECT TITLE: Vectoring  
ESTOL Control Tailless  
Operation Research  
(VECTOR)

(U) RELATED RDT&E: This program adheres to Defense S&T Reliance Agreements for Air Platforms (Fixed Wing Vehicles).

- (U) PE 0601101F (Geophysics)
- (U) PE 0601102F (Materials)
- (U) PE 0601153N (Defense Research Sciences)
- (U) PE 0602122N (Aircraft Technology)
- (U) PE 0602201F (Aerospace Flight Dynamics)
- (U) PE 0602203F (Aerospace Propulsion)
- (U) PE 0602234N (Materials, Electronic and Computer Technology)
- (U) PE 0602204F (Aerospace Avionics)
- (U) PE 0603112F (Advanced Materials)
- (U) PE 0603202F (Aerospace Propulsion Subsystems Integration)
- (U) PE 0603205F (Flight Vehicle Technology)
- (U) PE 0603211F (Aerospace Structures)
- (U) PE 0603216F (Aerospace Propulsion and Power Technology)
- (U) PE 0603245F (Advanced Flight Technology Integration)
- (U) PE 0603790N (NATO Research and Development)
- (U) PE 0603800N & 0603800F (Joint Advanced Strike Technology Program)

(U) SCHEDULE PROFILE: Not applicable.

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Budget Item Justification  
(Exhibit R-2, page 32 of 32)

# UNCLASSIFIED

# UNCLASSIFIED

FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

UDGET ACTIVITY: 3      PROGRAM ELEMENT: 0603238N  
 PROGRAM ELEMENT TITLE: Global Surveillance/Precision Strike and Air Defense Technology

U) COST: (Dollars in Thousands)

ROJECT UMBER/ ITILE	FY 1999 ACTUAL	FY 2000 ESTIMATE	FY 2001 ESTIMATE	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	TO COMPLETE	TOTAL PROGRAM
2145 Global Surveillance/Precision Strike and Air Defense Technology	46,798	47,582	63,780	60,074	57,512	57,144	56,194	CONT.	CONT.
2266 Mobile Offshore Basing (MOB)	4,856	0	0	0	0	0	0	0	37,188
0834 Naval Science Assistance Program (NSAP)	4,806	4,688	4,775	4,943	4,841	4,821	4,783	CONT.	CONT.
2371 Littoral Airborne Sensor/Hyperspectral (LASH)	11,711	11,933	0	0	0	0	0	0	35,048
2701 LASH Study	0	994	0	0	0	0	0	0	0
2703 Extending The Littoral Battlespace	0	5,967	0	0	0	0	0	0	0
2704 Hybrid LIDAR	0	1,989	0	0	0	0	0	0	0
2702 Small Combatant Craft	0	11,933	0	0	0	0	0	0	0
OTAL	68,171	85,086	68,555	65,017	62,353	61,965	60,977	CONT.	CONT.

(U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: This program focuses Science and Technology (S&T) resources in the areas of Precision Strike and Air Superiority/Defense in support of the Joint Chiefs of Staff's top five Joint Warfighting capabilities and the following Joint Mission Areas (JMAS): Strike, Littoral Warfare, Intelligence, Surveillance & Reconnaissance, Nuclear Deterrence, and Sea & Air Superiority. Effective modern warfare in the littorals demands simultaneous execution of these mission areas and requires information transfer and interoperability of multi-mission systems.

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Budget Item Justification  
(Exhibit R-2 Page 1 of 19)

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

UDGET ACTIVITY: 3 PROGRAM ELEMENT: 0603238N  
PROGRAM ELEMENT TITLE: Global Surveillance/Precision Strike and Air Defense Technology

U) Precision Strike is enabled by the integration of Command & Control, surveillance, and targeting capabilities developed in the Global Surveillance Area, and is implemented by high-speed processing and precision weapons for rapid response against high-value, short-dwell targets over extended ranges. The projection of power and Strike elements to defend military and civilian assets ashore using Maritime Forces is a key element for Littoral Warfare. The requirements can only be fulfilled with: careful correlation of intelligence and other indications and warnings, detection systems which can maintain track of round targets, methods of identification of targets and hostile intent, command and weapon control systems (to include ability for real-time re-targeting), rapid response and time critical Strike weapons, as well as effective and efficient fire support weaponry. This program supports elements of the Fleet and Force Commanders' top Command Capability Issues (CCIs): lexible Targeting, Battlespace Connectivity and Common Tactical Picture, and Integrated Fire Support.

U) Extending the Littoral Battlespace (ELB) is an Advanced Concept Technology Demonstration which responds to the top level military need to rapidly deploy a Naval Expeditionary Task Force with an embarked Marine Air Ground Task Force (MAGTF). This AGTF, as part of a larger Joint Task Force, is required to deploy to any region of the world's littorals and conduct military operations from a sea base across the spectrum of conflict to implement national military strategy. Forces employed ashore will be light, agile, distributed and disaggregated and capable of optimizing remote fires, to effectively deter aggression, halt attacks and secure critical areas as a precursor to a much larger force. Forces will be empowered by unprecedented situation understanding via a robust information infrastructure that is fully coupled to a decision/planning/execution system in a shared battlespace network (sea/land). The objective of the Advanced Concept Technology Demonstration is to demonstrate enhanced integrated command and control/fires and targeting capability to enable rapid employment, maneuver, and fires to support joint dispersed units operating in an extended littoral battlespace. Two Major System Demonstrations will be executed: one completed in FY-99 and one planned for FY01. The ELB ACTD was approved by Deputy Under Secretary of Defense Acquisition and Technology) (DUSD (AT) on 16 January 1997.

U) Air Defense/Air Superiority for at-sea operations and Littoral Warfare requires the development and demonstration of detect, Control, Engage capabilities within a fully integrated, Joint Battle Management, Command, Control and Communications architecture. These capabilities must be operational in all weather, day/night, at-sea/over-land, and electronic countermeasure environments. Modern threats (targeted at sea and shore units) which must be detected, identified accurately, and efficiently engaged include: manned aircraft, cruise missiles (including supersonic sea-skimmers and maneuvering land attack variants), helicopters, unmanned aerial vehicles, and tactical ballistic missiles. Variants of these

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Budget Item Justification  
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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

UDGET ACTIVITY: 3 PROGRAM ELEMENT: 0603238N  
PROGRAM ELEMENT TITLE: Global Surveillance/Precision Strike and Air Defense Technology

ould be Weapons of Mass Destruction. All of the above could employ stealth techniques, decoys, and other countermeasures to evade detection and/or engagement.

U) Cruise Missile Defense (CMD)/Theater Air and Missile Defense (TAMD) is a continuation/evolution of a program initiated in FY 1994. An 18 May 1998 Joint Mission Assessment (JMA) panel verified the Navy Mission of CMD/TAMD over land as well as at sea. This program consists of the following segments. (1) The CMD Phase I "Mountain Top" ACTD (completed January 1996) demonstrated that an AEGIS ship (or other surface/ground based missile launch platform), using one or more surrogate airborne sensor partners and Cooperative Engagement Capability, can provide greatly expanded air defense capability to engage air targets beyond the surface/ground based radar line of sight. (2) The CMD Phase II program (FY-96 to FY-99) aligned technology with the advanced E-2C Airborne Early Warning radar system and STANDARD Missile programs leading to a fielded CMD capability. (3) The program also developed and demonstrated engagement capabilities against next generation cruise missiles and all other air threats. (4) The program (FY-00 to FY-06) focuses technology associated with the full "system of systems" which will lead to future operational capability in Missile Defense. It will optimize the performance of science and technology products to detect, identify, reform fire control, and intercept Cruise Missile, Theater Ballistic Missile, and other theater air threats through the use of risk reduction and integrating tools which are compatible with Navy, Joint Service and International TAMD systems.

U) Mobile Offshore Basing (MOB) effort established the basis for a determination of technical feasibility and cost of a very large floating platform comprised of interconnected modules, assembled on site to provide support to U.S. military activities in areas lacking in adequate basing structure. Mission Requirements and Performance Measures were developed based on concerns over minimizing, or even eliminating, dependence on overseas military bases. Standards and Criteria for design were developed by modifying existing commercial standards with new design methods and specialized building blocks complimented by military standards to develop a MOB Classification Guide. Design Tools effort developed a new generation of efficient hydrodynamic motion prediction models which have up to 1000 times greater capability. These hydrodynamic motion methods were coupled with new universal ship structural deflection response prediction method. Comprehensive validation experiments are underway. Alternative Platform Concept preliminary designs were conducted for four different MOB platform concepts of 5000-foot length capable of C-17 air cargo operations; as well as developed the subsystem components critical to MOB feasibility. These platform concepts include Hinge Interconnected Semi-submersible Modules, Semi-submersible Modules Interconnected by Flexible Ridges, Independent Semi-submersible Modules without inter-module connectors but held in place by dynamic positioning, and

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Budget Item Justification  
(Exhibit R-2 Page 3 of 19)

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

UDGET ACTIVITY: 3 PROGRAM ELEMENT: 0603238N  
PROGRAM ELEMENT TITLE: Global Surveillance/Precision Strike and Air Defense Technology

concrete Material Interconnected Semi-submersible Modules. Subsystem components developed were Intermodule Connectors, Dynamic Positioning Systems, Construction and Repair Methods, and Open Ocean Ship Cargo Transfer methods.

U) Naval Science Assistance Program (NSAP): This program enables S&T to be moved to the operational Fleet/Force rapidly, averages long-term S&T investments to meet operational capability needs, and provides a method for the Research Development and Evaluation community to surge in response to real world crises. The program accomplishes this through several methods. It provides on the spot Science and Technology Advisors (STAs) and Representatives (STRs) to Joint, Navy, and Marine Corps operational and strategic planning commands worldwide. It also develops a compendium of mature technologies, not yet in the acquisition portfolio, for Fleet/Force Commander early evaluation and concurrent development of new tactics and operational concepts. In addition, NSAP facilitates and disseminates CCIIs provided by the Fleet/Force Commanders to the Director of Navy Test and Evaluation and Technology Requirements (OPNAV N091). Lastly, NSAP collaborates with the Fleet/Force to identify specific solutions to known operational capability needs and provides the means to develop and demonstrate prototype systems. The result is that NSAP provides insight into issues associated with Naval Warfighting Capabilities, hereby influencing long term S&T programs. The program also develops a cadre of civilian scientists and engineers who, upon completion of their NSAP STA/STR tours, return to the Naval technical community with first hand knowledge of the Fleet/Force and warfighting issues. NSAP enables a continuous collaboration between the warfighters, the technical community, and strategic development commands.

U) Littoral Airborne Sensor/Hyperspectral is a modular airborne imaging sensor system with an integrated navigation and control system. Operating in visible and near infrared spectrums, LASH collects hyperspectral imagery using many spectral channels (colors) to exploit subtle color features associated with targets of interest. Developed as a pod-mounted system, LASH can be operated from a P-3C Orion, or other platforms in support of Anti-Submarine Warfare mine detection, passive athymetry, near shore mapping, and land-based detection, discrimination and targeting.

U) The Navy S&T program includes projects that focus on or have attributes that enhance the affordability of warfighting systems.

U) JUSTIFICATION FOR BUDGET ACTIVITY: This program is budgeted within the ADVANCED TECHNOLOGY DEVELOPMENT Budget Activity because it encompasses design, development, simulation, or experimental testing or prototype hardware to validate

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Budget Item Justification  
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# UNCLASSIFIED

FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

UDGET ACTIVITY: 3 PROGRAM ELEMENT: 0603238N  
PROGRAM ELEMENT TITLE: Global Surveillance/Precision Strike and Air Defense Technology

chnological feasibility and concept of operations and reduce technological risk prior to initiation of a new acquisition program or transition to an ongoing acquisition program.

## U) PROGRAM CHANGE FOR TOTAL P.E.:

FY 2000 President's Budget:	FY 1999	FY 2000	FY 2001
Appropriated Value:	69,466	52,580	67,678
Adjustments from FY 2000 PRESBUDG:	-	85,580	-
SBIR/STTR Transfer	-1,084	0	0
Execution Adjustments	+89	0	0
Various Rate Adjustments	-300	0	-768
Program Adjustments		+32,933	+1,645
Congressional Plus-ups	0	-494	
Congressional Rescissions			
FY 2001 President's Submission:	68,171	85,086	68,555

## U) CHANGE SUMMARY EXPLANATION:

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

UDGET ACTIVITY: 3      PROGRAM ELEMENT: 0603238N  
PROGRAM ELEMENT TITLE: Global Surveillance/Precision Strike and Air Defense Technology

- U) Schedule: Not applicable
- U) Technical: Not applicable

R-1 Line Item 18

Budget Item Justification  
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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

UDGET ACTIVITY: 3 PROGRAM ELEMENT: 0603238N  
 PROGRAM ELEMENT TITLE: Global Surveillance/Precision Strike and Air Defense Technology

U) COST: (Dollars in Thousands)	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	TO	TOTAL
ROJECT	ACTUAL	ESTIMATE	ESTIMATE	ESTIMATE	ESTIMATE	ESTIMATE	ESTIMATE	COMPLETE	PROGRAM
UMBER/ ITILE									
2145 Global Surveillance/Precision Strike and Air Defense Technology	46,798	47,582	63,780	60,074	57,512	57,144	56,194	CONT.	CONT.

U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: Effective modern warfare in the littorals demands simultaneous execution of Surveillance, Strike and Air Defense Mission areas and requires information transfer and interoperability of multi-mission systems.

U) The Precision Strike and Air Superiority projects develop and demonstrate all/weather, day/night capability to support forces ashore through the use of ground surveillance, Strike warfare command and decision systems, advanced propulsion and eapon technology, and fire support technology.

The projection of power and Strike elements to defend military and civilian assets ashore using Maritime Forces is a key element for Littoral Warfare. The requirements can only be fulfilled with: careful correlation of intelligence and other indications and warnings, detection systems which can maintain track of ground targets, methods of identification of targets and hostile intent, command and weapon control systems (to include ability for real-time re-targeting), rapid response and time critical Strike weapons, as well as effective and efficient fire support weaponry. This project supports the Joint Chiefs of Staff top five Joint Warfighting Capabilities. In addition, six Fleet and Force Commanders included elements

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Budget Item Justification  
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FY 2000 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

UDGET ACTIVITY: 3 PROGRAM ELEMENT: 0603238N  
PROGRAM ELEMENT TITLE: Global Surveillance/  
Precision Strike and Air  
Defense Technology

PROJECT NUMBER: R2145  
PROJECT TITLE: Global Surveillance/  
Precision Strike and Air  
Defense Technology

of this as part of their Top Ten Command Capability Issues (CCIs): Flexible Targeting, Battlespace Connectivity and Common  
actical Picture, and Integrated Fire Support. (U) The Extending the Littoral Battlespace (ELB) Advanced Concept Technology  
emonstration (ACTD) effort responds to the top level military need to rapidly deploy a Naval Expeditionary Task Force with an  
mberked Marine Air Ground Task Force as part of a larger Joint Task Force to any region of the world's littorals and conduct  
ilitary operations from a sea base across the spectrum of conflict to implement national military strategy. Forces employed  
shore will be light, agile, distributed and dis-aggregated and capable of optimizing remote fires, to effectively deter  
gression, halt attacks and secure critical areas as a precursor to a much larger force. Forces will be empowered by  
nprecedented situation understanding via a robust information infrastructure that is fully coupled to a  
ecision/planning/execution system on a shared battlespace network (sea/land). The objective of the ACTD is to demonstrate an  
nanced integrated command and control/fires and targeting capability to enable rapid employment, maneuver, and fires to  
upport joint dispersed units operating in an extended littoral battlespace. Two Major System Demonstrations (MSDs) will be  
emonstrated: one completed in FY-99 and one planned for FY01. The ELB ACTD was approved by Deputy Under Secretary of Defense  
Acquisition and Technology) (DUSD (AT) on 16 January 1997.

U) The Cruise Missile Defense (CMD)/Theater Air and Missile Defense (TAMD) problem is a very complex one, which must be  
ystematically addressed. How can a single Carrier Battle Group in the "Offshore Presence" mode of operations, effectively  
efend assets at sea and ashore when it is required to execute "Forced Entry" in the event of hostilities. With the variety  
f air threats (Cruise Missiles (CMs), Theater Ballistic Missiles (TBMs), Unmanned Aerial Vehicle, Attack Aircraft), each  
aving the potential of requiring different engagement techniques, coupled with other mission requirements such as Strike, and  
urface Fire Support, what should be the Naval TAMD system of the future? In response to this, the project will be  
pproaching the demonstrations of Science and Technology TAMD elements in a "system-of-systems" context.

his is a continuation/evolution from the Cruise Missile Defense Program initiated in FY 1994 and completed with land based  
esting of government and contractor computer programs and hardware (contractor IRAD) as part of the Radar Modernization  
rogram (RMP) at Makaha Radar Facility, Hawaii, in 1999. The missile related technologies would be evaluated at White Sands  
issile Range, New Mexico. The next Phase (FY-00 to FY-06) will be performing risk reduction on evolving system elements as  
ell as incorporating advanced methods of integration and control of TAMD engagements in the littorals.

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Budget Item Justification  
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FY 2000 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

UDGET ACTIVITY: 3 PROGRAM ELEMENT: 0603238N  
PROGRAM ELEMENT TITLE: Global Surveillance/  
Precision Strike and Air  
Defense Technology

PROJECT NUMBER: R2145  
PROJECT TITLE: Global Surveillance/  
Precision Strike and Air  
Defense Technology

(1). The CMD Phase I "Mountain Top" ACTD (completed January 1996) demonstrated that an AEGIS ship (or other surface/round based missile launch platform), using one or more surrogate airborne sensor partners and Cooperative Engagement capability, can provide greatly expanded air defense capability to engage air targets beyond the surface/ground based radar line of sight.

(2). The CMD Phase II program aligned technology for the advanced E-2C Airborne Early Warning (AEW) radar system and STANDARD Missile programs leading to a fielded CMD capability. It balances cost, schedule, and risk across multiple echnology programs, while initiating advanced missile technology efforts to develop and demonstrate engagement capabilities against next generation cruise missiles and all other air threats.

(3). The Phase III program focuses technology associated with the full "system of systems" which will lead to Future Naval capability in Missile Defense. It will optimize the performance of science and technology products to detect, identify, reform fire control, and intercept CM, TBM, and other theater air threats through the use of risk reduction and integrating tools which are compatible with Navy, Joint Service and International TAMD systems. Included in this program are projects involving: electronically scanned array and infrared (IR) technology for airborne surveillance; methods of building Combat identification confidence through a distributed network and automation of Theater-level orders from Commanders directly to shooters"; electronically scanned array technology for missile application and advanced warhead technology for enhanced lethality.

## U) PROGRAM ACCOMPLISHMENTS AND PLANS:

- . (U) FY 1999 ACCOMPLISHMENTS:
- (U) Precision Strike
- (U) Direct Attack Munition Affordable Seeker (DAMASK):
- (U) Continued:
- (U) Fabrication and bench test of seeker and signal processor; evaluate simulation of terminal guidance algorithm.

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Budget Item Justification  
(Exhibit R-2 Page 9 of 19)

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FY 2000 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603238N

PROGRAM ELEMENT TITLE: Global Surveillance/  
Precision Strike and Air  
Defense Technology

PROJECT NUMBER: R2145

PROJECT TITLE: Global Surveillance/  
Precision Strike and Air  
Defense Technology

- (U) ELB
  - (U) Continued:
    - (U) Strike weapon control integration (Ring of Fire).
    - (U) Common tactical picture.
    - (U) Airspace Four Dimensional (4D) deconfliction.
    - (U) Conduct Major System Demonstrations (MSD) I.
  - (U) Initiated:
    - (U) Command and Control (C2) demonstration hardware and software upgrades to support MSD I.
    - (U) Field testing of Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance (C4ISR) system.
    - (U) Identification, preparation and support of residual technology for retention and further evaluation by the operating forces.
- (U) TAMD
  - (U) CMD Phase II
    - (U) Continued:
      - (U) Test planning for Makaha Ridge Facility 99 (MRF 99).
      - (U) Design, development, integration and planning efforts for the Phase II demonstration to support extended horizon engagement of cruise missiles.
      - (U) Advanced missile fuze and seeker technology development and surveillance upgrades targeting captive flight testing beyond FY 2000.
    - (U) Initiated:
      - (U) MRF 99 critical experiments/demonstration.
      - (U) Affordability focused development and demonstrations to reduce cost of technology transition and evaluate system interoperability; e.g. airborne system with interceptor.

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Budget Item Justification  
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FY 2000 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

UDGET ACTIVITY: 3 PROGRAM ELEMENT: 0603238N PROJECT NUMBER: R2145  
PROGRAM ELEMENT TITLE: Global Surveillance/  
Precision Strike and Air Defense Technology PROJECT TITLE: Global Surveillance/  
Precision Strike and Air Defense Technology

- (U) MRF 99 critical experiments/demonstration of government computer programs and contractor hardware (IRAD) which will transition to the Navy E-2C RMP.
- (U) Mobile Offshore Base (MOB)
  - (U) Completed:
  - (U) Initial assessment showing: (a) the feasibility of the MOB requirements, (b) MOB program could contribute to the ability to design large ships and other large floating structures.

#### (U) Classified Programs:

- (U) Advanced Surface Situational Awareness (ASSA): Initiated classified program.
- (U) High Powered Microwave: Initiated classified program.

#### (U) FY 2000 PLANS:

- (U) Precision Strike
  - (U) Initiate:
  - (U) Forward Air Support Marine (FASM):
  - (U) Effort to develop an expendable, gun-launched munitions capable of direct fire support, surveillance and targeting.
- (U) Development of operational concepts for deployment and perform design trade-off of airframe/engine configuration.
- (U) Complete:
- (U) DAMASK:
- (U) Complete efforts: conduct F/A-18 captive carry and free flight tests.

- (U) ELB:
  - (U) Continue:
  - (U) Strike weapons integration (Ring of Fire).

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Budget Item Justification  
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FY 2000 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

UDGET ACTIVITY: 3 PROGRAM ELEMENT: 0603238N  
PROGRAM ELEMENT TITLE: Global Surveillance/  
Precision Strike and Air  
Defense Technology

PROJECT NUMBER: R2145  
PROJECT TITLE: Global Surveillance/  
Precision Strike and Air  
Defense Technology

- (U) Common tactical picture.
  - (U) Airspace 4D deconfliction.
  - (U) Systems engineering and integration.
  - (U) Identification, preparation and support of residual technology from MSD I for retention and further evaluation by the operating forces.
- (U) Initiate:
- (U) Planning for full scale MSD in FY01.
  - (U) C2 demonstration hardware and software upgrades.
  - (U) Field testing of C4ISR systems.

(U) TAMM

- (U) Initiate:
- (U) CCI efforts to associate identification attributes to real-time air tracks and pass them over a surrogate Joint Composite Tracking Network for the purpose of development of distributed Combat Identification of "positive-hostile".
  - (U) Distributed Weapons Control (DWC) automated distributed engagement planning and tactical decision aid development intended to provide real-time sensor-to-shooter pairing and weapon selection recommendations based upon Theater Wide Single Integrated Air Picture.
  - (U) Multifunction Infrared Distributed Aperture System (MIDAS) program, which involves a passive infrared sensor system concept for tactical aircraft, and surface combatants exploiting recent rapid advances in infrared sensor and high speed digital image processing technologies.
  - (U) Ultra High Frequency (UHF) Electronically Scanned Array (UESA) effort, which will demonstrate a non-rotating electronically-scanning UHF surveillance radar antenna with a 360 field of regard to be demonstrated in FY02 at Pacific Missile Range Facility (PMRF) in Hawaii.
- (U) Continue:
- (U) Critical CMD risk reduction efforts leading to full Navy AEW airborne system demonstration in conjunction with demonstration exercises FY02/03.
- (U) Complete:

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Budget Item Justification  
(Exhibit R-2 Page 12 of 19)

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FY 2000 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

UDGET ACTIVITY: 3      PROGRAM ELEMENT: 0603238N      PROJECT NUMBER: R2145  
PROGRAM ELEMENT TITLE: Global Surveillance/  
Precision Strike and Air      Precision Strike and Air  
Defense Technology      Defense Technology

- (U) Analysis of technical data from MRF-99 critical experiments/demonstration, identifying elements to be included in Missile Defense Future Naval Capability initiative.

## (U) Classified Programs

- (U) ASSA: Continue classified program.
- (U) High Power Microwave: Continue classified program
- (U) Retract Cypress: Initiate classified program.
- (U) Claymore Marine: Initiate classified program.

## (U) FY 2001 PLANS:

- (U) Precision Strike
- (U) Continue:
  - (U) FASM:
  - (U) Effort to develop an expendable, gun-launched munition capable of direct fire support, surveillance and targeting.
  - (U) Development operational concepts for deployment and perform design trade-offs of airframe/engine configuration.

## (U) ELB

- (U) Continue:
  - (U) C2 demonstration hardware and software for MSD II.
  - (U) Conduct MSD II
  - (U) Conduct military utility assessment of MSD II

## (U) Initiate

- (U) Planning for residual support

## (U) TAMD

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FY 2000 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

UDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603238N

PROGRAM ELEMENT TITLE: Global Surveillance/  
Precision Strike and Air  
Defense Technology

PROJECT NUMBER: R2145

PROJECT TITLE: Global Surveillance/  
Precision Strike and Air  
Defense Technology

- (U) Continue:
- (U) Critical risk reduction efforts leading to full Navy AEW airborne system demonstration in conjunction with demonstration exercises FY-02/03
  - (U) System interface development and demonstration planning for Missile Defense Future Naval Capability to be conducted in the FY-02 and beyond timeframe.
  - (U) Composite Combat Identification efforts to associate identification attributes to real-time air tracks and pass them over a surrogate Joint Composite Tracking Network for the purpose of development of distributed Combat Identification of "positive- hostile".
  - (U) DWC automated distributed engagement planning and tactical decision aid development intended to provide real-time sensor-to-shooter pairing and weapon selection recommendations based upon Theater Wide Single Integrated Air Picture.
  - (U) MIDAS program, which involves a passive infrared sensor system concept for tactical aircraft, and surface combatants exploiting recent rapid advances in infrared sensor and high speed digital image processing technologies.
  - (U) UESA effort, which will demonstrate a non-rotating electronically scanning UHF surveillance radar antenna with a 360 field of regard in FY-02 at PMRF in Hawaii.
  - (U) Initiate:
    - (U) IR Search and Track program for multi-spectral detection and tracking of all airborne targets.
    - (U) Multi-source Integration program for all RF, IR, ESM and satellite data tracks.
    - (U) Seeker/Fuze program to develop an advanced seeker with integrated fusing.

## (U) Classified Programs

- (U) ASSA: Complete classified program.
- (U) High Power Microwave: Complete classified program.
- (U) Retract Cypress: Complete classified program.
- (U) Claymore Marine: Continue classified program.

(U) PROGRAM CHANGE SUMMARY: See total program change summary for P.E.

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FY 2000 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

UDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603238N

PROJECT NUMBER: R2145

PROGRAM ELEMENT TITLE: Global Surveillance/  
Precision Strike and Air  
Defense Technology

PROJECT TITLE: Global Surveillance/  
Precision Strike and Air  
Defense Technology

(U) OTHER PROGRAM FUNDING SUMMARY: Not applicable.

(U) RELATED RDT&E:

(U) PE 0203801A (Missile/Air Defense Product Improvement Program)  
(U) PE 0204152N (E-2 Squadrons)  
(U) PE 0207163F (Advanced Medium Range Air-to-Air Missile (AMRAAM))  
(U) PE 0207417F (Airborne Warning and Control System (AWACS))  
(U) PE 0601153N (Defense Research Sciences)  
(U) PE 0602111N (Air and Surface Launched Weapons Technology)  
(U) PE 0602121N (Ship, Submarine & Logistics Technology)  
(U) PE 0602122N (Aircraft Technology)  
(U) PE 0602232N (Communications, Command & Control, Intelligence, Surveillance & Reconnaissance (C3ISR))  
(U) PE 0602233N (Human Systems Technology)  
(U) PE 0602234N (Materials, Electronic and Computer Technology)  
(U) PE 0602314N (Undersea Warfare Surveillance Technology)  
(U) PE 0602435N (Oceanographic & Atmospheric Technology)  
(U) PE 0602633N (Undersea Warfare Weapon Technology)  
(U) PE 0603006A (C3 Advanced Technology)  
(U) PE 0603226E (Experimental Evaluation of Innovative Technologies)  
(U) PE 0603238F (Air Defense/Precision Strike Technology Demo)  
(U) PE 0603245F (Advanced Flight Technology Integration)  
(U) PE 0603270N (Advanced Electronic Warfare Technology)  
(U) PE 0603401F (Advanced Spacecraft Technology)  
(U) PE 0603563N (Ship Concept Advanced Design)  
(U) PE 0603601F (Conventional Weapons Technology)  
(U) PE 0603609N (Conventional Munitions)  
(U) PE 0603726F (C3I Subsystem Integration)

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FY 2000 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

UDGET ACTIVITY: 3      PROGRAM ELEMENT: 0603238N      PROJECT NUMBER: R2145  
PROGRAM ELEMENT TITLE: Global Surveillance/  
Precision Strike and Air      Defense Technology      PROJECT TITLE: Global Surveillance/  
Defense Technology      Precision Strike and Air      Defense Technology

- (U) PE 0603755N (Ship Self Defense)
- (U) PE 0603772A (Advanced Tactical Computer Science and Sensor Technology)
- (U) PE 0603794N (C3 Advanced Technology)
- (U) PE 0604366N (Standard Missile Improvements)
- (U) PE 0604770F (Joint Surveillance/Target Attack Radar Systems (JSTARS))
- (U) PE 0604866C (Patriot Risk Reduction Mitigation)

. (U) SCHEDULE PROFILE: Not applicable.

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FY 2000 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

UDGET ACTIVITY: 3      PROGRAM ELEMENT: 0603238N  
 PROGRAM ELEMENT TITLE: Global Surveillance/Precision Strike and Air Defense Technology  
 U) COST: (Dollars in Thousands)

ROJECT UMBER/ ITILE	FY 1999 ACTUAL	FY 2000 ESTIMATE	FY 2001 ESTIMATE	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	TO COMPLETE	TOTAL PROGRAM
0834 Naval Science Assistance Program (NSAP)	4,806	4,688	4,775	4,943	4,841	4,821	4,783	CONT.	CONT.

(U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION:  
 This program enables Science and Technology (S&T) to be moved to the operational Fleet/Force rapidly, leverages long-term S&T investments to meet operational capability needs, and provides a method for the Research Development Test and Evaluation (RDT&E) community to surge in response to real world crises. The program accomplishes this through several methods. It provides on the spot Science and Technology Advisors (STAs) and Representatives (STRs) to Joint, Navy, and Marine Corps operational and strategic planning commands worldwide. It also develops a compendium of mature technologies, not yet in the acquisition portfolio, for Fleet/Force Commander early evaluation and concurrent development of new tactics and operational concepts. In addition, NSAP facilitates and disseminates the Command Capability Issues (CCIs) provided by the Fleet/Force commanders to the Director of Navy Test and Evaluation and Technology Requirements (OPNAV N091). Lastly, NSAP collaborates with the Fleet/Force to identify specific solutions to known operational capability needs and provides the means to develop and demonstrate prototype systems. The result is that NSAP provides insight into issues associated with Naval Warfighting capabilities, thereby influencing long term S&T programs. The program also develops a cadre of civilian scientists and engineers who, upon completion of their NSAP STA/STR tours, return to the Naval technical community with first hand knowledge of the Fleet/Force and warfighting issues. NSAP enables a continuous collaboration between the warfighters, the technical community, and strategic development commands.

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

UDGET ACTIVITY: 3 PROGRAM ELEMENT: 0603238N  
PROGRAM ELEMENT TITLE: Global Surveillance/  
Precision Strike and Air  
Defense Technology

PROJECT NUMBER: R0834  
PROJECT TITLE: Naval Science  
Assistance Program

## U) PROGRAM ACCOMPLISHMENTS AND PLANS;

### . (U) FY 1999 ACCOMPLISHMENTS:

(U) NSAP facilitated and disseminated the CCIs that were provided by the Fleet/Force Commanders to OPNAV N091. It developed the Office of Naval Research's "Technologies for Rapid Response" (Blue Book), a compendium of mature technologies, not yet in the acquisition portfolio, for Fleet/Force Commander early evaluation and concurrent development of new tactics and operational concepts. It also leveraged a 15.5 man-year investment to provide 20 on the spot STAs and STRs to Joint, Navy, and Marine Corps operational and strategic planning Commands worldwide. These 20 STAs and STRs have gained experience working with high level decision-makers and operators to develop technologies for transition to the Fleet/Force. In addition, NSAP has collaborated with the Fleet/Force to identify specific solutions to known operational capability needs and provided the means to develop and demonstrate prototype systems. The program has helped move S&T to the operational Fleet/Force rapidly, leverage long-term S&T investments to meet operational Fleet/Force capability needs, and provide a method for the RDT&E community to surge in response to real world crises. Several of the technology insertions that were initiated in prior years were transitioned this year to operational use and acquisition programs.

### . (U) FY 2000 PLAN:

(U) Facilitate and disseminate the CCIs provided by the Fleet/Force Commanders to the OPNAV N091. Develop the Blue Book, a compendium of mature technologies, not yet in the acquisition portfolio, for Fleet/Force Commander early evaluation and concurrent development of new tactics and operational concepts. Leverage the investment to provide on the spot STAs and STRs to Joint, Navy, and Marine Corps operational and strategic planning Commands worldwide. Assist these STAs and STRs to obtain experience working with high-level decision-makers and operators to develop technologies for transition to the Fleet/Force. Collaborate with the Fleet/Force to identify specific solutions to known operational capability needs and provide the means to develop and demonstrate prototype systems. Help move S&T to the operational Fleet/Force rapidly, leverage long-term S&T investments to meet operational Fleet/Force capability needs, and provide a method for the RDT&E

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Budget Item Justification  
(Exhibit R-2 Page 18 of 19)

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

UDGET ACTIVITY: 3 PROGRAM ELEMENT: 0603238N  
PROGRAM ELEMENT TITLE: Global Surveillance/  
Precision Strike and Air  
Defense Technology

PROJECT NUMBER: R0834  
PROJECT TITLE: Naval Science  
Assistance Program

community to surge in response to real world crises. Transition the technology insertions that were initiated in prior years to operational use and acquisition programs.

. (U) FY 2001 PLANS:

(U) Facilitate and disseminate the CCIs provided by the Fleet/Force Commanders to the OPNAV N091. Develop the Blue Book, a compendium of mature technologies, not yet in the acquisition portfolio, for Fleet/Force Commander early evaluation and concurrent development of new tactics and operational concepts. Leverage the investment to provide on the spot STAs and STRS to Joint, Navy, and Marine Corps operational and strategic planning Commands worldwide. Assist these STAs and STRS to obtain experience working with high-level decision-makers and operators to develop technologies for transition to the Fleet/Force. Collaborate with the Fleet/Force to identify specific solutions to known operational capability needs and provide the means to develop and demonstrate prototype systems. Help move S&T to the operational Fleet/Force rapidly, leverage long-term S&T investments to meet operational Fleet/Force capability needs, and provide a method for the RDT&E community to surge in response to real world crises. Transition the technology insertions that were initiated in prior years to operational use and acquisition programs.

.PROGRAM CHANGE SUMMARY: See total program change summary for P.E.

.OTHER PROGRAM FUNDING SUMMARY: Not applicable.

U) RELATED RDT&E

U) SCHEDULE PROFILE: Not applicable.

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603270N

PROGRAM ELEMENT TITLE: Advanced Electronic Warfare Technology

(U) COST: (Dollars in Thousands)

PROJECT NUMBER & TITLE	FY 1999 ACTUAL	FY 2000 ESTIMATE	FY 2001 ESTIMATE	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	TO COMPLETE	TOTAL PROGRAM
E2194 Electronic Warfare Advanced Technology									
	9,562	10,302	8,988	9,441	9,475	9,468	9,368	CONT.	CONT.
R2090 Functional Recognition & Response	11,254	8,577	8,595	9,145	8,976	8,967	8,858	CONT.	CONT.
<b>TOTAL</b>	<b>20,816</b>	<b>18,879</b>	<b>17,583</b>	<b>18,586</b>	<b>18,451</b>	<b>18,435</b>	<b>18,226</b>	<b>CONT.</b>	<b>CONT.</b>

A. (U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION Advanced Electronic Warfare Technology (AEWT) is the Navy's continuing, core Advanced Technology Development program for Electronic Warfare (EW) and is oriented to demonstrate and transition EW technology in cooperation with the other Services, placing special emphasis on Naval EW applications of Command and Control Warfare. This program continues to develop technologies which support the effective employment of naval force capabilities in the conduct of the Navy's Joint Mission Areas as defined by the Chief of Naval Operations (CNO) (i.e., Strike, Littoral Warfare, Intelligence, Surveillance and Reconnaissance, Strategic Mobility, Readiness and Training). The program is managed at the Office of Naval Research (ONR) by the same office that directs Program Element (PE) 0602270N (Navy EW Technology) and provides the vast majority of projects to this program for demonstration and potential transition to full scale development. The ONR program manager is also a principal of the Director of Defense Research and Engineering (DDR&E) Technology Panel for EW that oversees and coordinates Tri-Service 6.2 & 6.3 EW programs. Consequently, this program is planned jointly in accordance with Defense Science and Technology Reliance agreements that allocate various EW disciplines and their attendant technology development responsibilities between the Army, Air Force and the Navy. As part of the Integrated Science and Technology EW Program, it is subject to the review and execution oversight of the DDR&E. AEWT is

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603270N

PROGRAM ELEMENT TITLE: Advanced Electronic Warfare Technology

responsive to CNO guidance and the Systems Commands, warfighting requirements and needs. It develops EW technologies to counter a broad range of electromagnetic threats and is linked to future joint warfighting capabilities of "maintaining near perfect real-time knowledge of the enemy.." and "to counter the threat of...cruise missiles to the Continental United States and deployed forces." This program is a primary technology feed for the newly established Platform Protection IPT to the ONR-091 Future Naval Capabilities initiative.

(U) The program transitions new technologies to tactical aircraft (TACAIR), low observable aircraft, surface EW platforms, and Pre-planned Product Improvement programs (P3I) to address the modern threat (including multi-spectral/multi-modal sensors and seekers). This is accomplished by improving threat detection, identification, location and response through developmental upgrades and direct, advanced technology insertions. Currently, AEWT consists of two projects:

(U) E2194 - Electronic Warfare Advanced Technology: This project is a core continuing effort that transitions high-payoff EW technologies to the Fleet and reduces the integration risk of advanced EW systems. Primary focus is on providing threat warning and countermeasures, particularly infrared countermeasures (IRCM) to TACAIR platforms.

(U) R2090 - Functional Recognition & Response: Develops algorithms and techniques to recognize emitters by measuring and analyzing their observable, radar function parameters and develops generic countermeasures techniques to provide protection against any hostile emitter. Uses non-developmental items or develops hardware (as required) to implement Functional Recognition demonstrations and assess overall operational improvement to extant capabilities.

(U) The Navy Science and Technology (S&T) program includes projects that focus on or have attributes that enhance the affordability of warfighting systems.

(U) JUSTIFICATION FOR BUDGET ACTIVITY: This program is budgeted within the ADVANCED TECHNOLOGY DEVELOPMENT Budget Activity because it encompasses design, development, simulation, or experimental testing or prototype hardware to validate technological feasibility and concept of operations and reduce technological risk prior to initiation of a new acquisition program or transition to an ongoing acquisition program.

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Budget Item Justification  
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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603270N

PROGRAM ELEMENT TITLE: Advanced Electronic Warfare Technology

## B. (U) PROGRAM CHANGE SUMMARY FOR TOTAL PE:

(U) FY 2000 President's Budget	FY 1999	FY 2000	FY 2001
(U) Appropriated Value	<u>18,093</u>	<u>18,984</u>	<u>18,429</u>
(U) Execution Adjustments	2,922	18,984	
(U) Congressional Rescissions		-105	-460
(U) Minor Program Adjustments			-386
(U) Various Rate Adjustments	-78		
(U) SBIR/STTR Transfer	-121		
(U) FY 2001 PRESBDG Submission	20,816	18,879	17,583

(U) CHANGE SUMMARY EXPLANATION:

(U) Schedule: Not applicable.

(U) Technical: Not applicable.

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Budget Item Justification  
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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603270N

PROGRAM ELEMENT TITLE: Advanced Electronic Warfare Technology

(U) COST: (Dollars in Thousands)

PROJECT NUMBER & TITLE	FY 1999 ACTUAL	FY 2000 ESTIMATE	FY 2001 ESTIMATE	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	TO COMPLETE	TOTAL PROGRAM
E2194 Electronic Warfare Advanced Technology	9,562	10,302	8,988	9,441	9,475	9,468	9,368	CONT	CONT

A. MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: The program transitions new technologies to Tactical Air (TACAIR), low observable aircraft, surface Electronic Warfare (EW) platforms, and Pre-planned Product Improvement programs, with emphasis on TACAIR, to address the modern threat (including multi-spectral/multi-modal sensors and seekers) by improving threat detection, identification, location and response through developmental upgrades and direct, advanced technology insertions.

(U) This project is a core continuing effort that transitions high-payoff EW technologies to the Fleet and reduces the integration risk of advanced EW systems. Primary focus is on providing threat warning and countermeasures, particularly infrared countermeasures (IRCM) to TACAIR platforms.

(U) PROGRAM ACCOMPLISHMENTS AND PLANS:

1. (U) FY 1999 ACCOMPLISHMENTS: During FY99 Electronic Warfare Advanced Technology (EWAT) continued to enhance survivability of tactical aircraft against threats operating in the infrared (IR) region of the spectrum. Advancements in threat countermeasure techniques drive research in IR countermeasure and warning technologies. Developing solutions for the EW suite requires exploitation of a variety of technologies resulting in

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603270N

PROJECT NUMBER: E2194

PROGRAM ELEMENT TITLE: Advanced Electronic Warfare Technology

PROJECT TITLE: Electronic Warfare Advanced

Technology

multiple tasks within the EWAT Project. Although EWAT's primary focus lies in IR warning and response, enhancements to radio frequency (RF) warning and self-protection are also being investigated. Projects currently ongoing that support the technology demonstrations that the EWAT team addresses are: Advanced IR Threat Countermeasures, Advanced Threat Analyses, Tactical Aircraft Directed IR Countermeasures, Integrated Laser and IR Threat Warning Concepts, Integration and Live Fire Demonstration, Advanced Graphical Display and Electronic Warfare Sensor Fusion, Advanced RF Threat Warning and Self-Protection, and Advanced Electronic Warfare Technical Research.

- (U) ADVANCED IR THREAT COUNTERMEASURES: Conducted and completed flight testing of advanced infrared countermeasures (IRCM) flare technologies for tactical fixed wing and rotary aircraft not scheduled to receive Advanced Strategic and Tactical Expendable (ASTE) decoys.
- (U) ADVANCED THREAT ANALYSES: Finalized studies on Symptom Ares. Began the analysis of the advanced Sensor Pantry air-to-air threat through hardware-in-the-loop testing of the threat system. Analyses from this focus area provide a defined and traceable specification of counter-measure (CM) requirements.
- (U) TACTICAL AIRCRAFT DIRECTED IR COUNTERMEASURES (TADIRCM): Performed laboratory, ground, and flight testing of the TADIRCM System in a pod on the EWAT QF-4 in preparation for a live fire demonstration.
- (U) INTEGRATED LASER AND IR THREAT WARNING CONCEPTS: Developed a co-located two color mid-wave IR focal plane array missile warning sensor and integrated a laser warning capability into the same form factor.
- (U) INTEGRATION AND LIVE FIRE DEMONSTRATION: Completed conversion of QF-4S to an EW aircraft test bed. Integrated pod version of TADIRCM into the QF-4S aircraft.
- (U) ADVANCED GRAPHIC DISPLAY AND ELECTRONIC WARFARE SENSOR FUSION Integrated the Advanced Graphical Display concept of the enemy's Launch Acceptability Region (LAR) into the F/A-18's head-up-display. Investigated advanced graphical presentations for development of a concept of sensor fusion hardware for TACAIR EW Systems.
- (U) ADVANCED RF THREAT WARNING AND SELF-PROTECTION: Conducted laboratory, ground, and flight tests of the wavelet transforms and Navy Integrated Antenna Down-converter (NIAD) antenna element and transitioned them to

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DATE: February 2000

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603270N

PROJECT NUMBER: E2194

PROGRAM ELEMENT TITLE: Advanced Electronic Warfare Technology

PROJECT TITLE: Electronic Warfare Advanced

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- the AN/ALR-67 (V)2 Upgrade program as a technology upgrade option. Initiated RF Towline conceptual study of Fiber-Optic Towed Decoy (FOTD).
- (U) ADVANCED ELECTRONIC WARFARE TECHNICAL RESEARCH: Conducted advanced EW technical research at the Naval Postgraduate School for next-generation EW warning and response for naval aviation.
  - (U) INVESTIGATION OF OPTIMUM LOGIC AND ALGORITHMS FOR AIRBORNE USE OF INSTANTANEOUS FREQUENCY MEASUREMENT RECEIVERS IN THE LOOK-THROUGH MODE. Upgraded algorithms of radar warning receiver (RWR) systems for sensitivity improvements, began prototype hardware in the loop testing and conducted laboratory demonstration.
2. (U) FY 2000 PLAN: The EWAT project will continue a strong focus in electro-optical (EO/IR) countermeasure technologies, however, the RF self-protection area will receive increased emphasis. Advancements in threat countermeasure techniques will continue to drive research in IR countermeasure and warning technologies. Although EWAT's main concentration is expected to remain in infrared EW technologies, advancements in RF wavelet processing for sensitivity improvements are projected to mature. EWAT will also demonstrate advanced graphical cockpit displays based on prior years research establishing situational awareness guidelines. Projected focus areas that support the technology demonstrations that the EWAT team addresses are: Advanced IR Threat Countermeasures, Advanced Threat Analyses, Tactical Aircraft Directed IR Countermeasures, Integrated Laser and IR Threat Warning Concepts, Integration and Live Fire Demonstration, Advanced Graphic Display and EW Sensor Fusion, Advanced RF Threat Warning and Self-Protection, and Advanced EW Technical Research.
- (U) ADVANCED IR THREAT COUNTERMEASURES: Optimize either the advanced tactical 6" expendable or the ASTE technology for low / slow aircraft not scheduled to receive ASTE expendables.
  - (U) ADVANCED THREAT ANALYSES: Complete the analysis of the advanced Sensor Pantry air-to-air threat. Initiate Sage Flat threat analysis. Execution of the analysis requires seeker acquisition so that hardware-in-the loop simulations can be performed.

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DATE: February 2000

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603270N

PROJECT NUMBER: E2194

PROGRAM ELEMENT TITLE: Advanced Electronic Warfare Technology

PROJECT TITLE: Electronic Warfare Advanced

Technology

- (U) TACTICAL AIRCRAFT DIRECTED INFRARED COUNTERMEASURES (TADIRCM): Complete Aerial Cable Car and podded TADIRCM system on a manned QF-4 against threat missile tests. Perform a live fire missile flight test of the TADIRCM system using an unmanned QF-4 aircraft with the TADIRCM pod installed.
- (U) INTEGRATED LASER AND IR THREAT WARNING CONCEPTS: Start feasibility & prototype development for long wave (LW) integration into 2 color IR technology. Work includes performing laboratory testing of the integrated electro-optical/infrared missile-warning concept.
- (U) INTEGRATION AND LIVE FIRE DEMONSTRATION: Support EO/IR/RF threat warning and countermeasures demonstrations through flight tests of advanced systems on the QF-4 EW test bed aircraft. Possibly flight test the advanced FOTD.
- (U) ADVANCED GRAPHIC DISPLAY AND ELECTRONIC WARFARE SENSON FUSION Continue interfacing with the fleet for improved situational awareness and use man-in-the-loop simulations to demonstrate the sensor fusion system in a laboratory environment.
- (U) ADVANCED RF THREAT WARNING AND SELF-PROTECTION: Continue research into RF self-protection for tactical aircraft including techniques to reduce radar warning receiver ambiguities and enhance angle-of-arrival determination and new RF applique techniques for ALR-67 (V2) & (V3). Continue NIAD development efforts. Initiate advanced RF towline technology development. Investigate the use of a Wavelets technology insertion into the Global Positioning System (GPS) in order to detect RF Jamming waveforms.
- (U) ADVANCED ELECTRONIC WARFARE TECHNICAL RESEARCH: Conduct advanced EW technical research at the Naval Postgraduate School for next-generation EW warning and response for naval aviation. Perform studies on aim point and the effect on IRCM Requirements.
- 3. (U) FY 2001 PLAN: The EWAT project will continue a strong focus in EO/IR countermeasure technologies. In addition, work will be done to evaluate combining LW, IR, and RF technologies into a single warning sensor. The RF self-protection area will also receive increased emphasis. Advancements in threat counter-countermeasure techniques will continue to drive research in IR countermeasure and warning technologies. Although EWAT's main concentration is expected to remain in infrared EW technologies, advancements in RF applique signal processing for sensitivity

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DATE: February 2000

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603270N

PROJECT NUMBER: E2194  
PROJECT TITLE: Electronic Warfare  
Advanced

PROGRAM ELEMENT TITLE: Advanced Electronic  
Warfare Technology

Technology

improvements are projected to mature. EWAT will also demonstrate advanced graphical cockpit displays based on prior year's research establishing situational awareness guidelines. Projected focus areas that support the technology demonstrations that the EWAT team addresses are: Advanced IR Threat Countermeasures, Advanced Threat Analyses, Tactical Aircraft Directed IR Countermeasures, Integrated Laser and IR Threat Warning Concepts, Integration and Live Fire Demonstration, Advanced Graphic Display and EW Sensor Fusion, Advanced RF Threat Warning and Self-Protection, and Advanced EW Technical Research.

- (U) ADVANCED IR THREAT COUNTERMEASURES: Ground and flight test the optimized 6" expendable for low / slow aircraft not scheduled to receive ASTE expendables.
- (U) ADVANCED THREAT ANALYSES: Complete the analysis of the Sage Flat surface-to-air threat. Initiate a Sage Flat follow-on threat analysis. Execution of the analysis requires seeker acquisition so that hardware-in-the-loop simulations can be performed. Procure a missile asset for exploitation.
- (U) TACTICAL AIRCRAFT DIRECTED INFRARED COUNTERMEASURES (TADIRCM): Complete the live fire missile flight test of the TADIRCM System using an unmanned QF-4 aircraft with the TADIRCM pod installed and begin testing the integration of LW technology in the 2 color IR warning sensor.
- (U) INTEGRATED LASER AND IR THREAT WARNING CONCEPTS: Complete prototype development for LW integration into 2 color IR technology. Work includes performing laboratory, ground, and flight testing of the integrated electro-optical/infrared missile-warning concept.
- (U) INTEGRATION AND LIVE FIRE DEMONSTRATION: Support EO/IR/RF threat warning and countermeasures demonstrations through flight tests of advanced systems on the QF-4 EW test bed aircraft. Possibly flight test the advanced RF towline technology.
- (U) ADVANCED GRAPHIC DISPLAY AND ELECTRONIC WARFARE SENSOR FUSION Continue interfacing with the fleet for improved situational awareness and use man-in-the-loop simulations to demonstrate the sensor fusion system in a laboratory environment.
- (U) ADVANCED RF THREAT WARNING AND SELF-PROTECTION: Continue research into RF self-protection for tactical aircraft including techniques to reduce radar warning receiver ambiguities and enhances angle-of-arrival

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DATE: February 2000

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603270N

PROJECT NUMBER: E2194

PROGRAM ELEMENT TITLE: Advanced Electronic Warfare Technology

PROJECT TITLE: Electronic Warfare Advanced

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determination and new RF applique techniques for ALR-67 (V2) & (V3). Flight test the NIAD antennae and advanced towline technology. Conduct flight tests of an airborne GPS system augmented with Wavelets technology in order to determine the systems detection capability of RF jamming waveforms.

- (U) ADVANCED ELECTRONIC WARFARE TECHNICAL RESEARCH: Conduct advanced EW technical research at the Naval Postgraduate School for next-generation EW warning and response for naval aviation.

C. (U) OTHER PROGRAM FUNDING SUMMARY: Not applicable.

(U) RELATED RDT&E: This Program Element (PE) adheres to Defense Reliance Agreements on EW with oversight and coordination provided by the DDR&E and is associated with efforts that are being pursued under the following Army and Air Force PEs:

- (U) PE 0602204F (Aerospace Avionics)
- (U) PE 0602270A (Electronic Warfare Technology)
- (U) PE 0602270F (Electronic Warfare Technology)
- (U) PE 0603270A (Advanced Electronic Warfare Technology)
- (U) PE 0603270F (Advanced Electronic Technology)
- (U) PE 0602601F (Phillips Lab Exploratory Development)
- (U) PE 0603605F (Advanced Weapons Technology)
- (U) PE 0601153N (Defense Research Sciences)
- (U) PE 0602234N (Materials, Electronics and Computer Technology)
- (U) PE 0602270N (Electronic Warfare Technology)
- (U) PE 0603217N (Air Systems and Weapons Advanced Technology)
- (U) PE 0603792N (Advanced Technology Transition)
- (U) PE 0604270N (EW Development)

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603270N

PROJECT NUMBER: E2194  
PROJECT TITLE: Electronic Warfare  
Advanced

PROGRAM ELEMENT TITLE: Advanced Electronic  
Warfare Technology

Technology

D. SCHEDULE PROFILE: Not applicable.

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603270N

PROGRAM ELEMENT TITLE: Advanced Electronic Warfare Technology

(U) COST: (Dollars in Thousands)

PROJECT NUMBER & TITLE	ACTUAL	FY 1999 ACTUAL	FY 2000 ESTIMATE	FY 2001 ESTIMATE	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	TO COMPLETE	TOTAL PROGRAM
R2090 Functional Recognition & Response		11,254	8,577	8,595	9,145	8,976	8,967	8,858	CONT.	CONT.

A. (U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: This project develops and demonstrates countermeasures to previously unknown threat systems which may be encountered for the first time during hostilities. Threat systems include anti-ship missile seekers, surface-to-air guidance systems, aircraft intercept radars, and ship surveillance and targeting systems. The Specific Emitter Identification (SEI) technology developed in this program significantly enhances the ability to quickly and accurately perform Combat Identification (ID) and support the Joint Mission Areas as defined by the Chief of Naval Operations (i.e., Joint Strike, Intelligence, Surveillance and Reconnaissance, etc.). Existing Electronic Warfare (EW) warning and countermeasure systems will be modified with techniques demonstrated under this program that do not rely on specific parameters. The approach will demonstrate related technology developed in the EW technology base through field trials and at-sea demonstrations.

(U) PROGRAM ACCOMPLISHMENTS AND PLANS:

1. (U) FY 1999 ACCOMPLISHMENTS: This objective focused on developing and demonstrating detection, identification and electronic attack of previously unknown threat systems that may be encountered for the first time during hostilities. Threat systems include anti-ship missile seekers, surface-to-air guidance systems, aircraft intercept radars, and ship surveillance and targeting systems. After detection and classification, the project focused on generating generic responses that rapidly and effectively counter the threat. Existing EW warning systems were

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DATE: February 2000

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603270N

PROJECT NUMBER: R2090

Functional Recognition/  
Response

PROGRAM ELEMENT TITLE: Advanced Electronic

PROJECT TITLE:

Warfare Technology

modified with techniques demonstrated under this program that do not rely on previously known parameters. The approach demonstrated related technology developed in the EW technology base through field trials and at-sea demonstrations.

- (U) Demonstrated and transitioned optimal Functional ID architecture into the Navy's Advanced Integrated Electronic Warfare System (AIEWS).
- (U) Demonstrated and transitioned optimal Functional ID architecture into the Navy's EA-6B and for a potential follow-on aircraft.
- (U) Demonstrated Functional ID, SEI and generic countermeasures to support development of AIEWS.
- (U) Evaluated Canadian Naval Electronic Warfare System (CANEWS-2) receiver system and identification algorithms to determine usefulness for application in AIEWS.
- (U) Initiated system integration for the AN/UXX-3 (SEI Processor) and development for new Digital Signal Processing (DSP) codes against modern radar modulations
- (U) Fabricated and demonstrated flight ready 40 GHz fiber optic links for communication over tow line with either ALE-50 or future millimeter wave towed decoy.
- (U) Competed initial version of the Networked Real-time 2 dimensional/3 dimensional (2-D/3-D) display for use on Unix Silicon Graphics machines and Sun and Windows NT PC workstations. Initial version transitioned to multiple Navy users and revisions are continuing.
- (U) Demonstrated at sea a high power Advanced Multifunction Radio Frequency (AMRFS) Electronic Countermeasures Transmitter using modern phased array technology which can concurrently function as both a jammer and communications link.

2. (U) FY 2000 PLAN:

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603270N

PROJECT NUMBER: R2090

Functional Recognition/

PROGRAM ELEMENT TITLE: Advanced Electronic

PROJECT TITLE:

Warfare Technology

Response

- (U) FUNCTIONAL RECOGNITION: The SEI technology developed in this program significantly enhances the ability to quickly and accurately perform Combat ID and support the Joint Mission Areas as defined by the Chief of Naval Operations (i.e., Joint Strike, Intelligence, Surveillance and Reconnaissance, etc.).
  - (U) Provide system integration of the AN/UUX-3 (SEI Processor) into Increment 1 of the AIEWS, finalize improvements to existing DSP code, continue software partitioning and finalize re-hosting and integration with new DSPs, presenting Increment 1 with a capability of identifying specific emitters by radar signature, thus greatly enhancing the Combat ID of the system.
  - (U) Final report of this one-year effort will be provided to the AIEWS office. Technologies developed by Canada (CANEWS 2) can be applied to address improvements to the complex pulse train de-interleaving requirements of AIEWS, allowing for transition of these technologies coupled with the SEI processing capability providing enhanced pulse train analysis.
  - (U) Design and fabricate high speed digital receiver and refine algorithms for application of the Double Delta precision DF system addressing the requirement of precise Angle of Arrival (AOA) information in support of de-interleaving of multiple emitters, situational awareness, and directional countermeasures.
- (U) GENERIC RESPONSE: Existing Electronic Warfare countermeasures systems will be modified with techniques demonstrated under this program that do not rely on specific parameters.
  - (U) Modify existing Synthetic Aperture Radar (SAR) countermeasures development hardware by providing multiple transmit antennas and controls to address the problem posed by the advanced interferometric SAR radars and denying these systems surveillance and targeting capabilities against United States (US) forces.
  - (U) Develop multi-spectral techniques for airborne EW systems perform field tests with surrogate systems and commence integration into Millimeter Wave Countermeasures pod to provide naval aircraft with a capability against anti-air threats employing both microwave and millimeter wave frequencies.

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Budget Item Justification  
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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603270N

PROJECT NUMBER: R2090

Functional Recognition/  
Response

PROGRAM ELEMENT TITLE: Advanced Electronic

PROJECT TITLE:

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- (U) Fabricate a Millimeter Wave (MMW) Fiber Optic Towed Decoy (FOTD), integrate with an onboard techniques generator, and flight test against threat simulators demonstrating a capability in the MMW frequency range for application to tactical aircraft in addressing the MMW threat.
- (U) Develop self-adaptive Electronic Attack (EA) techniques employing Artificial Intelligence (AI) against the counter-surveillance and counter-targeting threats for introduction into Increment 2 (EA) of the AIEWS program.
- (U) Conduct proof of concept demonstrations of advanced High Band Photonic Beamforming network for the Advanced Multifunction Radio Frequency System (AMRFS).
- (U) EW EFFECTIVENESS: This objective is focused on developing hardware and software models/simulations which allows one to evaluate EW concepts, hardware, techniques and software. Representative scenarios in part or in total must be available. The type of tools required must be representative of the threat, which may include Low Probability of Intercept, selectable radar parameters, and sophisticated signal processing. These tools will be available for both laboratory and field tests.
  - (U) Model ownship monostatic clutter effects, bistatic clutter and assess the environmental effects on the SEI technology, thus providing an analysis of the expected real world performance of a sensitive, high precision DF, SEI capable Electronic Support (ES) sensor in the detection and identification of threats.
  - (U) Develop improved 2-D/3-D display graphics and interfaces to provide a visual playback of field tests and digital modeling for users to evaluate the tests results providing a better understanding of system effectiveness, in particular when unknown threats are encountered for the first time.

3. (U) FY 2001 PLAN:

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DATE: February 2000

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603270N

PROJECT NUMBER: R2090

Functional Recognition/

PROGRAM ELEMENT TITLE: Advanced Electronic

PROJECT TITLE:

Warfare Technology

Response

- (U) FUNCTIONAL RECOGNITION: The SEI technology developed in this program significantly enhances the ability to quickly and accurately perform Combat ID and support the Joint Mission Areas as defined by the Chief of Naval Operations.
  - (U) Demonstrate technologies that can support system integration of the AN/UUX-3 (SEI Processor) into the Engineering Development Model (EDM) of AIEWS, continue software partitioning and perform at-sea tests demonstrating a capability of identifying specific emitters by radar signature, thus greatly enhancing the Combat ID of the system.
  - (U) Develop the AN/UUX-4 next generation SEI processor, which will provide an advanced SEI technology refresh capability to combat systems and develop an integration approach for incorporating these technologies into operational systems.
  - (U) Integrate and field test the Double Delta precision Direction Finding (DF) system demonstrating the ability of meeting the requirement of precise AOA information in support of de-interleaving of multiple emitters, situational awareness, and directional countermeasures.
- (U) GENERIC RESPONSE: Existing Electronic Warfare countermeasures systems will be modified with techniques demonstrated under this program that do not rely on specific parameters.
  - (U) Field test modified SAR countermeasures development hardware against an Air Force surrogate system demonstrating the ability to deny information to the advanced interferometric SAR radars and denying these systems surveillance and targeting capabilities against US forces for introduction into Increment 2 (EA) of the AIEWS program.
  - (U) Complete development of a low cost Millimeter Wave Countermeasures pod to provide naval aircraft with a capability against anti-air threats employing both microwave and millimeter wave frequencies.
  - (U) During at-sea tests, demonstrate self-adaptive Electronic Attack (EA) techniques employing Artificial Intelligence (AI) against the counter-surveillance and counter-targeting threats for introduction into Increment 2 (EA) of the AIEWS program.

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Budget Item Justification  
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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603270N

PROJECT NUMBER: R2090

Functional Recognition/

PROGRAM ELEMENT TITLE: Advanced Electronic

PROJECT TITLE:

Warfare Technology

Response

- (U) Conduct laboratory and field trials against simulators or surrogates to determine effectiveness of the coherent EA techniques against the emerging coherent Anti-ship Missile (ASM) threats for application to Increment 2 (EA) of the AIEWS program.
- (U) Define and develop High Band Beamformer for AMRFS.
- (U) EW EFFECTIVENESS: This objective is focused on developing hardware and software models/simulations which allows one to evaluate EW concepts, hardware, techniques and software. Representative scenarios in part or in total must be available. The type of tools required must be representative of the threat, which may include low Probability of Intercept, selectable radar parameters, and sophisticated signal processing. These tools will be available for both laboratory and field tests.
- (U) Model multiple ownship emitters and combine with ownship monostatic clutter effects, bistatic clutter to assess the environmental effects on the SEI technology, thus providing an analysis of the expected real world performance of a sensitive, high precision DF, SEI capable ES sensor in the detection and identification of threats.
- (U) Demonstrate network playback capability during fleet exercises and transition to Navy test ranges for users to evaluate the tests results providing a better understanding of system effectiveness, in particular when unknown threats are encountered for the first time.

C. (U) OTHER PROGRAM FUNDING SUMMARY: Not applicable.

(U) RELATED RDT&E PROGRAMS: This PE adheres to Defense Reliance Agreements on EW with oversight and coordination provided by the DDR&E and is associated with efforts that are being pursued under the following Army and Air Force PEs:

(U) PE 0602204F (Aerospace Avionics)

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DATE: February 2000

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603270N

PROJECT NUMBER: R2090

Functional Recognition/

PROGRAM ELEMENT TITLE: Advanced Electronic

PROJECT TITLE:

Warfare Technology

Response

(U) PE 0602270A (Electronic Warfare Technology)  
(U) PE 0603270A (Electronic Warfare Technology)  
(U) PE 0603270F (Electronic Combat Technology)  
(U) PE 0601153N (Defense Research Sciences)  
(U) PE 0602234N (Materials, Electronics and Computer Technology)  
(U) PE 0602270N (Electronic Warfare Technology)  
(U) PE 0603217N (Air Systems and Weapons Advanced Technology)  
(U) PE 0603792N (Advanced Technology Transition)  
(U) PE 0604270N (EW Development)

D. SCHEDULE PROFILE: Not applicable.

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 3      PROGRAM ELEMENT: 0603508N  
 PROJECT NUMBER & TITLE: Surface Ship & Submarine HM&E Advanced Technology

PROJECT NUMBER & TITLE	FY 1999 ACTUAL	FY 2000 ESTIMATE	FY 2001 ESTIMATE	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	TO COMPLETE	TOTAL PROGRAM
R2224 Ship and Submarine Hull, Mechanical and Electrical (HM&E) Advanced Technology	33,557	38,889	37,432	38,261	37,427	29,773	29,138	CONT.	CONT.
R2328 Project M	7,058	2,396	0	0	0	0	0	0	22,770
R2373 Composite Helicopter Hangar	4,856	4,973	0	0	0	0	0	0	19,320
R2488 Power Electronic Building Blocks	5,826	0	0	0	0	0	0	0	5,826
R2489 Power Node Control Centers	1,942	2,984	0	0	0	0	0	0	4,926
R2705 Virtual Test Bed	0	4,973	0	0	0	0	0	0	4,973
R2706 Project M	0	4,973	0	0	0	0	0	0	4,973
R2707 Reconfig. Ship Simulation	0	1,989	0	0	0	0	0	0	1,989
R2708 Electromagnetic Propulsion Systems	0	2,984	0	0	0	0	0	0	2,984

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DATE: February 2000

BUDGET ACTIVITY: 3      PROGRAM ELEMENT: 0603508N  
 PROGRAM ELEMENT TITLE: Surface Ship & Submarine HM&E Advanced Technology

PROJECT NUMBER & TITLE	FY 1999 ACTUAL	FY 2000 ESTIMATE	FY 2001 ESTIMATE	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	TO COMPLETE	TOTAL PROGRAM
R2709 High Temperature Superconducting Synchronous Motor	0	1,989	0	0	0	0	0	0	1,989
R2710 Permanent Magnet Motor	0	4,973	0	0	0	0	0	0	4,973
R2711 Superconducting DC Motor	0	4,973	0	0	0	0	0	0	4,973
<b>TOTAL</b>	<b>53,239</b>	<b>76,096</b>	<b>37,432</b>	<b>38,261</b>	<b>37,427</b>	<b>29,773</b>	<b>29,138</b>	<b>CONT.</b>	<b>4,973 CONT.</b>

**A. MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION:** This program element (PE) provides for the continued development of affordable surface ship and submarine hull, mechanical, and electrical system core technology demonstrations that contribute to meeting top joint warfare capabilities established by the Joint Chiefs of Staff; namely, to promptly engage regional forces in decisive combat on a global level.

In FY 2001, there is one active project: Ship and Submarine HM&E Advanced Technology (R2224). Products from this PE will improve the effectiveness and operational efficiency of all Navy ship and submarine platforms in all Joint Mission Areas. Affordability is addressed through large-scale demonstrations and validation of concepts that reduce costs associated with design, fabrication, outfitting, maintenance, and operation. All naval platforms inherently require mobility, efficiency, reliability, and availability as primary requirements for Naval Warfare. This program directly supports the Readiness and Support and Infrastructure Joint Mission Areas in the area of sustainability and supports Strike, Littoral Warfare, Joint Surveillance, Joint Surface Electronic Warfare, Strategic Deterrence, and Maritime Support for Land Forces, and Strategic Sealift relative to reduced signatures and increased survivability.

The Navy S&T program includes projects that focus on or have attributes that enhance the affordability of warfighting systems.

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Budget Item Justification  
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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603508N

PROGRAM ELEMENT TITLE: Surface Ship & Submarine HM&E Advanced Technology

JUSTIFICATION FOR BUDGET ACTIVITY: This program is budgeted within the ADVANCED TECHNOLOGY DEVELOPMENT Budget Activity 3 because it encompasses development, simulation, or experimental testing of prototype hardware to validate technological feasibility and/or concept of operations and to reduce technological risk prior to initiation of a new acquisition program or transition to an ongoing acquisition program.

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Budget Item Justification  
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DATE: February 2000

FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

BUDGET ACTIVITY: 3      PROGRAM ELEMENT: 0603508N  
 PROGRAM ELEMENT TITLE: Surface Ship & Submarine HM&E Advanced Technology

	<u>FY 1999</u>	<u>FY 2000</u>	<u>FY 2001</u>
PROGRAM CHANGE FOR TOTAL P.E.:			
FY 2000 President's Budget:	52,889	41,515	35,353
Appropriated Value:	-	76,515	-
Adjustments from FY 2000 PRESBUD:			
Execution Adjustments:	1,192	0	0
SBIR/STTR Transfers:	-842	0	0
Program Adjustments:	0	0	2,379
Congressional Plus-ups	0	35,000	0
Various Rate Adjustments:	0	0	-300
Congressional Recission:	0	-419	0
FY 2001 PRESBUDG Submission:	53,239	76,096	37,432

CHANGE SUMMARY EXPLANATION:

- Schedule: Not applicable.
- Technical: Not applicable.

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Budget Item Justification  
(Exhibit R-2, Page 4 of 13)

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603508N

PROGRAM ELEMENT TITLE: Surface Ship & Submarine HM&E Advanced Technology

COST: (Dollars in Thousands)

PROJECT NUMBER & TITLE	FY 1999 ESTIMATE	FY 2000 ESTIMATE	FY 2001 ESTIMATE	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	TO COMPLETE	TOTAL PROGRAM
R2224 Ship and Submarine Hull, Mechanical and Electrical (HM&E) Advanced Technology	33,557	38,889	37,432	38,261	37,427	29,773	29,138	CONT.	CONT.

A. MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: Project R2224 develops and demonstrates technological improvements for Ship and Submarine Hull, Mechanical, and Electrical (HM&E) systems in support of present and future surface ship and submarine platforms. This project demonstrates technology that has been explored for system feasibility at the applied research level, primarily in PE 0602121N, and focuses on system level development and demonstration for transition to higher budget category funding, or acquisition programs. Thus, this project is a continuing effort that demonstrates system technology to improve overall platform performance (stealth, affordability, survivability, mobility, efficiency, reliability and availability) and reduces maintenance, overhaul, and life cycle costs. Areas of current technology development and demonstration are Automation to Reduce Manning (ARM), Ship/Submarine Hull Systems (SSHS), and Advanced Electrical Systems (AES).

ARM technology develops sensing, control, actuation and decision making technology to enable reduction in manning for future ships and submarines. This effort is currently focused on Damage Control Automation to Reduce Manning (DCARM) and Affordable Interfaces for Optimal Manning on the family of 21st century combatants (SC21 Manning). DCARM is transitioning automated damage control technology options for SC21 and CVX. DCARM technology will be demonstrated in a series of system tests culminating in a final integrated demonstration of a survivable HM&E damage control system. SC21 Manning will demonstrate at least 50% manning reduction in surface ship combat systems through human-centered systems engineering and advanced watchstation design for the new destroyer class of surface combatants (DD21). The Integrated Engineering Plant (IEP) Demonstration will begin in FY 2001 and continue the ARM initiative into the operational areas of the ship propulsion

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Budget Item Justification  
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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603508N

PROJECT NUMBER: R2224

PROGRAM ELEMENT TITLE: Surface Ship & Submarine  
HM&E Advanced Technology

PROJECT TITLE: Ship & Submarine  
HM&E Advanced Technology

and auxiliary systems by developing, assessing and demonstrating architectures and technologies conducive to reducing operational workload.

SSHS develops and demonstrates system level technology from a multi-disciplinary approach; the Advanced Machinery Support Structures (AMSS) effort is focused on modular structures for submarine machinery spaces, to demonstrate a unified system that controls shock, acoustic vibration, and radiated noise. This technology enables use of affordable modular construction and commercial-off-the-shelf equipment. The Advanced Topside Systems (ATS) effort will demonstrate general ship topside technologies for future ship classes.

Advanced Electrical Systems (AES) demonstrates technology that will provide the fleet with: 1) Ship Service Fuel Cells (SSFC) — As an affordable alternative electrical source for ship service power, this technology addresses improvements in power density, fuel consumption, manning requirements, quiet operation, and emissions. Emphasis is placed on leveraging commercial fuel cell technology and solving Navy issues such as operation in salt-laden air, shipboard shock and vibration, and reforming diesel fuel. 2) Quiet Electric Drive (QED) technology for passive and active suppression of acoustic and electrical noise associated with electric motors — This technology is focused on submarine applications and enables cost savings, improved quieting and radically new arrangements of propulsion and auxiliary machinery. 3) Advanced Electrical Distribution (AED) to enable an electrically reconfigurable ship to have a survivable fight-through capability for all electrical shipboard systems during battle — This technology will contain intelligent electric power control modules, thereby creating a new paradigm in power network architectures and system control well beyond conventional capability. It will provide automatic, reconfigurable electric power distribution systems that are redundant, survivable, and reliable, with high quality power for ships and submarines. Solid State Switching Applications (SSSA) integrate Power Electronic Building Blocks (PEBB) into each of the above electrical technology demonstrations and provide the key undergirding technology for AES. This technology demonstrates the form, fit, and function of universal PEBB modules in shipboard system applications such as circuit breakers, current limiters, inverters, converters, motor controllers, etc. This multi-functional software controlled modular design reduces the size, cost and weight of all electrical systems.

## PROGRAM ACCOMPLISHMENT AND PLANS:

1. FY 1999 ACCOMPLISHMENTS:

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Budget Item Justification  
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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603508N

PROJECT NUMBER: R2224

PROGRAM ELEMENT TITLE: Surface Ship & Submarine  
HM&E Advanced Technology

PROJECT TITLE: Ship & Submarine  
HM&E Advanced Technology

## AUTOMATION TO REDUCE MANNING: INITIATED:

- Preparation for remote manual demonstration with 60% damage control manning reduction. (DCARM)
- Development and optimization of water mist distribution controls. (DCARM)

## CONTINUED:

- Sensor evaluation to verify performance and environmental acceptability for automated ship damage control systems. (DCARM)
- Development and programming of supervisory control processor for the automated ship damage control system. (DCARM)
- Development and installation of integrated control topology for damage control. (DCARM)
- Validation of initial fire suppression water mist system. (DCARM)
- Development of systems engineering tool set for human centric systems. (SC21 Manning)
- Development and evaluation of human-system performance metrics and predictive engineering models of combat systems decision-makers in warfighting scenarios. (SC21 Manning)
- Development of Multi-Modal Watchstation team designs for DD21 warfighting missions. (SC21 Manning)

## COMPLETED:

- Final Demonstration of 3-man Multi-Modal Watchstation team performance for current generation of surface combatants (AEGIS) Strike scenarios. (SC21 Manning)
- Fire parameter and alarm algorithms for a multi-criteria fire detection system. (DCARM)

## ADVANCED ELECTRICAL SYSTEMS:

### INITIATED:

- Application of 3D models for electric motor magnetic fields. (QED)
- Development of active control techniques for electric motors. (QED)
- Aircraft Electrical Servicing Station demonstration using programmable Power Electronic Build Blocks (PEBB) and Power Node Control Center technologies. (SSSA)
- Design reconfiguration demonstration electrical zone. (AED)

### TRANSITIONED:

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603508N

PROJECT NUMBER: R2224

PROGRAM ELEMENT TITLE: Surface Ship & Submarine  
HM&E Advanced Technology

PROJECT TITLE: Ship & Submarine  
HM&E Advanced Technology

- Power Node Control Center technologies for Integrated Power System applications. (AED)
- PEBB-based Power Control Modules for Integrated Power System Applications. (SSSA)  
CONTINUED:
- Design of a 500KW sub-scale demonstration model of the reformed diesel-fuel cell system. (SSFC)
- Development of electric motor acoustic prediction capability. (QED)
- Development/selection of critical component technology for intermediate-scale Quiet Electric Drive demonstration. (QED)
- Demonstration of key equipment capabilities for the Electrically Reconfigurable Ship. (AED)
- Demonstration of physical and computational electrical network system simulations. (AED)  
COMPLETED:
- Demonstration of prototype self-synthesizing, dynamically reconfigurable electric distribution systems. (AED)
- Ship Service Fuel Cell power system concept validation via numerical analysis, and testing of sub-scale articles. (SSFC)
- Multi-functional demonstration of second-generation PEBB modules for form and function. (SSSA)
- Demonstration of Power Controller Modules and Ship Service Inverter for Integrated Power System applications--key equipment capability for the Electrically Reconfigurable Ship demonstrations. (SSSA)
- Propulsion system concept studies. (QED)

## SHIP STRUCTURES AND HULL SYSTEMS: INITIATED:

- Design and demonstration of shock control features for Machinery Support Structure for in-water shock demonstrations. (AMSS)
- Preparation for in-water quarter-scale demonstration of Machinery Support Structure system concept for shock mitigation. (AMSS)
- Assessment of potential heavyweight Machinery Truss performance. (AMSS)
- Machinery flanking path component evaluation. (AMSS)

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Budget Item Justification  
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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603508N

PROJECT NUMBER: R2224

PROGRAM ELEMENT TITLE: Surface Ship & Submarine  
HM&E Advanced Technology

PROJECT TITLE: Ship & Submarine  
HM&E Advanced Technology

## CONTINUED:

- Evaluation of flexible truss and shock strengthening concepts on acoustic performance of truss. (AMSS)
  - Evaluation of coating system performance. (AMSS)
- ## COMPLETED:
- Measurement of impact of incomplete hull coating coverage. (AMSS)
  - Lightweight machinery truss acoustic performance evaluation. (AMSS)
  - Demonstration of next generation advanced mast test article for the LDP-17. (ATS)

2. FY 2000 PLAN:

## AUTOMATION TO REDUCE MANNING:

### INITIATE:

- Casualty response/system reconfiguration for reflexive fluid systems. (DCARM)

### CONTINUE:

- Sensor evaluation to verify performance and environmental acceptability for automated ship damage control systems. (DCARM)
- Installation of automated control topology for damage control. (DCARM)
- Development and programming of the supervisory control processor for the automated ship damage control system. (DCARM)
- Development of systems engineering tool set supporting design for humans as critical system elements. (SC21 Manning)

### COMPLETE:

- Water mist distribution controls. (DCARM)
- Hardware and software systems integration of fire protection systems. (DCARM)
- Casualty response/ system reconfiguration for reflexive fluid systems. (DCARM)
- Remote manual demonstration with 60% Damage Control Manning Reduction. (DCARM)

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Budget Item Justification  
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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603508N

PROJECT NUMBER: R2224

PROGRAM ELEMENT TITLE: Surface Ship & Submarine  
HM&E Advanced Technology

PROJECT TITLE: Ship & Submarine  
HM&E Advanced Technology

- Final Demonstration and evaluation of Multi-Modal Watchstation individual and team performance for DD21 warfighting missions. (SC21 Manning)

## ADVANCED ELECTRICAL SYSTEMS:

### INITIATE:

- Development of scale electric motors and controllers for demonstration. (QED)
- Demonstration of equipment capabilities using PEBB-3 technology. (AED)
- High Voltage Switch demonstration for dynamically reconfigurable power systems. (SSSA)
- High Energy System technologies for dynamically reconfigurable power systems. (AED)
- Fabrication of a 500KW sub-scale demonstration model of the reformed diesel-fuel cell system. (SSFC)

### CONTINUE:

- Demonstration of key system capabilities for the Electrically Reconfigurable Ship. (AED)
  - Aircraft Electrical Servicing Station demonstration using programmable PEBB and Power Node Control Center technologies. (SSSA)
  - Design reconfiguration demonstration electrical zone. (AED)
  - High Energy System technologies for dynamically reconfigurable power systems. (SSSA)
  - Development of active control techniques for electric motors. (QED)
  - Integration of submarine hydroacoustic model and structural response model. (QED)
- ### COMPLETE:
- Multi-functional demonstration of third-generation PEBB modules for fit, form and function. (SSSA)
  - Demonstration of physical and computational network system simulations. (AED)
  - Application of 3D models for electric motor magnetic fields (QED)
  - Conceptual design for 2.5 MW Ship Service Fuel Cell System. (SSFC)

## SHIP STRUCTURES AND HULL SYSTEMS:

### INITIATE:

- Heavyweight machinery truss design and demonstration. (AMSS)

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Budget Item Justification  
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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603508N

PROGRAM ELEMENT TITLE: Surface Ship & Submarine  
HM&E Advanced Technology

PROJECT NUMBER: R2224

PROJECT TITLE: Ship & Submarine  
HM&E Advanced Technology

- Advanced coating system concept definition. (AMSS)
  - Machinery flanking path system mitigation demonstration. (AMSS)
- CONTINUE:
- In-water quarter-scale demonstration of Machinery Support Structure system concept shock performance. (AMSS)
- COMPLETE:
- Machinery flanking path component evaluation. (AMSS)
  - Design and integration of shock control features into Machinery Support Structure for in-water shock demonstration. (AMSS)

3. FY 2001 PLAN:

#### AUTOMATION TO REDUCE MANNING:

##### INITIATE:

- Preparation for final demonstration of 85% reduction in damage control manning requirements. (DCARM)
- Conceptual systems engineering study and trade-off analysis of Integrated Engineering Plant demonstration system. (IEP)

##### CONTINUE:

- Evaluation of multi-criteria fire detection system. (DCARM)
  - Design for zonal smoke control system. (DCARM)
  - Detailed design and software interface for reflexive water mist system. (DCARM)
- COMPLETE:
- Demonstration of 85% reduction in damage control manning and requirements. (DCARM)

#### ADVANCED ELECTRICAL SYSTEMS:

##### INITIATE:

- Demonstration of an electrical Mission Reconfiguration. (AED)
- Demonstration of advanced architecture motor controller. (QED)
- Demonstration of active control algorithms to control ship signatures using motor as an actuator. (QED)

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Budget Item Justification  
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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603508N

PROJECT NUMBER: R2224

PROGRAM ELEMENT TITLE: Surface Ship & Submarine  
HM&E Advanced Technology

PROJECT TITLE: Ship & Submarine  
HM&E Advanced Technology

## CONTINUE:

- Demonstration of control of integrated motor/propulsor response. (QED)
  - Development of 500-KW Ship Service Fuel Cell reduced-scale demonstrator. (SSFC)
  - High Energy System technologies for dynamically reconfigurable power systems. (SSSA)
  - Demonstration of key system capabilities for the Electrically Reconfigurable Ship. (AED)
  - High Voltage Switch demonstration for dynamically reconfigurable power systems. (SSSA)
- COMPLETE:
- Development of active control techniques for electric motors. (QED)
  - Analytical model for fuel cell system dynamic performance. (SSFC)
  - Demonstration of a 500-KW sub-scale demonstration model of the reformed diesel-fuel cell system. (SSFC)
  - Aircraft Electrical Servicing Station demonstration using programmable PEBS and Power Node Control Center technologies. (SSSA)
  - Demonstration of design reconfiguration of an electrical zone. (AED)

## SHIP STRUCTURES AND HULL SYSTEMS:

### INITIATE:

- Large Scale Demonstration of advanced coating system concept. (AMSS)

### CONTINUE:

- Machinery flanking path system mitigation concepts. (AMSS)
- Heavyweight machinery truss design and demonstration. (AMSS)

### COMPLETE:

- In-water quarter-scale demonstration of Machinery Support Structure system concept for shock performance. (AMSS)

B. PROGRAM CHANGE SUMMARY: See total program change summary for P.E.

C. OTHER PROGRAM FUNDING SUMMARY: Not applicable.

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603508N

PROJECT NUMBER: R2224

PROGRAM ELEMENT TITLE: Surface Ship & Submarine  
HM&E Advanced Technology

PROJECT TITLE: Ship & Submarine  
HM&E Advanced Technology

• RELATED RDT&E:

- PE 0601153N (Defense Research Sciences)
- PE 0602121N (Ship, Submarine & Logistics Technology)
- PE 0602122N (Aircraft Technology)
- PE 0602234N (Materials, Electronics, and Computer Technology)
- PE 0603561N (Advanced Submarine Systems Development)
- PE 0603573N (Advanced Surface Machinery Systems)
- PE 0604558N (New Design SSN Development)
- PE 0604561N (SSN-21 Development)

D. SCHEDULE PROFILE: Not applicable  
Under the Defense S&T Reliance Agreement, the Navy has the lead for this Navy-unique program.

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 3      PROGRAM ELEMENT: 0603640M  
 PROGRAM ELEMENT TITLE: Marine Corps Advanced Technology Demonstrations

(U) COST: (Dollars in Thousands)

PROJECT NUMBER & TITLE	FY 1999 ESTIMATE	FY 2000 ESTIMATE	FY 2001 ESTIMATE	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	TO COMPLETE	TOTAL PROGRAM
R2223 Marine Corps Advanced Technology	18,996	11,430	12,499	16,131	15,621	16,838	17,155	CONT.	CONT.
C2297 Marine Corps Warfighting Laboratory(MCWL)	27,410	47,537	32,727	32,760	33,407	34,465	35,173	CONT.	CONT.
R2362 Extended Littoral Battlespace (ELB) Advanced Concept Technology Demonstration (ACTD)	9,898	9,598	9,523	946	943	0	0	0	45,503
<b>TOTAL</b>	56,304	68,565	54,749	49,837	49,971	51,303	52,328	CONT.	CONT.

A. (U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: As the land warfare component of Naval Expeditionary Forces, the Marine Corps has unique and technologically stressing requirements resulting from its amphibious mission, Marine Air-Ground Task Force (MAGTF) organizational structure, reliance on maneuver, logistic sustainability, and intensive tempo of operations in diverse environments. Critical Marine Corps requirements being addressed in this program element (PE) are: Maneuver, Firepower, Command and Control, Logistics, and Training and Education. These are ongoing efforts to develop and demonstrate advanced technologies and system concepts in a quasi-operational environment. Multiple transitions into the Demonstration/Validation phase are planned, as well as fieldable prototyping to reduce risk in Engineering and Manufacturing Development. Joint service efforts are in line with Defense Technology Objectives and Joint Warfighting Objectives (JWOs). In addition, Marine Corps Warfighting Experimentation in conceptual operational assessment of emerging technologies is funded. This PE also provides Extended Littoral Battlespace efforts in the area of: command, control, communications, computers and intelligence, and fires and targeting. Efforts focus on connectivity between MAGTF and Fleet organizations and naval sea-based fire support. Specifically, this PE supports the following capabilities: promptly engaging regional forces in decisive combat on a global basis; responding to all other contingencies and missions in the full spectrum of combat operations (high, mid and low intensity) in Military Operations in Urban Terrain, and in operations other than war, and warfighting experimentation. By providing the technologies to enable these capabilities, this PE primarily supports the

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 3                      PROGRAM ELEMENT: 0603640M  
 PROGRAM ELEMENT TITLE: Marine Corps Advanced Technology Demonstrations

goals and objectives of the Strike, Littoral Warfare and Surveillance Joint Mission Areas. This PE supports all of the Marine Corps mission areas.

(U) JUSTIFICATION FOR BUDGET ACTIVITY: This program is budgeted within the Advanced Technology Demonstration Budget Activity because it encompasses design, development, simulation, or experimental testing of prototype hardware to validate technological feasibility and utility, and reduce technological risk prior to initiation of a new acquisition program or transition to an ongoing acquisition program.

B. (U) PROGRAM CHANGE SUMMARY:

	<u>FY 1999</u>	<u>FY 2000</u>	<u>FY 2001</u>
(U) FY 2000 President's Budget	56,187	56,943	59,410
(U) Appropriated Value:		67,943	
(V) Adjustments from PRESBUDG:			
(U) SBIR/STTR Transfer	-1,240	0	0
(U) Execution Adjustments	+592	0	0
(U) Comparability Adjustments	+1,023	+1,002	0
(U) Program Adjustments	0	0	-4,103
(U) Inflation Rate Adjustments	-258	0	0
(U) Various Rate Adjustments	0	0	-558
(U) Congressional Rescissions	0	-380	0
(U) Congressional Plus ups	0	+11,000	0
(U) FY 2001 President's Submission	56,304	68,565	54,749

(U) Schedule: Not applicable.  
 (U) Technical: Not applicable.

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603640M

PROGRAM ELEMENT TITLE: Marine Corps Advanced Technology Demonstrations

(U) COST: (Dollars in Thousands)

PROJECT NUMBER & TITLE	FY 1999 ESTIMATE	FY 2000 ESTIMATE	FY 2001 ESTIMATE	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	TO COMPLETE	TOTAL PROGRAM
R2223 Marine Corps Advanced Technology	18,996	11,430	12,499	16,131	15,621	16,838	17,155	CONT.	CONT.

A. (U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: As the land warfare component of Naval Expeditionary Forces power projection, the Marine Corps has unique and technologically stressing requirements resulting from its amphibious mission; Marine Air-Ground Task Force (MAGTF) organizational structure; and reliance on maneuver, logistic sustainability, and intensive tempo of operations in diverse environments. Critical Marine Corps requirements/imperatives being addressed in this program element (PE) are: Maneuver, Firepower, Command and Control, Logistics, and Training and Education. These are ongoing efforts to develop and demonstrate advanced technologies and system concepts in a quasi-operational environment. Multiple transitions into the Demonstration/Validation phase are planned, as well as fieldable prototyping to reduce risk in Engineering and Manufacturing Development. Joint service efforts are in line with Defense Technology Objectives and Joint Warfighting Objectives (JWOs). Efforts focus on connectivity between MAGTF and Fleet organizations and naval sea-based fire support. Specifically, this PE supports the following capabilities: promptly engaging regional forces in decisive combat on a global basis; responding to all other contingencies and missions in the full spectrum of combat operations (high, mid and low intensity) in Military Operations in Urban Terrain (MOUT), and in operations other than war; and warfighting experimentation. By providing the technologies to enable these capabilities, this PE primarily supports the goals and objectives of the Strike, Littoral Warfare and Surveillance Joint Mission Areas. This PE supports all of the Marine Corps mission areas.

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603640M

PROJECT NUMBER: C2223

PROGRAM ELEMENT TITLE: Marine Corps Advanced Technology Demonstrations

PROJECT TITLE: Marine Corps Advanced Technology

## (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

### 1. (U) FY 1999 ACCOMPLISHMENTS:

- (U) Maneuver Imperative: Continuation of the Joint Defense Advanced Research Projects Agency (DARPA)/United States Marine Corps (USMC) Reconnaissance, Surveillance and Targeting - Vehicle (RST/V). Fabricated and tested RST/V platform and began integration of survivability and sensor systems. Down-selected to single contractor for fabrication, testing and test support for Reconnaissance, Surveillance and Targeting Vehicle. Conducted successful Critical Design Review with contractor. Purchased all critical components and began fabrication of two demonstrator platforms to be delivered IQ FY 2001. Completed system configuration and began fabrication of technology demonstrator for the Light Armored Vehicle SLEP. Platform will be key enabler for SLEP program and will transition to Program Manager in FY 2000.
- (U) Firepower Imperative: Continued design and fabrication of Object Individual Combat Weapon prototype. Analyzed and evaluated Contingent Low Altitude Weapons System (CLAWS), formerly HUMRAAM. Began development and evaluation of Enhanced Target Acquisition and Location System (ETALS).
- (U) Command and Control Imperative: Continued development and demonstrated technologies to make decisions, communicate information, and expand knowledge in a high tempo, uncertain, and chaotic battlefield. These technologies included large screen display technologies that are scalable for Battalion through Division and their appropriate Command Post environment. They also included horizontal integration of software capabilities/modules such that the commander and his staff see a consolidated picture of the battlespace rather than segregated applications. Continued to develop unique waveform technologies that provide low probability of detection/intercept.
- (U) Logistics Imperative: Developed and demonstrated the Combat Service Support Operations Center as a feeder to the Small Unit Logistics Advanced Concept Technology Demonstration (SUL ACTD). Configuration and testing focused on web-enabled technologies and data repositories for tactical logistics command and control. Completed fabrication and testing of Logistic Vehicle System-Replacement (LVS-R) Advanced Technology Demonstrator in support of Program Manager's acquisition strategy for LVS-R. Configuration and testing provided required data and reduced risk and cost while supporting future Milestone Decisions

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603640M

PROJECT NUMBER: C2223

PROGRAM ELEMENT TITLE: Marine Corps Advanced Technology Demonstrations

PROJECT TITLE: Marine Corps Advanced Technology

- (U) Training and Education Imperative: Continued development and demonstrated technologies to enhance the cognitive and higher-order abilities of Marine Warfighters. Efforts included: Development of the Small Unit Tactical Trainer (SUTT). Continued to support transitions to acquisition.
- (U) Project Albert funds the development of data, concepts and tools of 21<sup>st</sup> Century Operations Analysis especially in the areas of non-linear and asymmetric warfare. The goal is to generate data to support warfighting hypotheses with emphasis on questions relating to urban warfare.
- (U) Explored a K-Band Shoot Through Obscuration Technology and Training Scoring System under Congressional plus up program.
- (U) Developed the capability to fire the Shoulder Launched Multipurpose Assault Weapon from an enclosed space under Congressional plus up program.

2. (U) FY 2000 PLAN

- (U) Maneuver Imperative: Develop and demonstrate technologies that enhance operational mobility and survivability of expeditionary platforms. Continue the Joint DARPA/USMC Reconnaissance, Surveillance and Targeting-Vehicle (RST/V) program.
- (U) Firepower Imperative: Investigate technologies to increase accuracy, range, lethality, integration and timeliness of direct, indirect and close fires Begin development of the Objective Crew Served Weapon in conjunction with the Joint Service Small Arms Program. Continue development of the Complementary Low Altitude Weapons System.
- (U) Command and Control Imperative: Develop high precision target acquisition and location system that will be assembled from existing and future USMC fielded equipment. Key feature is an azimuth sensor with less than .5 degrees pointing accuracy. Develop Low Probability of Detection/Low Probability of Intercept (LPD/LPI) technology applicable to tactical hand-held dismounted communications tasks.
- (U) Logistics Imperative: Technology demonstration of new concepts in expeditionary bulk liquids distribution systems, focused on Naval seamless operation from ship to objective. Focuses on advanced concept technology demonstration for small unit logistics command and control Advanced Concept Technology Demonstration (ACTD), emphasizing decision support and improved logistics situational awareness at the tactical level. Future systems enabling logistics functions to be conducted in an OMFTS environment will be developed, tested, and

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demonstrated. These future systems will be from a result of the demonstration of the Tactical Logistics Distribution System (TLoADS), which was used by MCCDC S&A in Mission Area Analysis studies.

- (U) Training and Education Imperative: Continue to develop and demonstrate technologies to enhance the cognitive and higher-order abilities of Marine Warfighters. Efforts include: Development of the SUTT.

### 3. (U) FY 2001 PLAN

- (U) Maneuver Imperative: Continue to develop and demonstrate technologies that enhance operational mobility and survivability of platforms for Marine units. Conduct government testing of Reconnaissance, Surveillance and Targeting Vehicles to be delivered IQ FY 2001. Testing will include participation in USMC Capable Warrior Advanced Warfighting Experiments and Extended Littoral Battlespace ACTD, encompassing Mobility, Survivability, Sensor, and Communications performance testing. Technology will be transitioned to the Light Strike Vehicle.
- (U) Firepower Imperative: Investigate technologies to increase accuracy, range, lethality, integration and timeliness of direct, indirect and close fires. Transition CLAWS to PM. Continue development and evaluation of Objective Crew Served Weapon System.
- (U) Command and Control Imperative: Continue development of Enhanced Target Acquisition Location (ETAL) effort. Continue development of LPD/LPI technology and demonstrate unique waveform communications devices and package technology for transfer to Director C4I.
- (U) Logistics Imperative: Continue to develop and demonstrate technologies to enhance MAGTF capabilities in operational and tactical logistics in the areas of information systems, bulk liquids, and command service support platforms. The goal is to enable sea based logistics, a tailored presence ashore, and a reduction in consumables. Continued emphasis on tactical logistics information management in the naval sea based environment. Efforts include completion of the LCS Marine DARPA initiative for voice recognition and continued SUL ACTD development of a Client/Server and web-enabled system to provide near-real-time situational awareness/visibility for logistics assets. Continued demonstration of a concept of operations and coordinated the field demonstration of both Onboard Vehicle/Refueler Communication (OVRC) and Fuel Automated Quantity Sensor (FAQS) during one of the designated assessment exercises held in FY 00. A Naval focus for fuel information aggregation will be emphasized, providing the commander critical fuel awareness across a distributed battlefield. Additionally, this task will provide variable rate flow pumps to enable Marines to fuel different types of vehicles at their optimum rate(i.e. MIAI takes on fuel at a much higher rate than a

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HMMWV). The above mentioned sensors will tie into the Small Unit Logistics ACTD to provide that situational awareness by allowing a commander to query the status of fuel stores throughout the battlespace and allow for automatic requisition and distribution course of action. Budget also covers a spectrum of areas in maintenance, transportation/distribution, packaging (embarkation), and engineering (power/construction). Distribution concepts include touchpoint technologies and air/surface/ground tactical platforms as well as packaging/embarkation. Engineering areas include trafficability assessments, expedient gap crossing for small mobile units, and utilities. Maintenance concepts include predictive sensors tied to the information architecture as well as the tools to support maintenance functions in an OMFTS scenario. Future systems enabling logistics functions to be conducted in an OMFTS environment will be developed, tested, and demonstrated. These future systems will be from a result of the demonstration of the Tactical Logistics Distribution System (TLOADS), which was used by MCCDC S&A in Mission Area Analysis studies during FY00.

- (U) Training and Education Imperative: Continue to develop and demonstrate technologies to enhance the cognitive and higher-order abilities of Marine Warfighters. Efforts include: Transition of the SUFTT to acquisition. Begin development of the Military Operations In Urban Terrain-Instrumentation System. Initiate design of the Closed Loop Artillery Simulator System.

B. (U) PROGRAM CHANGE SUMMARY: See program change total summary for P.E.

C. (U) OTHER PROGRAM FUNDING SUMMARY: Not applicable.

D. (U) RELATED RDT&E:

- (U) PE 0603004A (Weapons and Munitions Advanced Technology)
- (U) PE 0603005A (Combat Vehicle and Automotive Advanced Technology)
- (U) PE 0603606A (Landmine Warfare and Barrier Advanced Technology)
- (U) PE 0603607A (Joint Service Small Arms Programs)
- (U) PE 0603619A (Landmine Warfare and Barrier Advanced Demonstrations)
- (U) PE 0603772A (Battlefield Force Integrations)
- (U) PE 0604710A (Night Vision Systems - Engineering Development)
- (U) PE 0604808A (Landmine Warfare and Barrier Engineering Development)
- (U) PE 0602301E (Computing Systems and Communications Technology)
- (U) PE 0602702E (Tactical Technology) Technology Demonstrations (ATDs)
- (U) PE 0603226E (Experimental Evaluation of Major Innovative Technologies)
- (U) PE 0206623M (Marine Corps Ground/Supporting Arms Systems)
- (U) PE 0602131M (Marine Corps Landing Force Technology)
- (U) PE 0603612M (Marine Corps Mine/Countermeasures Systems)

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- (U) PE 0603635M (Marine Corps Ground Combat/Support System)
  - (U) PE 0204163N (Fleet Communications)
  - (U) PE 0602315N (Mine Countermeasures, Mining and Special Warfare Technology)
  - (U) PE 0603555N (Undersea Superiority Technology Demonstrations)
  - (U) PE 0603782N (Mine and Expeditionary Warfare Advanced Technology)
  - (U) PE 0603794N (Command, Control, Communications, Advanced Technology)
  - (U) PE 0206313M (Marine Air Ground Task Force Command/Control/Communications/Computers & Intelligence)
  - (U) PE This program is in compliance with Tri-Service Reliance Agreements
- E. (U) SCHEDULE PROFILE: Not Applicable.

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PROGRAM ELEMENT: 0603640M

PROGRAM ELEMENT TITLE: Marine Corps Advanced Technology Demonstrations  
(U) COST: (Dollars in thousands)

PROJECT NUMBER & TITLE	FY 1999 ACTUAL	FY 2000 ESTIMATE	FY 2001 ESTIMATE	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	TO COMPLETE	TOTAL PROGRAM
C2297 Marine Corps Warfighting Laboratory (MCWL)	27,410	47,537	32,727	32,760	33,407	34,465	35,173	CONT.	CONT.

A. (U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: The Marine Corps Warfighting Laboratory (MCWL) is the centerpiece for the operational enhancement of the Marine Corps. Using the Special Purpose Marine Air-Ground Task Force (Experimental) (SPMAGTF(X)) as its "test bed" organization, MCWL demonstrates the usefulness and necessity of integrating new technological developments and advanced concepts into the Operational Forces of the Marine Corps. MCWL focuses on developing and field testing future operational and technological concepts to enhance warfighting capability. The organizational thrust is to provide an institutional mechanism for continuously generating new ideas for warfighting capabilities. Concepts of operation "Sea Dragon" are validated by means of various Warfighting Experiments.

(U) Sea Dragon is a process of experimentation which is designed as an ongoing mechanism to insure the relevance of Marine forces in the face of change. Sea Dragon encompasses inquiries into multiple technology and warfighting areas, including: Command, Control, Communications, Computers, and Intelligence (C4I); fires; medical, biological, chemical, and non-lethal technologies; expeditionary logistics; and advanced training and education techniques.

(U) Using experimental operational forces, beginning with the SPMAGTF(X) as the forward element of a future Naval Expeditionary Force, the MCWL will conduct a number of Advanced Warfighting Experiments (AWEs) supported by several Limited Objective Experiments (LOEs), Limited Technology Assessments (LTAs), Wargames, and Studies.

1) An AWE is defined as a larger scale operational experiment where advanced warfighting capabilities and enabling technologies are evaluated to determine the military utility, operational effectiveness, and operational suitability in as realistic an environment as possible. These AWEs will examine an operational concept that envisions a greatly expanded, lethal, fluid, chaotic, and more opportunistic battlefield within a maneuver warfare approach. All experimentation conducted during a phase builds toward the AWE.

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2) LOEs are considerably smaller in scope than AWEs and focus on a discrete set of closely related Experiment objectives. These experimental forces will be highly trained, technologically infused, highly lethal, and intellectually prepared to fight in this chaotic and opportunistic environment. LOEs are designed to answer questions that, if left unanswered, would have a significant adverse impact on the successful execution of experimental operations in the related AWE.

3) LTAs focus on the performance characteristics of specific technologies and assess their usefulness by means of analysis or experimentation. MCWL plans and conducts LTAs to effectively incorporate a technology into follow-on experiments.

4) A Wargame is a broad discipline manifested in a range of activities from a few individuals conducting Action-Reaction-Counteraction drills to a significant commitment from Operating Forces Staff or SPMAGTF(X) Command Element (CE) to execute a Command Post Exercise supported by extensive modeling and simulation. A Wargame is integral to MCWL's experimental process and precedes the execution of each LOE/AWE to refine the LOE/AWE experimentation plan.

5) A Study is a low-cost (relative to operational experimentation) technique designed to result in broader or deeper research into an Experimental Issue. MCWL undertakes a study when a literature search reveals that existing studies are inadequate to support experiment objectives and synthesis is required and is focused on one or a few closely related Experiment Issues. A Study can contribute to any stage of the Innovation and Experimentation Process, but is most useful during experiment planning.

(U) Under the guidance of the extended Five-Year Experimentation Plan, MCWL's current plans include five AWE "build-up" phases culminating in actual AWE execution:

1) Hunter Warrior: (March 1996 through April 1997) Experimented with advanced operational concepts and technologies on an extended and dispersed battlefield, in open and mountainous terrain at the mid-intensity operational level.

2) Urban Warrior: (April 1997 through June 1999) Focused on developing new tactics, techniques, and procedures; and supporting technologies for operations in urban, close terrain, and near urban littoral areas.

3) Capable Warrior: (June 1999 through 2001) Uses lessons learned in Hunter Warrior and Urban Warrior to integrate the full capability of a Marine Air-Ground Task Force (MAGTF) with naval units operating at the numbered fleet level of a Joint Task Force from the sea.

4) Coalition Warrior (FY 2002 through FY 2003) Focuses on the integration of 21<sup>st</sup> century sea-based technologies into coalition warfare; which begins to examine the challenges of Marine Expeditionary Force (MEF) level Operational Maneuver from the Sea (OMFTS) implementation.

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5) Joint Warrior (FY 2004) Encompasses designs to lead into United States Atlantic Command's "Olympic Event Experiment". Focuses on executing OMFTS as the maritime portion of Joint Vision (JV) 2010.

## (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

### 1. (U) FY 1999 ACCOMPLISHMENTS:

- (U) MCWL Operations (Support): Expanded Strategic Planning through the location, development, and evaluation of advanced warfighting operational and organizational concepts and related enabling technologies. Synthesized results and lessons learned into proposed tactics, techniques, and procedures (TTPs) for the Marine Corps. Expanded research; planning; model and simulation, concept, and wargame development; preparation; execution; and analysis and assessment to extend exploration of critical components. Began Capable Warrior Experimentation Planning and technology investigations. Continued to provide for MEF (Pacific) Battle Laboratory Scientific Advisor.
- (U) C4I: Expanded systems engineering; integration; and technical, hardware, and software support of the Integrated Marine Multi-Agent Command and Control System (IMMACCS) Engine and communications backbone (infrastructure integration) allowing situational awareness and the Common Operational Picture (COP) at all levels of the MAGTF. Continued systems engineering and integration efforts and provided technical support for the Experimental Combat Operations Center (ECOC). Continued two-dimensional (2D) Viewer development, which provides for rapid decision making in order to facilitate human understanding of operational plans, to support the IMMACCS concept. Continued to expand and enhance the Shared Net and Internet-Node-in-the-Sky (INITS), Unmanned Aerial Vehicle (UAV) transportable communications system, initiatives. Continue the integration of single integrated air/ground picture for mission planning and fire support. Completed Object-Oriented database effort required by the IMMACCS using National Imagery and Mapping Agency data as input. Purchased commercially available hand-held radios and conducted various squad-level communications experiments as well as conducted radio frequency spectrum analysis investigations. Provided funding for Information Operations support to interface with the IMMACCS developers, in the collection, interpretation, formulation, and validation of the elements of the IMMACCS Object Model (IOM), the customization of the IOM for the Urban Warrior AWE, and the identification, description, and explanation of appropriate warfighting scenarios that can be used as a basis for the design of the IMMACCS Agent Engine.
- (U) Drones, Aviation, and Sensors: Continued development of the Broad Area Unmanned Responsive Resupply Operations (helicopter/ UAV capable of carrying heavy loads) by initiating conversion of the commercial manned K-MAX

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helicopter into an unmanned platform, utilizing dynamic response modeling. Continued enhancing the Expendable Drone UAV (Dragon Drone), concentrating on payload development, to perform battle damage assessment; data targeting; reconnaissance and surveillance; and accurate deployment of unattended sensors. Obtained Drone aviation certification and completed Drone ship integration efforts which allow the system to be easily removed at the end of the deployment. Continued "Real Time Targeting", "Reachback", and "Network-Centric" experiments. Investigated the capabilities of Unmanned Ground Vehicles equipped with an unattended sensor suite, including video to improve battlefield situational awareness. Provided the SPMAGTF(X) with a complete battlefield sensor capability to improve battlefield situational awareness. Initiated aviation based simulation/instrumentation efforts. Expanded investigations/experimentation in aviation technologies and aviation employment in the urban environment to include initiation of a unique urban aviation range used to conduct close air support experimentation. Searched for new and emerging technologies.

- (U) Fires and Targeting: Continued development of the experimental prototype Dragon Fire (unattended) Mortar System. Continued development of Mobile Counter Fires System (automated fires system), to include advanced optics support. This capability will potentially allow the instant detection of incoming fires and rapid slewing of the weapon to the origin of fires. Continued development of a precision-targeting device that includes a laser range finder, which will provide ground forces with accurate target acquisition. Initiated sensor to weapons links for increased responsiveness to calls for fire. Investigated suppressed combat rifle initiatives. Continued to investigate emerging fires and targeting technologies.
- (U) Sea basing, Logistics, Combat Service Support (CSS), and Combat in Cities (including Training and Education): Continued integrating clothing and equipment that will enhance Marines' survivability in urban combat. Continued to search for, evaluate, and perform sea-basing analysis. Fabricated mounting assemblies, cables, and hardware modifications required to support the "Boom Gun" concept, which involves mounting a remotely controlled gun (Compact Lightweight Armored Weapons System on a 7.5 ton tactical crane and using the boom to raise the gun to a height of 40 to 50 feet. The elevated gun was then used to provide area surveillance and force protection for units operating in the vicinity. Continued to experiment with electronic markers, providing vehicle position/location data, time-stamp data, and remote maintenance data to the Combat Service Support Operations Center (CSSOC) via a long-range satellite based communications link. Continue to provide sea-based logistical support. Evaluated combat service support for emerging and developing weapons as they apply to operational concepts of logistics support and sustainment for various non-standard scenarios. Continued to support Military Operations in Urban Terrain (MOUT) training facility efforts by supplying a training munitions that allows for live fire training in existing and upgraded urban warfare training facilities that does no damage to buildings and is relatively safe to use. Continued development and implementation of components of a prototype Combat Squad Leaders Presentation in support of the MCWL experimentation efforts. Investigated existing and emerging training

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enhancements and simulation equipment and devices. Continued to search for and evaluate emerging commercially available technologies that could significantly improve efforts in this area.

- (U) Chemical/Biological (Chem/Bio), Medical, Analysis and Non-Lethals: Continued medical investigations by initializing planning stage for the development of high-density electric auxiliary power units to be used with a treatment shelter system designed to provide forward emergent resuscitative surgery and patient holding. Expanded instrumentation capability that supported MCWL experimentation in the urban environment. Continued efforts to improve upon the automated data collection system, which was designed and implemented during Hunter Warrior and used during Urban Warrior. Continued to provide overall systems engineering and integration support for ongoing experimentation. Continued to provide overall analysis and reporting of experimentation efforts. Conducted Hazards of Electromagnetic Radiation to Ordnance testing of the Dragon Drone non-lethal payload. Conducted an engineering investigation to determine the best way to interface the Dragon Drone ground control station to the non-lethal payload station. Seek Non-Lethal technologies, which can affect an opponent's infrastructure without necessarily destroying it. Investigate the use of Non-Lethal technologies to deter, delay, deny, disrupt, and destroy opponents or their material.

## 2. (U) FY 2000 PLAN:

- (U) MCWL Operations (Support): Continue Strategic Planning through the location, development, and evaluation of advanced warfighting operational and organizational concepts and related enabling technologies. Synthesized results and lessons learned into proposed TTPs for the Marine Corps. Continue research; planning; model and simulation, concept, and wargame development; preparation; execution; and analysis and assessment to extend exploration of critical components. Continue Capable Warrior Experimentation Planning and technology investigations. \$500K- Provide for Marine Forces (Atlantic and Pacific) Battle Laboratories to conduct experimentation to include MEF (Pacific) Battle Laboratory Scientific Advisor.
- (U) 4I: Incorporate lessons learned from the Urban Warrior AWE into ongoing development efforts and the three IOEs scheduled for FY 2000. Initiate experimental planning and C4I Surveillance Reconnaissance (C4ISR) development to support the Capable Warrior AWE. Continue to develop information processing and further integrate capabilities into IMMAGCS and the ECOC facility. Continue to develop enhanced capability for INITS, Shared Net, and 2D Viewer efforts. Develop additional capability for the IMMAGCS Agent Engine using adaptive algorithms. Develop enhancements for information management systems to provide the Common Tactical Picture at all levels (squad leader to Commander) of the MAGTF. Initiate advanced command and control investigations and experiments for sea based fire

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support. Continue to investigate commercially available (off-the-shelf) technology for providing wireless connectivity from Marine squads into IMMAGCS.

- (U) Drones, Aviation, and Sensors: Initiate UAV small payload development for the Dragon Warrior (low cost, small tactical vertical takeoff and landing drone); focusing on reconnaissance, surveillance, and target acquisition capabilities. Initiate UGV payload development focusing primarily on reconnaissance, surveillance, and target acquisition capabilities. Initiate development of a "Micro" (miniature) UAV. Develop a class of large population, autonomous, robots capable of collecting and reporting on battlefield intelligence. Initiate development or adaptation of an airborne vehicle platform that can remain aloft indefinitely to facilitate Over the Horizon (OTH) communications to support nearly all aspects of OMFTS. Expand investigations/experimentation in aviation technologies that could lead to increasing accuracy and effectiveness of Close Air Support missions and also reduce the possibility of fratricide. Continue aviation experimentation in the urban environment. Continue aviation based simulation/instrumentation efforts. Continue search for new and emerging technologies.
- (U) Fires and Targeting: Complete development of the experimental prototype Dragon Fire (Unattended) Mortar System. Complete development of Mobile Counter Fires System (automated fires system). Continue development of a precision targeting device that includes a laser range finder that will provide ground forces with accurate target acquisition. Initiate experimentation with/development of small precise munitions. Initiate rapid target system exploration/demonstration/development as a technical means of ensuring that the target selected by the ground observer is in fact the same one the pilot is intending to attack by providing a video image of the target to the pilot, the terminal controller, and the individual tasked with coordinating fires. Develop a Combined Arms Coordination Simulation that would use computerized decision support tools to rapidly de-conflict the paths of friendly airborne objects in the battlespace. This technology investigation has the capability to increase responsiveness of supporting fires while reducing the possibility of fratricide. Continue to investigate emerging fires and targeting technologies.
- (U) Sea basing, Logistics, CSS, and Combat in Cities (including Training and Education): Develop and integrate the combat service support tools/system that will make up the Marine of 2010. Invest in all types of simulation to allow required OMFTS warfighting capabilities to be tested. Continue to search for, evaluate, and perform enhanced sea based logistics support and sea basing analysis. Experiment with the Object Individual Combat Weapon (OICW) and make a determination as to whether it fulfills MCWL capability requirements. Investigate development of a system that tracks personnel involved in a Non-combatant Evacuation Operations, to include personal data (i.e., name, family background, medical and administrative data, etc). Continue rapid prototype development, demonstration, and transition of logistics information resources technologies for deployable expeditionary CSSOC applications. Complete development of the Rapid Request Tracking System. Continue system concept

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modeling/simulation support for decision support and technology plan development for Joint Expeditionary Forcers. Investigate and incorporate automated information technologies for asset tracking, interactive, condition based maintenance support, and sensor logistics information feeds. Develop expeditionary bulk liquids technology to support a total distribution concept. Continue integrating clothing and equipment that will enhance Marines' survivability. Continue to experiment with electronic markers. Continue to leverage ongoing work in the Day/Night Small Unit Target Acquisition field. Continue to evaluate combat service support for emerging and developing weapons as they apply to operational concepts of logistics support and sustainment for various non-standard scenarios. Develop and implement components of a prototype Combat Lieutenant's Course in support of MCWL experimentation efforts. Continue to investigate existing and emerging training enhancements and simulation equipment and devices. Continue to search for and evaluate emerging commercially available technologies that could significantly improve efforts in this area

- (U) Chem/Bio, Medical, Analysis, and Non-Lethals: Continue medical investigations and complete the planning stage for the development of high-density electric auxiliary power units to be used with medical treatment shelters. Complete a Human Physical Performance in MOUT study by developing a physiologically based conditioning program to enhance physical performance and prevent injuries for Marine infantry in MOUT. Define the scope; nature; technical utilities; and TTPs that support domestic and international responses to the human and material casualties of a weapon of mass destruction (WMD) deployment. Continue to support instrumentation capability that provides battlespace instrumentation for experimentation. Continue efforts to improve upon the automated data collection system. Continue to provide overall systems engineering and integration support for ongoing experimentation. Continue to provide overall analysis and reporting of experimentation efforts. Continue to seek Non-Lethal technologies that can affect an opponent's infrastructure without necessarily destroying it. Continue to investigate the use of Non-Lethal technologies to deter, delay, deny, disrupt, and destroy opponents or their material.
- (U) MCWL Operations (Support): Continue Strategic Planning through the location, development, and evaluation of advanced warfighting operational and organizational concepts and related enabling technologies. Synthesized results and lessons learned into proposed TTPs for the Marine Corps. Continue research; planning; model and simulation, concept, and wargame development; preparation; execution; and analysis and assessment to extend exploration of critical components. Continue Capable Warrior Experimentation Planning and technology investigations. Initiate Coalition Warrior Experimentation Planning and technology investigations. Continue to provide for Marine Forces (Atlantic and Pacific) Battle Laboratories to conduct experimentation, including MEF (Pacific) Battle Laboratory Scientific Advisor.

3. (U) FY 2001 PLAN:

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- (U) C4I: Continue ongoing technical development efforts and conduct LOEs planned for the build up to the Capable Warrior AWE. Continue experimental planning and C4ISR development to support the Capable Warrior AWE. Continue to develop information processing and further integrate capabilities into IMMACCS and the ECOC facility. Integrate developed capability for INITS, Shared Net, and 2D Viewer efforts to support demonstration in Capable Warrior. Integrate and test IMMACCS Agent Engine capability. Evaluate performance of information management systems to provide the Common Tactical Picture at all levels (squad leader to Commander) of the MAGTF. Conduct experiments and evaluates the performance of advanced command and control investigations and experiments for sea based fire support. Evaluate the effectiveness of commercially available (off-the-shelf) technology for providing wireless connectivity from Marine squads into IMMACCS.
- (U) Drones, Aviation, and Sensors: Continue small payload development for Dragon Warrior UAV. Continue UGV payload and UAV micro development efforts. Continue development of a class of large population, autonomous, robots capable of collecting and reporting on battlefield intelligence. Continue development of an airborne vehicle platform to facilitate OTH communications. Continue investigations/experimentation in aviation technologies that could lead to increasing accuracy and effectiveness of Close Air Support missions and also reduce the possibility of fratricide. Continue aviation experimentation in the urban environment and aviation based simulation/instrumentation efforts. Continue to search for new and emerging technologies.
- (U) Fires and Targeting: Complete development of Mobile Counter Fires System (automated fires system). Continued development of a precision targeting device that includes a laser range finder that will provide ground forces with accurate target acquisition. Continue experimentation with / development of small precise munitions. Continue rapid target system exploration/demonstration/development. Continue Combined Arms Coordination Simulation efforts. Continue to investigate emerging fires and targeting technologies.
- (U) Sea basing, Logistics, CSS, and Combat in Cities (including Training and Education): Continue to develop and integrate the combat service support tools/system that will make up the Marine of 2010. Continue to invest in all types of simulation to allow required OMPTS warfighting capabilities to be tested. Continue to search for, evaluate, and perform sea based logistics support and sea basing analysis. Continue to experiment with the OICW. Continue investigation/development of a system that tracks personnel involved in a Non-combatant Evacuation Operations. Continue rapid prototype development, demonstration, and transition of logistics information resources technologies. Continue system concept modeling/simulation support for decision support and technology plan development for Joint Expeditionary Force. Continue to investigate and incorporate automated information technologies for asset tracking, interactive, condition based maintenance support, and sensor logistics information

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BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603640M

PROJECT NUMBER: C2297

PROGRAM ELEMENT TITLE: Marine Corps Advanced Technology Demonstrations

PROJECT TITLE: MCWL

feeds. Continue development of expeditionary bulk liquids technology to support a total distribution concept. Continue integrating clothing and equipment that will enhance Marines' survivability. Continue to experiment with electronic markers. Continue to leverage ongoing work in the Day/Night Small Unit Target Acquisition field. Continue to evaluate combat service support for emerging and developing weapons as they apply to operational concepts of logistics support and sustainment for various non-standard scenarios. Continue to investigate existing and emerging training enhancements and simulation equipment and devices. Continue to search for and evaluate emerging commercially available technologies that could significantly improve efforts in this area.

- (U) Chem/Bio, Medical, Analysis, and Non-Lethals: Continue medical investigations, including investigations into the chemical/biological arena. Continue to define the scope; nature; technical utilities; and TTPs that support domestic and international responses to the human and material casualties of a weapon of mass destruction WMD deployment. Continue to support instrumentation capability that provides battlespace instrumentation for experimentation. Continue efforts to improve upon the automated data collection system. Continued to provide overall systems engineering and integration support for ongoing experimentation. Continued to provide overall analysis and reporting of experimentation efforts. Continue to seek Non-Lethal technologies that can affect an opponent's infrastructure without necessarily destroying it. Continue to investigate the use of Non-Lethal technologies to deter, delay, deny, disrupt, and destroy opponents or their material.

B. (U) PROGRAM CHANGE SUMMARY: See program change total summary for P.E.

C. (U) OTHER PROGRAM FUNDING SUMMARY: Not applicable.

D. (U) RELATED RDT&E:

- (U) PE 0603640M (Marine Corps Advanced Technology Demonstrations), Project C2223, Advanced Technology Demonstrations
  - (U) PE 0603640M (Marine Corps Advanced Technology Demonstrations), Project C2362, Extended Littoral Battlespace, Advanced Concept Technology Demonstration
  - (U) PE 0305204 (Marine Corps Tactical UAV), Project C2672, Marine Corps close Range Tactical UAV (Dragon Warrior)
- E. (U) SCHEDULE PROFILE: Not applicable.

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Budget Item Justification  
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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET  
 PROGRAM ELEMENT: 0603640M  
 PROGRAM ELEMENT TITLE: Marine Corps Advanced Technology Demonstrations

DATE: February 2000

UDGET ACTIVITY: 3

U) COST: (Dollars in thousands)

PROJECT NUMBER & TITLE	FY 1999 ACTUAL	FY 2000 ESTIMATE	FY 2001 ESTIMATE	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	TO COMPLETE	TOTAL PROGRAM
2362 Extended Littoral Battlespace (ELB) Advanced Concept Technology Demonstration (ACTD)	9,898	9,598	9,523	946	943	0	0	0	45,503

.U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: Concept of Operations for the Extending the Littoral Battlespace (ELB) Advanced Concept Technology Demonstration (ACTD) responds to the top level military need to rapidly deploy a Naval Expeditionary Task Force with an embarked Marine Air Ground Task Force (MAGTF) as part of a larger Joint Task Force to any region of the world's littorals and conduct military operations from a sea base across the spectrum of conflict to implement national military strategy. Forces employed ashore will be light, agile, distributed and disaggregated and capable of optimizing remote fires, to effectively deter aggression, halt attacks and secure critical areas as a precursor to a much larger force. Forces will be empowered by unprecedented situation understanding via a robust information infrastructure that is fully coupled to a decision/planning/execution system on a shared battlespace network (sea/land). The objective of the ACTD is to demonstrate an enhanced integrated command and control/fires and targeting capability to enable rapid employment, maneuver, and fires to support joint dispersed units operating in an extended littoral battlespace. Two Major System Demonstrations (MSDs) are planned for FY 1999 and FY 2001. The ELB ACTD was approved by DUSD(AT) on 16 January 1997.

U) PROGRAM ACCOMPLISHMENTS AND PLANS:

1. (U) FY 1999 ACCOMPLISHMENTS:
  - (U) Continued pre-demonstration activities to include system installation, integration, test, software verification and validation, ship installation, operator training, system scenario tests and dry runs. Completed the integration of selected enabling technologies into the Command, Control, Communication, Computers and Intelligence, Surveillance, Reconnaissance (C4ISR) system. The C4ISR system was deployed on ELB testbeds and integrated with other distributed command center nodes, integrated feasibility demonstrations were performed, and demonstration training did commence along with final preparations for MSD I.

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

UDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603640M

PROJECT NUMBER: C2297

PROGRAM ELEMENT TITLE: Marine Corps Advanced Technology Demonstrations

PROJECT TITLE: ELB ACTD

- (U) Conducted a demonstration of C4ISR system architecture in a realistic combat scenario utilizing operational forces from the Fleet and the Fleet Marine Force. Demonstration did provide the means for operators and developers to evaluate the operational utility, technological feasibility, and life cycle implications of new technologies.
  - (U) Initiated demonstration/post demonstration analysis for evaluating the system concept and assessing its military utility.
  - (U) Initiated planning for MSD II.
  - (U) Initiated planning for transition sets of MSD I technology to appropriate users for military utility assessment.
2. (U) FY 2000 PLAN:
- (U) Continue planning and augment/scope the C4ISR system design for MSD II in FY 2001 based on results of MSD I in sufficient time to develop necessary interface/integration of hardware and software, verification and validation, and assessment criteria.
  - (U) Conduct enabling technology efforts to incorporate and integrate newly emerging commercial state-of-the-shelf technologies in areas of communications, combat operations center, sensor integration, and fires and targeting into the second demonstration. Provide full database and object interoperability between emerging and legacy systems.
  - (U) Initiate selection, purchase, and installation of "next generation" mature commercial off-the-shelf system and subsystem components for the FY 2001 demonstration.
  - (U) Plan and conduct integrated feasibility demonstrations to provide an operational assessment and to collect data relative to technologies/systems for purposes of defining technical risks and refinement of hardware/software design configurations.
  - (U) Conduct engineering, technical and operational assessments to define system demonstration scenarios.
  - (U) Complete the demonstration/post demonstration analysis. Determine, provide, and support transition sets of

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Budget Item Justification  
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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

UDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603640M

PROJECT NUMBER: C2297

PROGRAM ELEMENT TITLE: Marine Corps Advanced Technology Demonstrations

PROJECT TITLE: ELB ACTD

MSD I technology to appropriate users for further military utility assessment.

### 3. (U) FY 2001 PLAN:

- (U) Continue pre-demonstration activities to include system purchase installation, interface/integration, test, software verification and validation, ship installation, and operator training based on IFD results and completed design. Complete the selection and integration of selected enabling technologies into the C4ISR system. Incorporate improved system features from areas such as sensor fusion, improved network security and precision-guided indirect fire weapons either in IFDs or through simulation.
- (U) Conduct a demonstration of C4ISR system-of-systems in a realistic combat scenario utilizing operational forces from the Fleet and the Fleet Marine Force. Demonstration will provide the means for operators and developers to evaluate the operational utility, technological feasibility, and life cycle implications of new technologies.
- (U) Initiate demonstration/post demonstration assessment for evaluating the system concept and assessing its military utility and obtain milestone acquisition decision.
- (U) Select, provide, and support transition sets from MSD II to user for further military utility and operator assessment.

(U) PROGRAM CHANGE SUMMARY: See program change total summary for P.E.

(U) OTHER PROGRAM FUNDING SUMMARY: Not applicable.

(U) RELATED RDT&E:

- (U) PE 0603238N (Precision Strike and Air Defense Advanced Technology)
- (U) PE 0602315N (Mine Countermeasures, Mining and Special Warfare Technology)
- (U) PE 0603782N (Mine and Expeditionary Warfare Advanced Technology)
- (U) PE 0603750D (Advanced Concept Technology Demonstrations)
- (U) PE 0603217N (Air Systems and Weapons Advanced Technology)

E. (U) SCHEDULE PROFILE: Not applicable.

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Budget Item Justification  
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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 3      PROGRAM ELEMENT: 0603706N  
 PROGRAM ELEMENT TITLE: Medical Development (Advanced)

(U) COST: (Dollars in Thousands)

PROJECT NUMBER & TITLE	FY 1999 ACTUAL	FY 2000 ESTIMATE	FY 2001 ESTIMATE	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	TO COMPLETE	TOTAL PROGRAM
R0095 Fleet Health Technology	2,772	3,983	4,839	4,809	4,799	4,634	4,514	CONT.	CONT.
R0096 Fleet Health Standards	5,393	5,429	5,271	5,418	5,409	5,379	5,279	CONT.	CONT.
R2022 Bone Marrow Donor Registry	800	0	0	0	0	0	0	0	149,651
R2332 Mobile Medical Device	1,991	0	0	0	0	0	0	0	1,991
R2333 Rural Health	2,905	2,984	0	0	0	0	0	0	5,889
R2334 Bone Marrow	33,014	33,813	0	0	0	0	0	0	145,974
R2336 Freeze Dried Blood	823	0	0	0	0	0	0	0	823
R2375 Dental Research	2,942	2,984	0	0	0	0	0	0	5,926
R2377 Naval Biodynamics Lab	1,744	994	0	0	0	0	0	0	2,738
R2491 Naval Blood Research Lab	1,490	2,486	0	0	0	0	0	0	3,976
R2492 Medical Readiness Telemedicine	2,912	8,951	0	0	0	0	0	0	11,863
R2493 Directly Transfusable Blood	823	0	0	0	0	0	0	0	823
R2494 Center for Disaster Management	969	2,984	0	0	0	0	0	0	3,953
R2495 Telemedicine	971	0	0	0	0	0	0	0	971
R2712 Prostate Cancer Immunotherapy	0	1,491	0	0	0	0	0	0	1,491
R2713 Improved Bone Marrow Trans	0	1,989	0	0	0	0	0	0	1,989
R2714 Teleradiology	0	2,984	0	0	0	0	0	0	2,984
<b>Total</b>	<b>59,549</b>	<b>71,072</b>	<b>10,110</b>	<b>10,227</b>	<b>10,208</b>	<b>10,013</b>	<b>9,793</b>	<b>CONT.</b>	<b>CONT.</b>

(U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: This program element (PE) supports the Future Naval Capability in warfighter Protection by providing advanced medical care to Navy and Marine Corps personnel in operational theaters and by

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Budget Item Justification  
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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 3 PROGRAM ELEMENT: 0603706N  
PROGRAM ELEMENT TITLE: Medical Development (Advanced)

providing means for force health protection from hazardous occupational and operational exposures. The PE also contributes to Joint Support Areas including Readiness, Support & Infrastructure, and Manpower, Personnel & Shore Training. Goals include increasing return-to-duty rates of troops injured in combat, enhancing personnel performance in demanding Fleet jobs (and the selection of candidates for these jobs), reducing operationally related morbidity and mortality, and ensuring the physical readiness and safety of deployed personnel. Specific task areas include medical care and life-saving therapies for shipboard and battlefield casualties, blood and stem cell products and substitutes, treatments for wounds and multiple organ system and failure, methods for managing injuries related to extreme thermal environments, and new capabilities in field diagnostics and medical support. This PE also provides validated techniques for the selection of personnel based on medical criteria and standards and procedures that will protect Fleet personnel during exposure to Navy and Marine Corps operational environments. The impact of this PE includes improved medical logistics, safety, Service-wide standards and technologies. This PE also has supported the Navy's effort to register and match donors and complete bone marrow transplants.

(U) This Navy S&T program includes projects that focus on or enhance the affordability of warfighting systems.

(U) JUSTIFICATION FOR BUDGET ACTIVITY: This program is budgeted within the Advanced Technology Development Budget Activity because it encompasses design, development, simulation, or experimental testing or prototype hardware to validate technological feasibility and concept of operations and reduce technological risk prior to initiation of a new acquisition program or transition to an ongoing acquisition program.

## (U) PROGRAM CHANGE SUMMARY FOR TOTAL PROGRAM ELEMENT:

	<u>FY 1999</u>	<u>FY 2000</u>	<u>FY 2001</u>
FY 2000 President's Budget	68,505	15,064	15,929
Appropriated Value	-	77,064	-

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Budget Item Justification  
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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603706N

PROGRAM ELEMENT TITLE: Medical Development (Advanced)

Adjustments from FY 2000 PRESBU DG			
Comparability Adjustments to PE 0603707N	-5,200	-5,600	-
Program Adjustment to PE 0603707N	-	-	-5,000
Congressional Plus-ups	-	+62,000	-
Congressional Rescissions	-	-392	-
SBIR/STTR Transfer	-1,187	-	-
Execution Adjustments	-2,223	-	-
Minor Program Adjustments	-32	-	-723
Various Rate Adjustments	-314	-	-96
FY 2001 President's Budget Submission	59,549	71,072	10,110

(U) SCHEDULE: Not applicable

(U) TECHNICAL: Not applicable

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Budget Item Justification  
(Exhibit R-2, page 3 of 19)

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603706N

PROGRAM ELEMENT TITLE: Medical Development (Advanced)

PROJECT NUMBER & TITLE	FY 1999 ACTUAL	FY 2000 ESTIMATE	FY 2001 ESTIMATE	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	TO COMPLETE PROGRAM	TOTAL PROGRAM
R0095 Fleet Health Technology	2,772	3,983	4,839	4,809	4,799	4,634	4,514	CONT.	CONT.

A. (U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: This project supports the Future Naval Capability in Warfighter Protection by providing advanced medical care and treatment to Navy and Marine Corps personnel in operational theaters. The project encompasses critical endeavors designed to enhance fleet health care, augment field treatment capabilities, and improve medical logistics necessary for support of Naval and Marine Corps forces and combat casualties. Ongoing projects focus on key biomedical and casualty-relevant areas including: (1) casualty stabilization and far-forward echelon critical care; (2) blood products; (3) combat wounds and multiple organ system failure; and (4) field diagnostics and medical support capabilities.

(U) PROGRAM ACCOMPLISHMENTS AND PLANS:

(U) FY 1999 ACCOMPLISHMENTS:

- (U) TREATMENT OF CASUALTIES TO PREVENT HEMORRHAGIC SHOCK AND COMPLICATIONS ASSOCIATED WITH COMBAT TRAUMA: Continued studies that validate the feasibility and efficacy of lifesustainment and casualty stabilization interventions. Tested modalities that impact metabolic down-regulation and delayed resuscitation. Demonstrated that normal neurologic function could be restored following 15 minutes of experimentally induced cardiac arrest in animal models. Conducted studies into the complications of hemorrhagic shock and late sequelae that may be prevented with early immune modulator or other interventions. Extended studies to large animal models. Completed

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603706N

PROJECT NUMBER: R0095

PROGRAM ELEMENT TITLE: Medical Development (Advanced) PROJECT TITLE: Fleet Health Technology

initial development of improved local hemostatic agents/devices -- demonstrated the effectiveness of a hemostatic dressing (based on a complex sugar derived from a marine alga) in stopping arterial hemorrhage.

- (U) BLOOD AND BLOOD SUBSTITUTES: Conducted pre-clinical trials and modifications for Food and Drug Administration approval for technologies that extend the refrigerated liquid storage time for red blood cell transfusion units. Demonstrated that red blood cells can be stored for 9.5 weeks under anaerobic conditions. Continued development of freeze-dried red blood cell units having a minimum of a two-year room temperature shelf life and ease of use with immediate transfusion post-rehydration. Maintained efforts to develop improved frozen and freeze-dried platelet products with enhanced storage capabilities. Continued initial human studies on freeze-dried platelets. Initiated studies to develop freeze-dried plasma and vitrified platelets. Continued automated processing of frozen red blood cells to extend the post-thaw storage beyond 24 hours. Completed the development of a porcine model for testing the toxicity of liposome encapsulated hemoglobin.
- (U) MODULATION OF IMMUNE SYSTEM IN COMBAT CASUALTIES: Continued development of advanced modulation techniques for cytokines and immune cell functions that impact the cellular and physiological responses of combat casualties. Conducted large animal studies to demonstrate the efficacy of cytokines in preventing complications from combat relevant trauma and hemorrhage. Completed a study to enhance transplant acceptance by modulation of the immune response -- demonstrated the successful use in non-human primates of a novel drug ("hu5C8") that allows the immune system to accept transplant tissue that normally would be rejected.
- (U) MEDICAL MANAGEMENT TOOLS AND EQUIPMENT USED IN FIELD OPERATIONS: Developed interface for selected medical databases for advanced medical support planning and casualty management. Continued validation of the relationships of these databases and ensure their effectiveness in military environments. Supported development of models for projecting casualty rates for various battle scenarios and war fighting intensities, upgrading systems to current war fighting and enemy systems information. Completed model of casualty flows between echelons

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603706N

PROJECT NUMBER: R0095

PROGRAM ELEMENT TITLE: Medical Development (Advanced)

PROJECT TITLE: Fleet Health Technology

of care and developed planning factors needed to forecast medical requirements at these echelons and project necessary evacuation assets incorporating terrain features into optimization models based on changing warfighting scenarios and medical support capabilities. Initiated the development of an eye oximeter for field use and demonstrated that the device provides a reliable, non-invasive indicator of blood loss. Completed effort to incorporate into Mobile Medical Monitor a database system to capture, store, display and report data from sensors, for multiple casualties.

- (U) PHYSIOLOGICAL ENHANCEMENT OF PERFORMANCE IN MILITARY/EXTREME ENVIRONMENTAL CONDITIONS: Completed study to modify physical training programs to reduce training related injuries in female recruits - provided recommendations to Marine Corps Recruit Depot, Parris Island, South Carolina (approved for implementation by recruit training leadership). Completed study to access the value of intervention techniques, which preclude high-risk individuals from musculoskeletal trauma.

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603706N

PROJECT NUMBER: R0095

PROGRAM ELEMENT TITLE: Medical Development (Advanced)

PROJECT TITLE: Fleet Health Technology

(U) FY 2000 PLAN:

- (U) TREATMENT OF CENTRAL NERVOUS SYSTEM TRAUMA: Initiate studies in animal models of traumatic injury to the central nervous system.
- (U) TREATMENT OF CASUALTIES TO PREVENT HEMORRHAGIC SHOCK AND COMPLICATIONS ASSOCIATED WITH COMBAT TRAUMA  
Continue studies that validate the feasibility and efficacy of life sustainment and casualty stabilization interventions. Test modalities that impact metabolic down-regulation and delayed resuscitation. Maintain studies on the complications of hemorrhagic shock and late sequelae that may be prevented with early immune modulator or other interventions. Refine studies in large animal models. Complete development of improved local hemostatic agents/devices. Continue studies of traumatic injury to the central nervous system. Initiate the development of a system to produce sterile water for injection from potable water. [This task area moves to PE 0603707N Project R0542 in FY01.]
- (U) BLOOD AND BLOOD SUBSTITUTES: Complete pre-clinical trials and modifications for Food and Drug Administration approval for technologies that extend the refrigerated liquid storage time for red blood cell transfusion units. Continue development of freeze-dried red blood cell units having a minimum of a two-year room temperature shelf life and ease of use with immediate transfusion post-rehydration. Further the development of improved frozen and freeze dried platelet products with enhanced storage capabilities. Extend pre-clinical trials for freeze-dried platelets. Continue studies on the development of freeze-dried plasma and vitrification of platelets. Complete automated processing of frozen red blood cells to extend post-thaw storage beyond 24 hours. [This task area moves to PE 0603707N Project R0542 in FY01.]
- (U) MODULATION OF IMMUNE SYSTEM IN COMBAT CASUALTIES: Further support development of advanced modulation techniques for cytokines and immune cell functions that impact the cellular and physiological responses of combat

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603706N

PROJECT NUMBER: R0095

PROGRAM ELEMENT TITLE: Medical Development (Advanced) PROJECT TITLE: Fleet Health Technology

casualties. Continue large animal studies to demonstrate the efficacy of cytokines in preventing complications from combat relevant trauma and hemorrhage. Initiate a study to rescue lethally irradiated bone marrow cells (using an endothelial cell culture system) and to reconstitute lethally irradiated animals.

- (U) MEDICAL MANAGEMENT TOOLS AND EQUIPMENT USED IN FIELD OPERATIONS: Continue to establish interface for selected medical databases for advanced medical support planning and casualty management. Extend validation of the relationships of these databases and ensure their effectiveness in military environments. Complete the development of models for projecting casualty rates for various battle scenarios and war fighting intensities, upgrading systems to current war fighting and enemy systems information.

(U) FY 2001 PLAN:

- (U) TREATMENT OF CENTRAL NERVOUS SYSTEM TRAUMA: Continue animal studies of traumatic injury to the central nervous system.
- (U) MODULATION OF IMMUNE SYSTEM IN COMBAT CASUALTIES: Further develop advanced modulation techniques for cytokines and immune cell functions that impact the cellular and physiological responses of combat casualties. Continue large animal studies to demonstrate the efficacy of cytokines in preventing complications from combat relevant trauma and hemorrhage.
- (U) MEDICAL MANAGEMENT TOOLS AND EQUIPMENT USED IN FIELD OPERATIONS: Refine interface for selected medical databases for advanced medical support planning and casualty management. Finalize validation of the relationships of these databases and ensure their effectiveness in military environments.

B. (U) PROGRAM CHANGE SUMMARY: See Total Program Summary for Total Program Element.

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603706N

PROJECT NUMBER: R0095

PROGRAM ELEMENT TITLE: Medical Development (Advanced)

PROJECT TITLE: Fleet Health Technology

C. (U) OTHER PROGRAM FUNDING SUMMARY: Not applicable.

(U) RELATED RDT&E:

- (U) PE 0601152N In-House Laboratory Independent Research
- (U) PE 0601153N Defense Research Sciences
- (U) PE 0602233N Human Systems Technology
- (U) PE 0603707N Manpower, Personnel and Training Advanced Technology Development
- (U) PE 0604771N Medical Development
- (U) PE 0602787A Medical Technology
- (U) PE 0603002A Medical Advanced Technology

(U) This program is coordinated through the Armed Services Biomedical Research Evaluation and Management Committee.

D. (U) SCHEDULE PROFILE: Not applicable.

(U) COST: (Dollars in thousands)

PROJECT NUMBER & TITLE	FY 1999 ACTUAL	FY 2000 ESTIMATE	FY 2001 ESTIMATE	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	TO COMPLETE PROGRAM	TOTAL
R0096 Fleet Health Standards	5,393	5,429	5,271	5,418	5,409	5,379	5,279	CONT.	CONT.

A. (U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: This project supports the future Naval capability in Warfighter Protection by providing means for force health protection from hazardous occupational and operational exposures. The project

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Budget Item Justification  
(Exhibit R-2, page 9 of 19)

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 3 PROGRAM ELEMENT: 0603706N

PROGRAM ELEMENT TITLE: Medical Development (Advanced)

develops valid medical standards for selection, training, and retention, reduces attrition and injury, and enhances personnel performance in Navy operational environments.

(U) PROGRAM ACCOMPLISHMENTS AND PLANS:

(U) FY 1999 ACCOMPLISHMENTS:

- (U) UNDERSEA MEDICINE, DIVER DECOMPRESSION, AND OXYGEN TOXICITY: Continued development of programs to enhance the safety of Navy divers/submariners. Identified that limbic structures are areas of the brain associated with high-pressure oxygen seizures; this information will facilitate the development of prevention drugs. Completed development of biochemical decompression technology to accelerate decompression with hydrogen. Technology developed within biochemical decompression produced two patents. State-of-the-art review on bioeffects of underwater blasts on human divers completed. Research on skull resonant frequencies resulting from low frequency sonar exposures provided guidance on damage risk thresholds for central nervous system effects.
- (U) DELIVER GUIDELINES: Provided recommendations for use of biomedical countermeasures to counteract performance decrements associated with sustained operations. Exploited current technology for evaluation of stimulant effects, susceptibility to sleep loss, and fatigue-related impairment. Fielded guidance for use of specific pharmacological agents during sustained operations. Collected and analyzed data on injuries resulting from small boat operations at SBUI2 and SBUI22 -- results show substantial reduction in operational readiness. Guidance developed on the use of nutritional and ergogenic supplements for Navy and Marine Corps special operations personnel.
- (U) MEDICAL STANDARDS FOR SELECTION: Began validation of an integrated, updated database of medical conditions associated with, or precluding, service.

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Budget Item Justification  
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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603706N

PROJECT NUMBER: R0096

PROGRAM ELEMENT TITLE: Medical Development (Advanced) PROJECT TITLE: Fleet Health Standards

- (U) ENHANCED HUMAN PERFORMANCE: Fielded a model of the physical and perceptual stress of shipboard firefighting. Provided guidance for use of existing Physiological Heat Exposure Limits (PHEL) for women, including use of ice vests for microclimate cooling. Extended investigation of operational impact of photorefractive keratectomy (PRK). Continued development of occupational physical standards for sustained operations. Further developed means to reduce neck and back injuries in Naval aviators.
- (U) AVIATION/SPATIAL DISORIENTATION ATTRITION AND INJURY REDUCTION Continued program in identification and prevention of aircraft mishaps due to spatial disorientation, human performance and human factors problems.
- (U) REDUCE ATTRITION AND INJURY RELATED TO HAZARDOUS MATERIALS Initiated development of criteria for evaluating direct-reading instruments for detecting and quantifying airborne toxic chemicals aboard ship to ensure that, as state-of-the-art sensors and devices are developed, there will be a generally-recognized methodology, acceptable to Federal regulatory agencies, for evaluating their precision and accuracy.
- (U) REDUCE ATTRITION AND INJURY RELATED TO TOXICITY: Identified mechanisms of action for select neurotoxics; results used to develop the Neuromolecular Toxicity Assessment System (NTAS), a molecular-level set of tests that can assess possible performance deficits caused by exposure to hazardous materials.
- (U) REDUCE ATTRITION AND INJURY RELATED TO TOXICITY/SHIPBOARD FIRES Developed capability to measure particle-vapor interactions of smoke and measure their effects upon pulmonary function. Initiated development of biomarkers (enzyme and cytokines) that can be used to identify the onset of acute respiratory distress syndrome (ARDS).
- (U) HEALTH PROMOTION; REDUCTION OF MILITARY ATTRITION AND INJURY: Delivered guidelines for health promotion and physical readiness of active duty personnel. Initiated study to evaluate dietary interventions to reduce loss of

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Budget Item Justification  
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# UNCLASSIFIED

FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603706N

PROJECT NUMBER: R0096

PROGRAM ELEMENT TITLE: Medical Development (Advanced) PROJECT TITLE: Fleet Health Standards

bone mineral density in physically active females. Conducted a feasibility study to assess the value of nicotine replacement therapy for Navy recruits who were smokers prior to enlistment.

- (U) RADIO FREQUENCY (RF) RADIATION EXPOSURE EFFECTS (REDUCE ATTRITION AND INJURY): Completed computational dosimetry model of radiofrequency (RF)-induced current. Used mock-up shipboard topside to evaluate RF-induced body and limb currents; utilized results to develop criteria for exposure standards and guidelines.

(U) FY 2000 PLAN:

- (U) UNDERSEA MEDICINE, DIVER DECOMPRESSION, AND OXYGEN TOXICITY: Continue development of programs to deliver products that enhance the safety and effectiveness of Navy divers/submariners and extend the operational envelope by permitting extended use of hyperbaric oxygen, faster decompression procedures, longer bottom time, and submersed rescue operations. Initial identification of pharmacological agents to reduce incidence of decompression sickness. Start procedural interventions concerned with blood flow for protection against oxygen toxicity. Initiate study of sonar low frequency sound effects on biological function.
- (U) DELIVER GUIDELINES: Continue to provide recommendations for use of biomedical countermeasures to counteract performance decrements associated with sustained operations. Further exploit current technology for evaluation of stimulant effects, susceptibility to sleep loss, and fatigue-related impairment. Complete guidance for use of specific pharmacological agents during sustained operations.
- (U) MEDICAL STANDARDS FOR SELECTION: Extend fielding of an integrated updated database of medical conditions associated with, or precluding, service. Continue validation.

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Budget Item Justification  
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DATE: February 2000

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603706N

PROJECT NUMBER: R0096

PROGRAM ELEMENT TITLE: Medical Development (Advanced) PROJECT TITLE: Fleet Health Standards

- (U) ENHANCED HUMAN PERFORMANCE: Continue to field a model of the physical and perceptual stress of shipboard firefighting. Complete guidance for use of existing PHEL for women, including use of ice vests for microclimate cooling. Refine investigation of operational impact of PRK. Maintain development of occupational physical standards for sustained operations. Continue study concerning reduction of neck and back injuries in Naval aviators.
- (U) AVIATION/SPATIAL DISORIENTATION ATTRITION AND INJURY REDUCTION Maintain program in identification and prevention of aircraft mishaps due to spatial disorientation, human performance and human factors problems. Initiate an effort to apply, to large surface areas, the sound-attenuating technology developed for the aviation environment. Begin studies on an advanced treatment for hearing loss/inner ear disorder. Begin the development of a digital anthropomorphic video-imaging device as a computer-based method for anthropometric screening of aviation candidates.
- (U) REDUCE ATTRITION AND INJURY RELATED TO HAZARDOUS MATERIALS Continue development of criteria for evaluating direct-reading instruments for detecting and quantifying airborne toxic chemicals (aboard ship and in the field and work environments) to ensure that, as state-of-the-art sensors and devices are developed, there will be a generally-recognized methodology, acceptable to Federal regulatory agencies, for evaluating their precision and accuracy.
- (U) REDUCE ATTRITION AND INJURY RELATED TO TOXICITY: Conduct application testing of military-relevant chemicals utilizing the NTAS, a molecular level set of tests that can assess possible performance deficits caused by exposure to hazardous materials. Upon completion of final validation studies, transition Neuromolecular Toxicity Assessment Battery (NTAB) to toxicology laboratories for testing of navy materials as part of the Health Hazard Evaluation program.

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DATE: February 2000

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603706N

PROJECT NUMBER: R0096

PROGRAM ELEMENT TITLE: Medical Development (Advanced)

PROJECT TITLE: Fleet Health Standards

- (U) REDUCE ATTRITION AND INJURY RELATED TO TOXICITY/SHIPBOARD FIRES: Develop real-time measures of acute response and hypersensitivity, and other measures of permanent damage, from certain smoke and fire gases and incorporate them into experimental models. Develop predictive models of aerosol lung deposition and clearance, carboxyhemoglobin formation (biomarker), and changes in lung ventilation.
- (U) HEALTH PROMOTION; REDUCTION OF MILITARY ATTRITION AND INJURY: Complete data analysis to develop predictive medical models for injury in Marine Corps recruits for the reduction of risk of stress fractures and musculoskeletal injuries. Initiate a study of heart rate variability associated with simulated combat stress. Complete efforts on real-time medical supply modeling/requirements on Navy ships. Complete the effort to assess medical requirements to support Operational Maneuver from the Sea.
- (U) PHYSIOLOGICAL ENHANCEMENT OF PERFORMANCE IN MILITARY/EXTREME ENVIRONMENTAL CONDITIONS: Initiate studies to develop predictors and preventive interventions for traumatic and exercise related injuries among shipboard personnel during deployment. Initiate studies to establish performance standards and training guidelines for Military Operations in Urban Terrain (MOUT), which optimize performance and minimize musculoskeletal injury. Further the evaluation of dietary interventions to reduce loss of bone mineral density in physically active females.
- (U) RADIO FREQUENCY RADIATION EXPOSURE EFFECTS (REDUCE ATTRITION AND INJURY): Compare and validate mockup exposures and models to RF-induced currents against actual shipboard exposures. Evaluate chronic health effects of RF-induced body and limb currents from topside shipboard exposures.

(U) FY 2001 PLAN:

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Budget Item Justification  
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DATE: February 2000

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603706N

PROJECT NUMBER: R0096

PROGRAM ELEMENT TITLE: Medical Development (Advanced) PROJECT TITLE: Fleet Health Standards

- (U) UNDERSEA MEDICINE, DIVER DECOMPRESSION, AND OXYGEN TOXICITY: Maintain programs to deliver products that enhance the safety of Navy divers/submariners and extend the operational envelope by permitting extended use of hyperbaric oxygen, faster decompression procedures, longer bottom time, and submersed rescue operations.
- (U) DELIVER GUIDELINES: Provide recommendations for use of biomedical countermeasures to counteract performance decrements associated with military operations. Complete studies on evaluation of stimulant effect and provide guidance. Continue to exploit current technology for evaluation of methodologies to improve impaired operational performance due to stress and fatigue. Initiate development of measurement tests for assessment of performance of Navy/Marine Corps personnel in operational environments.
- (U) MEDICAL STANDARDS FOR SELECTION: Maintain extended efforts to field an integrated updated database of medical conditions associated with, or precluding, service. Continue validation efforts.
- (U) ENHANCED HUMAN PERFORMANCE: Continue to field a model of the physical and perceptual stress of shipboard firefighting. Further refine investigation of operational impact of PRK. Continue development of occupational physical standards for sustained operations. Finalize study concerning reduction of neck and back injuries in Naval aviators.
- (U) AVIATION/SPATIAL DISORIENTATION ATTRITION AND INJURY REDUCTION: Continue program in identification and prevention of aircraft mishaps due to spatial disorientation, human performance and human factors problems. Maintain effort to apply, to large surface areas, the sound-attenuating technology developed for the aviation environment. Perform additional studies on an advanced treatment for hearing loss/inner ear disorder. Continue the development of a digital anthropomorphic video-imaging device as a computer-based method for anthropometric screening of aviation candidates.

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BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603706N

PROJECT NUMBER: R0096

PROGRAM ELEMENT TITLE: Medical Development (Advanced) PROJECT TITLE: Fleet Health Standards

- (U) REDUCE ATTRITION AND INJURY RELATED TO HAZARDOUS MATERIALS/PHYSICAL AGENTS: Complete development of criteria for evaluating direct-reading instruments for detecting and quantifying airborne toxic chemicals; field-test new methodology for evaluating their precision and accuracy using one or more new-technology sensors. If successful, submit to appropriate Federal regulatory agency recommending adoption. Initiate studies comparing use of evoked otoacoustic emissions with pure-tone audiometry for screening for temporary and permanent hearing losses in Fleet/Fleet Marine Force personnel.
- (U) REDUCE ATTRITION AND INJURY RELATED TO TOXICITY: Complete application testing of military-relevant chemicals utilizing the Neuromolecular Toxicity Assessment System (NTAS), a molecular-level set of tests that can assess possible performance deficits caused by exposure to hazardous materials. Initiate development of a clinical set of tests based on the NTAS that can be validated against the previously developed Neuromolecular Toxicity Assessment Battery (NTAB) and used eventually for medical surveillance examinations of exposed personnel. Initiate assessment of second-order electroencephalogram measures for evaluating effects of neurotoxicants and incorporation into NTAB to enhance predictive capability.
- (U) REDUCE ATTRITION AND INJURY RELATED TO TOXICITY/SHIPBOARD FIRES Complete real-time measures of acute response and hypersensitivity, and other measures of permanent damage, from certain smoke and fire gases; complete development of experimental response models, and of predictive pharmacokinetic models of aerosol lung deposition and clearance, carboxyhemoglobin formation (biomarker), and changes in lung ventilation. Initiate pharmacodynamic modeling of fire/smoke aerosol interactions with identified lung biomarker(s) to enhance predictive value of Acute Respiratory Distress Syndrome (ARDS) model.
- (U) PHYSIOLOGICAL ENHANCEMENT OF PERFORMANCE IN MILITARY/EXTREME ENVIRONMENTAL CONDITIONS: Initiate studies to develop predictors and preventive interventions for traumatic and exercise related injuries among shipboard personnel during deployment. Initiate studies to establish performance standards and training guidelines for

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PROGRAM ELEMENT: 0603706N

PROJECT NUMBER: R0096

PROGRAM ELEMENT TITLE: Medical Development (Advanced) PROJECT TITLE: Fleet Health Standards

Military Operations in Urban Terrain (MOUT), which optimize performance and minimize musculoskeletal injury. Continue study to evaluate dietary interventions to reduce loss of bone mineral density in physically active females.

- (U) RADIO FREQUENCY RADIATION EXPOSURE EFFECTS (REDUCE ATTRITION AND INJURY): Complete validation of RF-induced currents models against actual shipboard exposures. Complete evaluation of chronic health effects of RF-induced body and limb currents from topside shipboard exposures. Initiate dosimetry modeling for realistic operational RF exposures.
- B. (U) PROGRAM CHANGE SUMMARY: See Total Program Summary for Total Program Element.
- C. (U) OTHER PROGRAM FUNDING SUMMARY: Not applicable.

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PROGRAM ELEMENT: 0603706N

PROJECT NUMBER: R0096

PROGRAM ELEMENT TITLE: Medical Development (Advanced) PROJECT TITLE: Fleet Health Standards

(U) RELATED RDT&E:

(U) PE 0601152N In-House Laboratory Independent Research  
(U) PE 0601153N Defense Research Sciences  
(U) PE 0602233N Human Systems Technology  
(U) PE 0603707N Manpower, Personnel and Training Advanced Technology Development  
(U) PE 0604771N Medical Development  
(U) PE 0602787A Medical Technology  
(U) PE 0603002A Medical Advanced Technology  
(U) PE 0602202F Human Effectiveness Applied Research  
(U) PE 0603231F Crew Systems and Personnel Protection Technology

(U) This program is coordinated through the Armed Services Biomedical Research Evaluation and Management Committee.

D. U) SCHEDULE PROFILE: Not applicable.

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PROGRAM ELEMENT: 0603706N

PROJECT NUMBER: R0096

PROGRAM ELEMENT TITLE: Medical Development (Advanced)

PROJECT TITLE: Fleet Health Standards

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DATE: February 2000

BUDGET ACTIVITY: 3      PROGRAM ELEMENT: 0603707N  
 PROGRAM ELEMENT TITLE: Manpower, Personnel, and Training  
                                     Advanced Technology  
                                     Development

(U) COST: (Dollars in thousands)

PROJECT NUMBER & TITLE	FY 1999 ACTUAL	FY 2000 ESTIMATE	FY 2001 ESTIMATE	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	TO COMPLETE	TOTAL PROGRAM
R0542 Air Human Factors Engineering (HFE)	8,897	8,845	9,375	10,016	10,233	10,402	10,432	CONT.	CONT.
R1770 Manpower and Personnel Development	3,459	4,187	4,280	4,394	4,119	4,097	4,022	CONT.	CONT.
R1772 Education and Training Development	11,612	13,055	13,333	13,684	11,560	11,271	10,869	CONT.	CONT.
R2379 Center for Integrated Manufacturing Studies	969	1,989	0	0	0	0	0	0	4,899
R2496 Advanced Distributed Learning (ADL) Systems	4,359	9,945	0	0	0	0	0	0	14,304
R2715 Distributed Simulation Warfighting Concepts	0	5,967	0	0	0	0	0	0	5,967
R2716 T-STAR	0	1,491	0	0	0	0	0	0	1,491
<b>TOTAL</b>	<b>29,296</b>	<b>45,479</b>	<b>26,988</b>	<b>28,094</b>	<b>25,912</b>	<b>25,770</b>	<b>25,323</b>	<b>CONT.</b>	<b>CONT.</b>

A. (U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: This program element (PE) supports: a) the Integrated Warfare Architecture (IWAR) Support Areas for Manpower & Personnel, Training, and Readiness; b) the IWAR Mission Areas; c) the Future

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Budget Item Justification  
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DATE: February 2000

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603707N

PROGRAM ELEMENT TITLE: Manpower, Personnel, and Training  
Advanced Technology  
Development

Joint Warfighting Capabilities identified by the Joint Chiefs of Staff; and d) the Future Naval Capabilities (FNCs) for Decision Support Systems, Capable Manpower, Total Ownership Cost Reduction, and Warfighter Protection. It develops technologies that enable the Navy to recruit, select, classify, assign and manage its people; to train effectively and affordably in classroom settings, in simulated environments and while deployed; and to operate and maintain complex weapon systems. It consists of the following technologies:

(U) HFE: This project develop information management techniques, advanced interface technologies, and Decision Support Systems, all of which help ensure that complex systems will be operated and maintained more effectively, with fewer human induced errors, and with greater safety. The project also, commencing in FY01, develops products to reduce the morbidity and mortality of combat trauma.

(U) Manpower and Personnel: This project 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. Fleet readiness can be enhanced and personnel costs reduced via such technologies as modeling and simulation, mathematical optimization, advanced testing, statistical forecasting, information visualization, data warehousing, data cleansing, web-based knowledge management, and human performance measurement.

(U) Training Systems: This project improves mission effectiveness and safety by applying both simulation and instructional technology to the design of affordable education and training methods and systems. The project develops and evaluates systems to improve basic through advanced individual and team training, skill maintenance, and mission rehearsal capability. It improves training efficiency and cost-effectiveness by applying operations research, modeling and simulation, and instructional, cognitive, and computer sciences to the logistics, development, delivery, evaluation, and execution of training.

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BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603707N

PROGRAM ELEMENT TITLE: Manpower, Personnel, and Training  
Advanced Technology  
Development

(U) The Navy S&T program includes projects that focus on or have attributes that enhance the affordability of warfighting systems.

(U) JUSTIFICATION FOR BUDGET ACTIVITY: This program is budgeted within the Advanced Technology Development Budget Activity because it encompasses design, development, simulation, or experimental testing of prototype hardware and software to validate technological feasibility and concept of operations and reduce technological risk prior to initiation of a new acquisition program or transition to an ongoing acquisition program.

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DATE: February 2000

BUDGET ACTIVITY: 3      PROGRAM ELEMENT: 0603707N  
 PROGRAM ELEMENT TITLE: Manpower, Personnel, and Training  
 Advanced Technology  
 Development

	FY 1999	FY 2000	FY 2001
B. (U) PROGRAM CHANGE FOR TOTAL PE:			
FY 2000 President's Budget	26,466	20,632	21,196
Appropriated Value	-	40,132	-
Adjustments from FY 2000 PRESBUDG			
Comparability Adjustments from PE 0603706N	+5,200	+5,600	-
Program Adjustment from PE 0603706N	-	-	+5,000
Congressional Plus-ups	-	+19,500	-
Congressional Rescissions	-	-253	-
SBIR/STTR Transfer	-197	-	-
Execution Adjustments	-2,053	-	-
Program Adjustments	-	-	+1,006
Various Rate Adjustments	-120	-	-214
FY 2001 President's Budget Submission	29,296	45,479	26,988

(U) Schedule: Not applicable.

(U) Technical: Not applicable.

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603707N

PROGRAM ELEMENT TITLE: Manpower, Personnel, and Training  
Advanced Technology  
Development

(U) COST: (Dollars in thousands)

PROJECT NUMBER & TITLE	FY 1999 ACTUAL	FY 2000 ESTIMATE	FY 2001 ESTIMATE	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	TO COMPLETE	TOTAL PROGRAM
R0542 Air Human Factors Engineering (HFE)	8,897	8,845	9,375	10,016	10,233	10,402	10,432	CONT.	CONT.

A. (U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: The goal of this project is to improve platform, task force and battle group operations by developing human factors technology for incorporation into operational systems and training programs. It supports the Future Naval Capabilities (FNCs) for Decision Support Systems and Capable Manpower through enhancing human performance and decision-making effectiveness, reducing design-induced critical human performance errors, and accelerating insertion of advanced HFE technology into existing and new weapons systems. Outcomes from this technology reduce operational errors, provide a better match between personnel and skill/knowledge requirements, and reduce training requirements. The project emphasizes human-centered design and has tasks that address: integration and display of operator-oriented navigation/targeting information; adaptive automation in support of human operators; three dimensional (3D) visualization of command and control information; modeling and simulation tools for design and evaluation of ship manning; human computer interface requirements in workstation design; collaborative support technologies for distributed planning and analysis; advanced sonar operator perception techniques; command and control warfare analysis aids, advanced data fusion and presentation techniques; decision support for joint and coalition Command, Control, Communication, Computers & Intelligence systems; multi-modal sonar workstation design; advanced alerting techniques; and intelligent integration of doctrine and display technology. The Project also supports the FNC for Warfighter Protection, commencing in FY01, by funding advanced technology development for the treatment of casualties of combat trauma. This thrust of the project includes developing: life sustainment and casualty stabilization interventions, preventions for the complications of hemorrhagic shock by early immune modulator or other interventions, improved local hemostatic devices, and improved freeze-dried blood components.

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DATE: February 2000

BUDGET ACTIVITY: 3

PROJECT TITLE: Air Human Factors  
Engineering

1, and  
Training Advanced Technology  
Development

## (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

### (U) FY 1999 ACCOMPLISHMENTS:

- Initiated:
  - (U) Adaptive Automation (AA) - Developed a decision support system (DSS) incorporating adaptive automation that provides a dynamic function allocation of operational tasks. The adaptive automation will recognize high operator/pilot workload conditions and transfer normal monitoring and adjustment tasks, as well as other, more routine, human-initiated tasks, to automation. The AA will also recognize high Operating Tempo and potentially stressful situations to dynamically re-allocate appropriate operational tasks. Accomplishments include: (1) identification of the most appropriate target platform(s) and operators to demonstrate these advanced automation decision support tools and techniques, (2) identification of appropriate mission scenarios and Measures of Effectiveness, and (3) preliminary selection of those adaptive automation technologies that seem best suited to the operator/pilot environment.
  - (U) Decision Support System for Coalition Operations (DSSCO) - Developed a DSS that assists U.S. military personnel in developing operational decisions in a cross-cultural coalition military environment. The DSS will aid U.S. decision makers in collaborative planning, situation assessment, response management, and plan revision across culturally diverse military and civilian organizations as well as in coalition operations and operations other than war. The first year addressed the taxonomy and identification of relevant parameters for developing and maintaining situation awareness in a multi-cultural context as well as compilation of past coalition operations and lessons learned associated with planning, re-planning, and executing operations other than war.
  - (U) Virtual Information Center Technologies for Open-Source Requirements (VICTOR) - Developed and applies human-centric decision support technology to Commander in Chief (CINC) level "what if?" analysis in support of

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PROGRAM ELEMENT: 0603707N

PROJECT NUMBER: R0542

PROGRAM ELEMENT TITLE: Manpower, Personnel

Engineering

Development

course of action selection. VICTOR will target the existing Open Source information c  
in U.S. Commander in Chief, Pacific's (USCINCPAC's) Virtual Information Center (VIC). The project focuses on  
the process of knowledge management, extraction and presentation from open source data and development of  
s models to support C4I decisions that involve diverse, rapidly changing, unclassified data  
that is collected from political, military, civilian and coalition sources. VICTOR FY99 products include  
requirements, and a user assessment of an initial advanced human computer interface (HCI) prototype.

(U) Advanced Sonar Workstation (SWKS)-

technologies of: (1) multiple flat panel visual displays and helmet mounted display technology, (2) three  
-modal control and input methods including touch (augmented with a  
hetic speech production, 4) information management user support

including modality change, attention alerting mechanisms. Limited first year funding provided support for  
-21 (Undersea Warfare) working groups and review of rel  
documentation.

(U) Display and User Enhancement Technologies (DUETS) -

-on 3D display for use with Command, Control, Communication, Computers & Intelligence (C4I  
operational systems. This project will (1) review the critical human performance (e.g., perceptual, cognitive,  
and motor response) issues related to specific 3D display and object manipulation techniques, (2) identify a  
C4I system suitable for 3D capabi

space environment and maintain the common tactical picture, (4) add a system independent 3D display to an  
operational C4I system, and design and develop 3D object manipulation a  
related to increased understanding of the battle space environment, and (5) demonstrate and evaluate 3D object  
manipulation and display concepts. Tasks (1) and (2) have been completed.

- (U) Advanced Alerting (ADALT) - Established requirements, design and prototype an attention allocation subsystem  
-alert model used with contemporary naval command

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DATE: February 2000

BUDGET ACTIVITY: 3 PROGRAM ELEMENT: 0603707N  
PROGRAM ELEMENT TITLE: Manpower, Personnel, and  
Training Advanced Technology

PROJECT NUMBER: R0542  
PROJECT TITLE: Air Human Factors

and weapon control systems. Revised requirements definition to directly support DD 21, completed literature review, and developed integrated 6.2/6.3 technical approach.

- Continued:

(U) The Combat Enhancement through Integrated Decision Support (CEIDS) project was refocused from its original objective of developing the Multi-

Decision Making Under Stress (TADMUS) with the concept of operations being developed by the manning

-21 Manning Affordability project in FY99. Significant concepts developed as part of Tactical

Action Officer and air warfare functions of the MMWS. Further, a working version of the TADMUS Decision support

At the request of Commander, Third Fleet (CO

- and identified those events where human factor considerations are critical. In FY99, categorized the high tools and applications; and assessed existing MST tools and applications for applicability in evaluating

Completed:

- (U) In Open Systems Advanced Workstation project, conducted final performance demonstrations of the workstation  
Transitioned the multi-

SC-

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603707N

PROJECT NUMBER: R0542

PROGRAM ELEMENT TITLE: Manpower, Personnel, and  
Training Advanced Technology  
Development

PROJECT TITLE: Air Human Factors  
Engineering

(U) FY 2000 PLAN:

- Continue:
  - (U) In AA, complete knowledge engineering of operator/pilot tasks. Identification of avionics architecture and software support systems insertion points.
  - (U) In ADALT, identify and map both visual and auditory alerting modalities onto ongoing tactical console operator task activities.
  - (U) In DUEETS, design and implement the prototype 3D displays, procure 3D hardware. Complete 3D software tools. Design user interface. Perform software modifications to identified C4I system. Draft mission scenarios based on identified C4I track database. Validate scenarios with subject matter experts. Implement Ø user interface for finalized scenarios.
  - (U) In DSSCO, conduct evaluations in military exercises to assess decision requirements for operations other than war (OOTW) planning with coalition military forces and civilian organizations in demanding, uncertain situations. Define, and partially implement, the prototype design requirements for DSS for coordinated OOTW operations.
  - (U) In SWKS, develop quantitative procedures for laboratory evaluations of proposed Integrated Undersea Warfare 21 display formats will be developed and initial testing started. Special attention will be given to quantifying risks and gains associated with multi-modal display support for data fusion and multi-source information integration. Work will begin on development of appropriate laboratory demonstrations of interface concepts.
  - (U) In MST, develop plan for integrating, modifying, and augmenting identified available models and tools. Modify and augment existing tools and techniques to facilitate integration. Develop strategy to fill the gaps. Define a plan to validate the tool set. Validate and modify tool set.
  - (U) Develop VICTOR open-source data collection and presentation guidelines and conduct a cognitive task analysis of VIC analyst functions. Expand VICTOR technology to include data collection and presentation capabilities

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DATE: February 2000

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603707N

PROJECT NUMBER: R0542

PROGRAM ELEMENT TITLE: Manpower, Personnel, and  
Training Advanced Technology  
Development

PROJECT TITLE: Air Human Factors  
Engineering

for Coalition Planning in support of the Operational Planning Team (OPT) and Crisis Action Team (CAT). Expand VICTOR technology to address HCI issues with respect to multi level security in an effort to provide a fused classified and unclassified picture. Introduce VICTOR technologies into other CINCs beginning with investigation of applications at US Atlantic Command (ACOM).

- Complete:
  - (U) In CEIDS, complete development and testing of AEGIS application of TADMUS Decision Support Software.
  - Complete experiments of revised TADMUS software integrated with the Multi-Modal Workstation for DD-21.
  - Transition experimental results to reduced manning initiatives and Decision Centered Design program.
  
- (U) FY 2001 PLAN:
  - Initiate:
    - (U) Intelligent Doctrine (ID) project -- develops an improved doctrine system that will intelligently assist tactical console operators in doctrine development, evaluation, modification, visualization, and use. It will provide a means to write doctrine statements using natural language terms and 3D-object manipulation.
    - Evaluation of doctrine will be assisted by graphically displaying the implications of each doctrine statement using 3D graphics and track symbology. Graphics associated with related systems will be integrated with doctrine visualization.
  
  - Continue:
    - (U) In ADALT, demonstrate the speed and accuracy of alert acknowledgment for six alert presentation methods under two workload conditions using experienced combat information center watchstanders. Correlated visual and auditory displays will be demonstrated and evaluated.

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DATE: February 2000

BUDGET ACTIVITY: 3 PROGRAM ELEMENT: 0603707N

PROJECT NUMBER: R0542

PROGRAM ELEMENT TITLE: Manpower, Personnel, and  
Training Advanced Technology  
Development

PROJECT TITLE: Air Human Factors  
Engineering

- (U) In SWKS, proposed displays will be demonstrated and evaluated in an operational environment using the DB21 Advanced Multi-Modal Watch-Station prototype.
- (U) In DUETS, develop and evaluate DUETS 3D display system prototype. Specify human computer interface for 3D display navigation and object manipulation. Develop and validate mission scenarios based on C4I track database. Modify prototype based on initial evaluations. Implement and assess final DUETS display system in an operational environment.
- (U) In DSSCO, develop and field-test the DSS for OOTW planning. Test DSS for coordinated military other than war operations with coalition forces and civilian organizations in demanding, uncertain situations.
- (U) In AA, develop prototype and design simulator tests of adaptive automation DSS for operational tasks. Compare and validate simulator against current operational environment of pilot/operator workstations.
- (U) Develop a prototype of the VICTOR methodology for use in exercise experiments, and develop metrics for the evaluation of technology products and guideline/specifications for the application of these technologies. Continue to expand VICTOR technology to address HCI issues with respect to Multi Level Security in an effort to provide a fused classified and unclassified picture. Introduce VICTOR technologies into other CINCs beginning with investigation of applications at Special Operations Command (SOCOM).
- Complete:
  - (U) In MST, demonstrate tool set in operational environment, such as the DD 21 program. Transition set of validated modeling and simulation tools to DD 21/SC 21 design assessment group to support the application of HFE in early stages of ship development.
  - (U) Warfighter Protection Reprogramming from PE 0603706N Project R0095.
  - (U) Treatment of Casualties to Prevent Hemorrhagic Shock and Complications Associated with Combat Trauma: Further validate the feasibility and efficacy of life sustainment and casualty stabilization interventions. Continue testing modalities that impact metabolic down-regulation and delayed resuscitation. Maintain studies into the complications of hemorrhagic shock and late sequelae that may be prevented with early immune modulator

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Budget Item Justification  
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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603707N

PROJECT NUMBER: R0542

PROGRAM ELEMENT TITLE: Manpower, Personnel, and  
Training Advanced Technology  
Development

PROJECT TITLE: Air Human Factors  
Engineering

or other interventions. Extend studies in large animal models. Refine a system to produce sterile water for injection from potable water.

- (U) Blood And Blood Substitutes: Continue development of freeze-dried red blood cell units having a minimum of a two-year room temperature shelf-life and ease of use with immediate transfusion post-rehydration. Further develop freeze-dried plasma and vitrification of platelets. Complete the development of improved frozen and freeze dried platelet products with enhanced storage capabilities.

B. (U) PROGRAM CHANGE SUMMARY: See Total Program Summary for Total Program Element.

C. (U) OTHER PROGRAM FUNDING SUMMARY: Not applicable.

(U) RELATED RDT&E: This project adheres to Tri-Service Reliance Agreements on Human Systems Technology. Work is related to and fully coordinated with efforts in:

- (U) PE 0601152N In-House Laboratory Independent Research
- (U) PE 0601153N Defense Research Sciences
- (U) PE 0602233N Human Systems Technology
- (U) PE 0603792N Advanced Technology Transition
- (U) PE 0604703N Personnel, Training, Simulation, and Human Factors
- (U) PE 0603007A Manpower, Personnel and Training Advanced Technology
- (U) PE 0603227F Personnel, Training, and Simulation Technology

D. (U) SCHEDULE PROFILE: Not applicable.

R-1 Line Item 23

Budget Item Justification  
(Exhibit R-2, page 12 of 26)

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603707N

PROGRAM ELEMENT TITLE: Manpower, Personnel, and  
Training Advanced Technology  
Development

(U) COST: (Dollars in thousands)

PROJECT NUMBER & TITLE	FY 1999 ACTUAL	FY 2000 ESTIMATE	FY 2001 ESTIMATE	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	TO COMPLETE PROGRAM	TOTAL PROGRAM CONT.
R1770 Manpower and Personnel Development	3,459	4,187	4,280	4,394	4,119	4,097	4,022	CONT.	CONT.

A. (U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: This project supports the Integrated Warfare Architecture (IWAR) Support Area for Manpower & Personnel, and the Future Naval Capabilities for Capable Manpower and Total Ownership Cost Reduction. It responds to requirements for technologies that will maintain or improve fleet readiness while optimizing personnel end strength, and enable the Navy to manage the force through recruiting, selecting, classifying, and assigning people to highly demanding jobs effectively and efficiently. The major goals are to ensure that the Navy has a force that is flexible, integrated, responsive, and affordable so that skilled personnel are available to handle complex weapons systems when needed; and that smaller forces will have greater capabilities by placing the right person in the right job at the right time. The program supports the delivery of new technologies in modeling and simulation, mathematical optimization, advanced testing, statistical forecasting, information visualization, data warehousing, data cleansing, webbased knowledge management, and human performance measurement.

(U) PROGRAM ACCOMPLISHMENTS AND PLANS:

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Budget Item Justification  
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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603707N

PROJECT NUMBER: R1770

PROGRAM ELEMENT TITLE: Manpower, Personnel, and Training, Advanced Technology Development  
PROJECT TITLE: Manpower and Personnel Development

## (U) FY 1999 ACCOMPLISHMENTS:

- Initiated:

- Initiated Comprehensive Officer Force Management Environment (COFME) effort. This effort builds upon the 6.2 research, Visual Information Filtering for Force Management (VISMFO) project to design a comprehensive Officer modeling environment that includes readiness assessment. The research focuses on the development of an intelligent data-mining approach that will uncover emerging trends and identify data problems. In FY99, a survey of relevant research was conducted, data requirements were identified, baseline Measures of Effectiveness (MOEs) and historical data were collected. Work began identifying, classifying, and quantifying data errors in the Officer Master File.

- Continued:

- (U) The Enlisted Strategic Planning and Assessment (ESPA) effort developed dynamic methods to model and forecast monthly personnel transactions with four interacting variables in an unstable environment. Developed an intelligent automated user override processing approach to minimize the potential for human error. The Navy Enlisted Force Analysis Model (NEFAM) prototype, a multidimensional long-term forecasting model, was introduced to the user community and subsequently modified in accordance with user community recommendations. A forecasting accuracy tool that the enlisted strength planners can use as a confidence tool for SPAN (an extensive suite of models for enlisted strength planning) forecasts was initiated.
- (U) The Distribution 2000 Prototyping / Assignment Policy Management System (D2K) effort developed a new concept to integrate the allocation, Navy Manning Plan, and requisition processes as a single process; developed an integrated mathematical model to formulate this new integrated distribution process. The prototype model and system have proved that it is feasible to replace the current lengthy sequential distribution decision processes by a simultaneous decision process. This prototype also includes an experiment of accessing the

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Budget Item Justification  
(Exhibit R-2, page 14 of 26)

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603707N

PROJECT NUMBER: R1770

PROGRAM ELEMENT TITLE: Manpower, Personnel, and  
Training Advanced Technology  
Development

PROJECT TITLE: Manpower and Personnel  
Development

model through the Internet. Managers from BUPERS and the fleet can enter the policy inputs, execute the model, and review requisitions through the web.

- Completed:

- (U) Completed development of the Selection and Classification Management effort. Developed two innovative classification models. Captured the vocational interest framework of Navy jobs as a foundation for developing a Navy vocational interest inventory with sufficient detail and structure necessary for optimal classification decisions. Developed predictive model of school success using new criteria (First Pass Pipeline Success) which goes beyond the traditional definition of a successful student as one who passes Aschool; instead looks at optimal performance throughout the training pipeline, including costly academic setbacks and recycling.
- (U) Completed Modeling and Information Advances for Enlisted Management (MIADEM) effort that provides improved school and sea/shore planning capabilities, resulting in higher productivity and more effective personnel policy decisions. Incorporated school and sea/shore optimization into the webbased prototype variable dimensional community management tool.
- (U) Completed the Computing and Communications technology for Recruiting (REMOTE) effort for the Boston and the San Diego area Navy Recruiters. Most notably, recruiters are now able to work anywhere, anytime using the computer and communications tools provided as part of the REMOTE project. The final results, costs, and benefits will be evaluated and Navy wide implementation recommendations will be completed in the first quarter, FY00.
- (U) Completed Training and Transfer Costs for Navy Personnel Models effort using computer simulation to tie together current systems, and track the status of each person and each billet over the duration of the planning horizon. The model projects personnel flows for training and transfer and their associated costs, providing tools needed to make accurate estimates of permanent change of station/Temporary Duty Under Instructions costs for assessment planning.

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Budget Item Justification  
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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603707N

PROJECT NUMBER: R1770

PROGRAM ELEMENT TITLE: Manpower, Personnel, and  
Training Advanced Technology  
Development

PROJECT TITLE: Manpower and Personnel  
Development

(U) FY 2000 PLAN:

- Initiate:
  - (U) Manpower Implications of Advertising to Target Markets (TAMI) effort seeks to determine how advertising affects the propensity to enlist in the Navy. In FY00, an advertising literature review will be conducted, current methodologies, metrics and approaches will be explored, and alternative metrics will be developed.
  - (U) Enlisted Manpower and Personnel Integrated Planning System (EMPIPS) effort will begin developing sophisticated techniques to dynamically identify the data elements and conditions which are likely to have a significant impact on the health (quantity and quality) of the enlisted force. In FY00, user requirements will be identified. A preliminary design concept will be developed. Development of an Integrated Data Environment will be initiated. A proof of concept cost dimension of SKIPPER III (third generation of a system Skilled Personnel Projection for Enlisted Retention) will be initiated.
  - (U) Rating Identification Engine (RIDE) is a classification subproject enabled by the development of a multi-dimensional classification model, which focuses on combating attrition through maximizing training pipeline success, minimizing personnel resource wastage, and emphasizing job satisfaction. Laboratory development of an evolutionary model using a modular combination of ability and interest specifications to improve the Sailor to Rating match; model specifically constructed to reduce attrition, minimize training wastage and improve job satisfaction. Utilizes an innovative success criteria (First Pass Pipeline Success) which goes beyond the traditional definition of a successful student as one who passes A-school; instead looks at optimal performance throughout the training pipeline, including costly academic setbacks and recycling. In FY00 efforts towards model development (research, analysis, design, prototype algorithms, laboratory test, evaluation and assessment) and process redesign (problem diagnosis, end-state vision) will begin.
  - (U) Skill Assessment, Training, Evaluation, and Assistance for Recruiters (STEAR) subproject builds upon the 6.2 New Personnel Assessment Technology project and the 6.3 Computer Communications Technologies for Recruiters projects. This new effort will identify characteristics of successful recruiters and assess what their

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Budget Item Justification  
(Exhibit R-2, page 16 of 26)

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603707N

PROJECT NUMBER: R1770

PROGRAM ELEMENT TITLE: Manpower, Personnel, and  
Training Advanced Technology  
Development

PROJECT TITLE: Manpower and Personnel  
Development

training needs are. The characteristics and needs will be used to evaluate both primary and refresher training for recruiters. Similarly, the project will elucidate current selection processes for Navy recruiters and measure personality characteristics of incoming recruiters and compare these results to successful recruiters and current training curricula. Combining these sources of information, the project will specify how training can be improved and how training may be tailored to the personality characteristics of candidate recruiters. In FY00, the current recruiter selection process and evaluation and goaling system will be documented. Recruiters will be surveyed on job skills/activities, training efficacy, job satisfaction, and quality of life issues. A recruiter database will be developed from the Enlisted Master File to include recruiter surveys, training results, productivity measures, and turnover rates. Likely selection measures will be identified and located, pilot tested and modified. Recruiters will be observed on-the-job to determine what training would help them become productive sooner, do their jobs better, and perhaps improve their quality of life.

- (U) Training Continuum and Readiness Modeling (TCARM) will focus on developing and assessing a simulation and optimization model of the training continuum's requirements and resourcing. A requirements analysis and conceptual design will be done in FY00 as will data collection and performance measurement development.

- Continue:

- (U) Continue CofME effort. Historical data for an Officer econometric retention / accession model will be collected, data cleansing techniques and facilities will be developed, and force monitoring techniques will be specified.

- Complete:

- (U) Complete ESPA effort. A prototype long-range multidimensional policy assessment system (NEFAM) will be completed, enabling significant gains associated with forecast error. Manpower requirements will be compared with personnel forecasts by paygrade and produce an assessment of the shortages and surpluses in both manpower

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Budget Item Justification  
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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603707N

PROJECT NUMBER: R1770

PROGRAM ELEMENT TITLE: Manpower, Personnel, and Training Advanced Technology Development

PROJECT TITLE: Manpower and Personnel Development

- readiness and dollar terms. The system will be tested and evaluated. A forecasting accuracy tool will be incorporated into SPAN forecasts.
- (U) Complete D2K effort. An integrated conceptual model will be recommended, to seamlessly link the allocation, manning, requisition, and assignment distribution process. The advantages, disadvantages and risks of the alternative approaches presented will be evaluated.

(U) FY 2001 PLAN:

- Initiate:
  - (U) Initiate Prototype for Assessing Total Force Manpower Management System (TFMMS) Change Requests effort. This effort's objective is to explore the feasibility of using artificial intelligence: Expert Systems, Fuzzy Logic, and Neural Networks to develop a prototype system to improve the TFMMS manpower change process. The inability of TFMMS to capture the critical Navy manpower business practices with respect to seashore rotation, Defense Officer Personnel Management Act, validity of application of military essentiality codes, Navy Enlisted Classification requirements, and others results in inaccurate demand signals to the fleet that must be corrected. The preliminary prototype system will be designed based on the preliminary knowledge developed during this first year.
  - (U) Initiate Shore-based Forces Attrition Model. The objective of this effort is to demonstrate new technologies applicable to estimating the quantity and quality of personnel replacements and fillers needed to support contingency and war plans. These new technologies will be synthesized into a demonstration system that will assist Operation Plan, mobilization and personnel planners to better manage Active and Reserve Component personnel for use as attrition replacements.
  - (U) Initiate Simulation Modeling Tool for Manpower Requirements (SimBas) effort. Development of a prototype simulation model that will capture the relationship between Navy force structure (e.g., ships, aircraft) and supporting infrastructure. Such a model would be expected to provide manpower, financial and facility planners

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Budget Item Justification  
(Exhibit R-2, page 18 of 26)

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603707N

PROJECT NUMBER: R1770

PROGRAM ELEMENT TITLE: Manpower, Personnel, and  
Training Advanced Technology  
Development

PROJECT TITLE: Manpower and Personnel  
Development

with a tool to assess the impact of changes in force structure size, configuration and operating tempo on the size of the Navy's infrastructure. The first year's effort will focus on detailing the functional requirements, data needs and developing the model design.

- Continue:
  - (U) Continue COFME effort. An Officer econometric retention / accession model will be developed, quality of life data will be collected, force monitoring techniques will be developed.
  - (U) TAMI effort will initiate a decision support system that will facilitate advertising resource allocation and provide measures of effectiveness for alternative advertising strategies. Alternative metrics and models and methodologies will be developed and based upon earlier stages of TAMI, improvements on metrics, models and methodologies currently being used to determine effective marketing strategies to target groups will be proposed.
  - (U) EMPIPS effort will research software modeling and simulation, methods of model and data integration, component based development, internet / intranet implementation, data quality management and cleansing, intelligent software agents, data mining and warehousing, and forecasting methodologies. In FY01, the Integrated Data Environment will be completed. The cost dimension prototype for SKIPPER III will be generalized and the generalize prototype completed. Development of an EMPIPS Accession Planning System prototype and Skill-All Navy (ALNAV) System will be initiated. Work will continue on developing the integrated model prototype.
  - (U) RIDE effort will provide laboratory development of RIDE classification systems software including interface optimization, prototyping and demonstration. Focuses on the delivery of the model as being as important as the validity of the model; classification as part of the recruiting sales process requires a credible, configurable, user-friendly delivery.
  - (U) STEAR effort will begin to evaluate the training curriculum for recruiters, to insure that the coursework is providing the proper skills and experiences to prepare recruiters for their work. Successful and unsuccessful

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Budget Item Justification  
(Exhibit R-2, page 19 of 26)

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603707N

PROJECT NUMBER: R1770

PROGRAM ELEMENT TITLE: Manpower, Personnel, and Training Advanced Technology Development  
PROJECT TITLE: Manpower and Personnel Development

recruiters will be identified. New selection measures will be administered to determine what differentiates the successful and unsuccessful recruiters. Recruiters will be surveyed on job satisfaction, what they like and do not like, what is difficult and easy. Recruiters will be surveyed about what was good, beneficial, unnecessary, and/or missing in their training. Results of this survey will be related to the current curriculum.

- (U) As part of the development of simulation models for Navy-wide impact, the TCARM effort will design a simulation model to analyze the Training Planning and Execution process and collect data to run the simulation.

B. (U) PROGRAM CHANGE SUMMARY: See Total Program Summary for Total Program Element.

C. (U) OTHER PROGRAM FUNDING SUMMARY: Not applicable.

(U) RELATED RDT&E: This project adheres to Tri-Service Reliance Agreements on Human Systems Technology. Work is related to and fully coordinated with efforts in:

- (U) PE 0601152N In-House Laboratory Independent Research
- (U) PE 0601153N Defense Research Sciences
- (U) PE 0602233N Human Systems Technology
- (U) PE 0603007A Manpower, Personnel and Training Advanced Technology
- (U) PE 0603227F Personnel, Training, and Simulation Technology

D. (U) SCHEDULE PROFILE: Not applicable.

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Budget Item Justification  
(Exhibit R-2, page 20 of 26)

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# UNCLASSIFIED

FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 3      PROGRAM ELEMENT: 0603707N  
 PROGRAM ELEMENT TITLE: Manpower, Personnel, and  
 Training Advanced Technology  
 Development

(U) COST: (Dollars in thousands)

PROJECT NUMBER & TITLE	FY 1999 ACTUAL	FY 2000 ESTIMATE	FY 2001 ESTIMATE	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	TO COMPLETE	TOTAL PROGRAM
R1772 Education and Training Development	11,612	13,055	13,333	13,684	11,560	11,271	10,869	CONT.	CONT.

A. (U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: This project supports the Integrated Warfare Architecture (IWAR) Support Area for Training, as well as most IWAR Mission Areas and Joint Chiefs of Staff Future Joint Warfighting Capabilities, all of which depend on high quality training to ensure mission success. It also supports the Future Naval Capabilities for Capable Manpower by responding to requirements for effective and affordable education, training and mission rehearsal capability through applying advanced simulation technology and innovative instructional concepts to the design of individual and team training methods and systems. It applies operations research, modeling / simulation, and instructional, cognitive, and computer sciences to improve: (a) training throughput, efficiency and affordability necessary for "right-sizing" both the operational forces and the training infrastructure; (b) the effectiveness of training for increasingly complex weapons systems employed in littoral warfare, under fast-paced and stressful conditions, and with limited opportunities for "real-world" practice; and (c) training assessment and training system feedback capabilities for maximizing training responsiveness to operational requirements.

(U) PROGRAM ACCOMPLISHMENTS AND PLANS:

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Budget Item Justification  
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# UNCLASSIFIED

FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603707N

PROJECT NUMBER: R1772

PROGRAM ELEMENT TITLE: Manpower, Personnel, and  
Training Advanced Technology  
Development

PROJECT TITLE: Education and Training  
Development

## (U) FY 1999 ACCOMPLISHMENTS:

- Initiated:
  - (U) Development of Conning Officer Virtual Environment (COVE) modular training technologies for teaching ship handling knowledge and skills for various classes of ships. The technology demonstrator will deliver initial, intermediate, advanced, and remedial, "seaman's eye," ship handling instruction and practice which alternatively tests and remediates until mastery is complete for a wide variety of ship handling tasks.
  - (U) Development of Intelligent Exercise Planning and Control Agents (IEPCA), a system that supports planning and real-time control and modification of training-objectives-based scenarios in large-scale modeling and simulation training environments.
  - (U) Development of Computer Simulation Based Training System with Intelligent Tutoring Components (CSITS). This project uses cost-efficiently authored interactive simulations and tutoring systems teaching trouble-shooting to improve the instructional effectiveness of fundamental technical training in electronics. Completed curriculum design and selection of instructional strategies, developed two curriculum modules, and conducted initial evaluation of usability.
- Continued:
  - (U) Conducted Deployable Sonar Operator Trainer (DSOT) development and evaluation, including onboard data hcollection. For evaluation purposes, prototype systems were built for test and evaluation aboard ship. Scenario-based performance exercises were constructed to include opportunities for users to develop search plans and propose tactics to deal with particular sonar or environmental circumstances. Evaluation methods for user planning and tactical knowledge were developed.
  - (U) Demonstrated authoring tool for the creation of multimedia training materials and lessons in the area of tactical decision-making (TDM) in the AEGIS environment, and a delivery tool for the actual presentation and management of instruction.

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Budget Item Justification  
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## FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603707N

PROJECT NUMBER: R1772

PROGRAM ELEMENT TITLE: Manpower, Personnel, and  
Training Advanced Technology  
Development

PROJECT TITLE: Education and Training  
Development

- (U) Continued development of required technology components and demonstrated Transportable Strike/Assault Rehearsal System (TSTARS) for precision strike using validated training mission rehearsal requirements, simulation components and supporting databases. Advanced the state-of-the-art in real-time physics-based sensor modeling and simulation.

- Completed:

- (U) Interactive Multisensor Analysis Trainer (IMAT) development and evaluation in shore school based Undersea Warfare training and at-sea anti-submarine warfare (ASW) exercises.
- (U) Implemented Training Effectiveness Assessment Methodologies (TEAM) automated performance recording and assessment of individual and team skills in order to greatly improve deployable tactical training and readiness.

(U) FY 2000 PLAN:

- Initiate:
  - (U) Initiate the development of Synthetic Cognition for Operations Team Training (SCOTT) performance models of simulated teammates and a training research testbed to investigate instructional strategies for training an individual within a simulated environment.
- Continue:
  - (U) Continue DSOT development and evaluation Phase II.
  - (U) Design and develop initial software components for the COVE intelligent tutoring system, instructor/operator system, and marine simulation. Conduct task analysis for shiphandling tasks.

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Budget Item Justification  
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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603707N

PROJECT NUMBER: R1772

PROGRAM ELEMENT TITLE: Manpower, Personnel, and  
Training Advanced Technology  
Development

PROJECT TITLE: Education and Training  
Development

- (U) Continue the development of an authoring tool for the creation of multimedia training materials and lessons in the area of tactical decision making (TDM) in the AEGIS environment, and a delivery tool for the actual presentation and management of instruction. Conduct a training effectiveness evaluation.
- (U) Continue CSITS development completing two-thirds of planned curriculum, and conduct classroom experiments to determine time requirements and instructional effectiveness of the completed curriculum modules.
- (U) Continue IEPCA development, focusing primarily on designing and developing common data structures to enable distributed databases to act in a collaborative manner.

- Complete:

- (U) Implement TSTARS for precision strike using validated training mission rehearsal requirements, physics based sensor models for Forward Looking Infrared Radar and night vision goggles, correlated sensor displays, and supporting data bases.

- (U) FY 2001 PLAN:

- Initiate:

- (U) Initiate the development of Computer-based Automated Training Effectiveness Evaluation System (CATEES). This effort will develop and demonstrate a computer-based training support toolkit, and a data warehouse and management system. The toolkit will contain a mode for assessing skill proficiency based on job sample testing, and a mode for supporting the development of training scenarios and measuring performance. The data warehouse and management system will be a repository for training performance data storage, and will contain the necessary capabilities for normative databasing, trend analysis, "what if" simulations, and estimating readiness.

- Continue:

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603707N

PROJECT NUMBER: R1772

PROGRAM ELEMENT TITLE: Manpower, Personnel, and  
Training Advanced Technology  
Development

PROJECT TITLE: Education and Training  
Development

- (U) Continue DSOT development and evaluation Phase III, including A-RCI (Advanced Reconfigurable COTS Insertion upgrade for submarine combat systems) interface and further at-sea test and evaluation.
- (U) Integrate, test and evaluate the COVE modular training system. Incorporate required enhancements, and conduct a training effectiveness evaluation in a classroom and at sea.
- (U) Integrate SCOTT performance models of simulated teammates into the training research testbed and experimentally determine the effectiveness and additional perceptual requirements for individual training within a simulated team environment.
- Complete:
  - (U) Implement an authoring tool for the creation of multimedia training materials and lessons in the area of TDM in the AEGIS environment to enable faster and better tactical decisions.
  - Complete planned development and evaluation of the CSITS electronics-training curriculum. Evaluate cost-effectiveness of experimental authoring tools used in curriculum development. Demonstrate potential for internet delivery of distance instruction.

B. (U) PROGRAM CHANGE SUMMARY: See Total Program Summary for Total Program Element.

C. (U) OTHER PROGRAM FUNDING SUMMARY: Not applicable.

(U) RELATED RDT&E: This project adheres to Tri-Service Reliance Agreements on Human Systems Technology. Work is related to and fully coordinated with efforts in:  
(U) PE 0601152N In-House Laboratory Independent Research  
(U) PE 0601153N Defense Research Sciences  
(U) PE 0602233N Human Systems Technology

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Budget Item Justification  
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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603707N

PROJECT NUMBER: R1772

PROGRAM ELEMENT TITLE: Manpower, Personnel, and  
Training Advanced Technology  
Development

PROJECT TITLE: Education and Training  
Development

- (U) PE 0604703N Personnel, Training, Simulation, and Human Factors
- (U) PE 0603007A Manpower, Personnel, and Training Advanced Technology
- (U) PE 0603227F Personnel, Training, and Simulation Technology

D. (U) SCHEDULE PROFILE: Not applicable.

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

Date: February 2000

UDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603712N

PROGRAM ELEMENT TITLE: Environmental Quality & Logistics Advanced Technology

U) COST: (Dollars in Thousands)

PROJECT NUMBER & TITLE	FY 1999 ACTUAL	FY 2000 ESTIMATE	FY 2001 ESTIMATE	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	TO COMPLETE	TOTAL PROGRAM
1910 Logistics Engineering Advanced Demonstrations (LEAD)	15,922	18,411	18,680	19,282	18,946	19,394	19,239	CONT.	CONT.
2206 Environmental Requirements Advanced Technology (ERAT)	4,145	5,194	5,322	5,961	5,902	5,849	5,767	CONT.	CONT.
2384 Visualization of Technical Information	98	74	0	0	0	0	0	0	2,071
2498 Visualization of Technical Information	1,936	2,984	0	0	0	0	0	0	4,920
2719 Allegheny Ballistics Laboratory	0	994	0	0	0	0	0	0	994
<b>TOTAL</b>	<b>22,101</b>	<b>27,657</b>	<b>24,002</b>	<b>25,243</b>	<b>24,848</b>	<b>25,243</b>	<b>25,006</b>	<b>CONT.</b>	<b>CONT.</b>

(U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: This program element funds the Navy's advanced technology development core efforts in environmental quality and logistics. The focus is on Navy-unique aspects of these technologies. The Logistics Engineering Advanced Demonstrations (LEAD) project supports, maintains and upgrades Navy systems and processes. It extends systems life cycles and streamlines processes to increase reliability and reduce operations. Environmental requirements Advanced Technology (ERAT) an environmental quality project is aimed at demonstrating ways to reduce shipboard pollution, remediation of harbors and shore facilities, and improve industrial treatment processes. Program response to

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Date: February 2000

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603712N

PROGRAM ELEMENT TITLE: Environmental Quality & Logistics Advanced Technology

ffordability requirements includes research and development on antifouling hull coatings, waterfront structures, amphibious logistics, maintenance, electronics logistics and replenishment. The program directly support the proposed Future Naval capabilities in Total Ownership Cost and Expeditionary Logistics.

U) The Navy S&T program includes projects that focus and have attributes that enhance the affordability of warfighting systems.

U) JUSTIFICATION FOR BUDGET ACTIVITY: This program is budgeted within the ADVANCED TECHNOLOGY DEVELOPMENT Budget Activity because it encompasses design, development, simulation, or experimental testing of prototype hardware to validate echnological feasibility and concept of operations and reduce technological risk prior to initiation of a new acquisition program or transition to an ongoing acquisition program.

## (U) PROGRAM CHANGE SUMMARY:

(U) FY 2000 President's Budget:	<u>FY 1999</u>	<u>FY 2000</u>	<u>FY 2001</u>
(U) Appropriated Value:	23,373	23,809	22,513
	-	27,809	-

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Date: February 2000

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603712N

PROGRAM ELEMENT TITLE: Environmental Quality & Logistics Advanced Technology

(U) Adjustments from FY 2000 PRESBDG:				
Program Adjustments	0	0	0	+1,785
SBIR/STTR Transfer	-228	0	0	0
Execution Adjustments	-941	0	0	0
Inflation Rate Adjustment	-103	0	0	0
Congressional Rescissions	0	-152	0	0
Various Rate Adjustments	0	0	0	-287
SSP	0	0	0	-9
Congressional Adds:				
Visualization of Technical Information	0	3,000	0	0
Allegheny Ballistics Laboratory	0	1,000	0	0
(U) FY 2001 PRESBDG Submission:	22,101	27,657	24,002	24,002

(U) CHANGE SUMMARY EXPLANATION:

- Schedule: Not applicable.
- Technical: Not applicable.

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Budget Item Justification  
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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

Date: February 2000

UDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603712N

PROGRAM ELEMENT TITLE: Environmental Quality & Logistics Advanced Technology

U) COST: (Dollars in Thousands)

PROJECT NUMBER & TITLE	FY 1999 ACTUAL	FY 2000 ESTIMATE	FY 2001 ESTIMATE	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	TO COMPLETE	TOTAL PROGRAM
1910 Logistics Engineering Advanced Demonstrations (LEAD)	15,922	18,411	18,680	19,282	18,946	19,394	19,239	CONT.	CONT.

(U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: This project develops technologies to support vital and integral logistics aspects of Joint Mission Areas, specifically in Support & Infrastructure and Readiness. Science and Technology investment in logistics assures affordable technologies that provide rapid deployment, replenishment, and sustainment of Naval and other combat forces in peacetime and wartime operations. Other needs addressed include reducing life cycle and maintenance costs while increasing system capability and readiness. This project also responds to several Defense Technology Area Plan (DTAP) goals, including Materials & Process and Ground & Sea Vehicles. This project responds to Defense Science & Technology Strategy Areas including: Affordability, Dual Use, and Strong Technology Base. The LEAD project improves weapon system readiness and supportability through development of advanced logistics technology. Tasks in this project typically fall into the following categories per the Defense Logistics Agency: Supply, Maintenance, Transportation, and Engineering. This project facilitates transition of concepts from Applied Research to higher development categories or directly to the fleet.

(U) PROGRAM ACCOMPLISHMENTS AND PLANS:

1. (U) FY 1999 ACCOMPLISHMENTS:

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Date: February 2000

UDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603712N

PROJECT NUMBER: R1910

PROGRAM ELEMENT TITLE: Environmental Quality  
& Logistics Advanced Technology

PROJECT TITLE: Logistics Engineering Advanced  
Demonstration (LEAD)

- (U) Condition Based Maintenance (CBM):
  - (U) Completed development of aircraft corrosion sensor system utilizing a radio transceiver and a lap-top computer for the implementation of condition based maintenance.
  - (U) Evaluated corrosion sensors based on corrosion potential measurements in the ballast tanks of operating ships for the implementation of condition based maintenance.
- (U) Real Time Infrared (RTIR):
  - (U) Continued optics upgrade fabrication, and performed system integration for RTIR Test Set. A series of hardware demonstrations were begun to offer potential transition partners the opportunity to observe the qualities of the test set which will make it a useful tool for in-field testing of weapons systems.
- (U) Battery Charger/Analyzer:
  - (U) Developed battery diagnostics and charge technology that will reduce maintenance and extend the service life of the batteries. Development of a nickel-cadmium diagnostic algorithm was completed; lead-acid and nickel-cadmium software were developed.
- (U) D-Day Mobile Fuel Distribution:
  - (U) Developed and demonstrated light weight, high strength, collapsible, fluid containers and rapid fluid transfer mechanisms to provide the capability for expeditious ship-to-shore movement of fuel and other liquids during the initial stages of an amphibious assault. System requirements and interfaces for each of the proposed systems were completed.
- (U) Low Cost Radio Frequency (RF) Power Measurement Devices:

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Date: February 2000

UDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603712N

PROJECT NUMBER: R1910

PROGRAM ELEMENT TITLE: Environmental Quality  
& Logistics Advanced Technology

PROJECT TITLE: Logistics Engineering Advanced  
Demonstration (LEAD)

- (U) Produced RF power measurements devices to achieve improved affordability by reducing initial acquisition cost, reducing logistics manpower, minimizing life-cycle cost of power measurement equipment, improving maintenance techniques and processes, and reducing personnel injury/material damage. Demonstrated the operation and performance of a micromachined power sensor and Effective Isotropic Radiated Power (EIRP) detection elements and subsystems in chip form.
- (U) Naval Total Asset Visibility (NTAV):
  - (U) Continued to demonstrate the concepts of wide-area asset visibility using (RFID) technology and interoperability with logistics command and control systems. Completed system criteria definition; completed system integration elements of satellite communications, remote maintenance monitoring, and Combat Service Support Operations Center (CSSOC).
- (U) Affordable Green Energetics:
  - (U) Demonstrated twin-screw extruder processing of BAMO-AMMO Thermoplastic Elastomer (TPE) based propellants. Demonstrated recycling processes for TPE-based propellants and TPE-based explosives in the laboratory. Conducted 5" gun firing at Dahlgren test range and 5" static rocket motor firing on a Thiokol Propulsion test stand using TPE-based propellants. Estimated life cycle cost of TPE-based propellants and TPE-based explosives in the Extended Range Guided Munition (ERGM) will be 15% less than conventional propellants and explosives.
- (U) Technology Assessment Management Tool
  - (U) Developed a comprehensive capability to proactively manage all aspects of support and sustainment of military systems whether the system or support is government derived or commercial. This task developed

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Date: February 2000

UDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603712N

PROJECT NUMBER: R1910

PROGRAM ELEMENT TITLE: Environmental Quality & Logistics Advanced Technology  
PROJECT TITLE: Logistics Engineering Advanced Demonstration (LEAD)

methodologies, processes, and techniques to make current and future weapons systems and infrastructures more affordable by increasing systems life cycle, decreasing cost of support, and increasing operational effectiveness through modernization.

- (U) Arc Fault Wire Protection
  - (U) Developed the ability to detect a 400Hz power wire insulation failure which could ignite a fire on the ground or in the air. This affordable arc fault detection reduced the maintenance time to find the damaged wire to be repaired by 35%.
- (U) Autonomous Marine Booster Pump (AMBP)
  - (U) Developed a reliable, automated pressure boosting mechanism to permit ship-to-shore transfer of bulk liquids from extended standoff distances during the assault phase of an amphibious operation where shallow beach gradients, subsequent standoff distances, and rapid installation are critical factors. AMBP conceptual designs have been refined and analysis and benchtop testing have been conducted to validate concept feasibility.
- (U) Pier Lateral Stability
  - (U) Developed non-destructive diagnostic techniques coupled with computer modeling to rapidly assess pier capacity to resist lateral loads imposed by berthing impact, wind, and current on berthed vessels, or by earthquakes. The project increased flexibility of berthing vessels. Fewer in-port movements of vessels will be required to accommodate re-supply and intermediate maintenance functions.
- (U) High Sea State Shipboard Crane Technology

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

Date: February 2000

UDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603712N

PROJECT NUMBER: R1910

PROGRAM ELEMENT TITLE: Environmental Quality & Logistics Advanced Technology  
PROJECT TITLE: Logistics Engineering Advanced Demonstration (LEAD)

- (U) Developed enhanced capabilities and reduced training requirements for advanced shipboard crane to facilitate loading/unloading operations in sea states 3 and above.
- (U) Waterfront Structures Repairs and Upgrades
  - (U) Completed demonstration of improved performance of new technology for waterfront structures. Demonstrated ability of laminate quality and strain monitoring systems to assess load safety of upgraded hybrid concrete/composite structures. Demonstrated corrosion stabilization system.
- (U) SEAWAY
  - (U) Developed adaptive command and control to planning and execution of Joint Logistics Over-the-Shore/maritime logistic operations by applying the Integrated Cooperative Decision-Making (ICDM) framework. This task responded to the demand for responsive sea-based support to Joint Vision 2010, particularly the requirement to enable ship-to-objective maneuver (STOM), deep inland operations, and a reduced logistic footprint ashore.
- (U) Ship-Based Theatre Logistics Management and Distribution
  - (U) Developed a maritime logistic and sea basing support system for the management of theatre logistics using agent-based collaborative planning technology. This task: projected, planned and directed the flow of supplies during sea base operations within the sea base, from ship to shore, and/or from ship to inland objectives; visualize cargo items on a theater-wide basis; projected availability ashore of any item stowed in vessels destined for or located within the contingency area.
- (U) Proton Exchange Membrane (PEM) Fuel Cell Using Synthetic Logistic Fuel

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Date: February 2000

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603712N

PROJECT NUMBER: R1910

PROGRAM ELEMENT TITLE: Environmental Quality

PROJECT TITLE: Logistics Engineering Advanced Demonstration (LEAD)

& Logistics Advanced Technology

- Demonstrated the possibility of using synthetic fuels to power PEM fuel cells. At present, fuel cells are powered by natural gas. Logistically, batteries can be replaced on-shore or on-board with the added benefit that a fuel cell provides energy at constant voltage until all the fuel is consumed.

- (U) AutoLog Advanced Model Development and Demonstration

- Developed a land- and sea-based container handling capability through a new class of Large Cable Array Robots (LCARs). The task will provide an approach to controlling the motion of containers suspended from cranes in sea state 3 and higher.

2. (U) FY 2000 PLAN:

- (U) CBM:

- (U) Evaluate radio-monitored corrosion sensor in naval H-60 helicopters and initiate evaluation in naval P-3 aircraft for the implementation of condition based maintenance.

- (U) Continue evaluation on corrosion sensors based on corrosion potential measurements in ballast tanks of operating naval ships for the implementation of condition based maintenance.

- (U) Real-Time Infrared Test Set

- (U) Continue development of technology for in-field testing of weapons systems. This technology will increase the ability to isolate faults at lower levels in the logistics maintenance structure, reduce required time for maintenance, and decrease the number of sensor and seeker test systems required in the logistics chain necessary to provide a given degree of operational readiness.

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Date: February 2000

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603712N

PROJECT NUMBER: R1910

PROGRAM ELEMENT TITLE: Environmental Quality & Logistics Advanced Technology  
PROJECT TITLE: Logistics Engineering Advanced Demonstration (LEAD)

- (U) D-Day Mobile Fuel Distribution
- (U) Develop and demonstrate light-weight, high-strength, collapsible fluid containers and rapid fluid transfer mechanisms to provide the capability for expeditious ship-to-shore movement of fuel and other liquids during the initial stages of an amphibious assault.
- (U) Low Cost RF Power Measurement Devices
- (U) Produce RF power measurements devices to achieve improved affordability by reducing initial acquisition cost, reducing logistics manpower, minimizing life-cycle cost of power measurement equipment, improving maintenance techniques and processes, and reducing personnel injury/material damage.
- (U) Naval Total Asset Visibility
- (U) Continue to demonstrate the concepts of wide-area asset visibility using RFID technology and interoperability with logistics command and control systems.
- (U) Affordable Green Energetics
- (U) Affordable High Lethality Green Energetic Materials will demonstrate propellents and explosives which can lower the life-cycle cost of ordnance systems by reducing the waste and pollution created during manufacture and loading of the materials and by reducing the waste and pollution created during the demilitarization of the propellants and explosives at the end of the useful life of ordnance.
- (U) Technology Assessment Management Tool
- (U) Develop a comprehensive capability to proactively manage all aspects of support and sustainment of military systems whether the system or support is government derived or commercial.

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Date: February 2000

UDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603712N

PROJECT NUMBER: R1910

PROGRAM ELEMENT TITLE: Environmental Quality  
& Logistics Advanced Technology

PROJECT TITLE: Logistics Engineering Advanced  
Demonstration (LEAD)

- (U) Arc Fault Wire Protection
- (U) Develop the ability to detect a 400Hz power wire insulation failure which could ignite a fire on the ground or in the air.
- (U) Autonomous Marine Booster Pump (AMBP)
- (U) Develop a reliable, automated pressure boosting mechanism to permit ship-to-shore transfer of bulk liquids from extended standoff distances during the assault phase of an amphibious operation.
- (U) Pier Lateral Stability
- (U) Develop non-destructive techniques coupled with computer modeling to rapidly assess pier capacity to resist lateral loads imposed by berthing impact, wind, and current on berthed vessels, or by earthquakes.
- (U) High Sea State Shipboard Crane Technology
- (U) Develop enhanced capabilities and reduced training requirements for advanced shipboard crane to facilitate loading/unloading operations in sea states 3 and above.
- (U) SEAWAY
- (U) Develop adaptive command and control to planning and execution of Joint Logistics Over-the-Shore/maritime logistic operations by applying the Integrated Cooperative Decision-Making (ICDM) framework. This task responds to the demand for responsive sea-based support to Joint Vision 2010, particularly the requirement to enable ship-to-objective maneuver (STOM), deep inland operations, and a reduced logistic footprint ashore.
- (U) AIRWAY

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PROGRAM ELEMENT: 0603712N

PROJECT NUMBER: R1910

PROGRAM ELEMENT TITLE: Environmental Quality  
& Logistics Advanced Technology

PROJECT TITLE: Logistics Engineering Advanced  
Demonstration (LEAD)

- (U) Develop adaptive command and control to planning and execution of Joint Logistics Over-the-Shore/aircraft logistic operations by applying the Integrated Cooperative Decision-Making (ICDM) framework. This task assists the logistics support effort of moving men and material from ship to shore and inter-theater operation.
- (U) Ship-Based Theatre Logistics Management and Distribution
- (U) Continue the development of a maritime logistic and sea basing support system for the management of theatre logistics using agent-based collaborative planning technology. This task would: project, plan and direct the flow of supplies during sea base operations within the sea base, from ship to shore, and/or from ship to inland objectives; visualize cargo items on a theater-wide basis; project availability ashore of any item stowed in vessels destined for or located within the contingency area. In conjunction with SEAWAY a demonstration of visibility is planned.
- (U) AutoLog Advanced Model Development and Demonstration
- Develop a land- and sea-based container handling capability through a new class of Large Cable Array Robots (LCARs). The task will provide an approach to controlling the motion of containers suspended from cranes in sea state 3 and higher.
- (U) Collaborative Infrastructure Assessment Tool
- (U) Demonstrate port infrastructure planning tool with user conflict resolution capabilities. This technology would optimize operations and Navy infrastructure, lowering operational costs.
- (U) Seabased Logistic Modeling & Simulation
- (U) Develop a sea-based logistics technology assessment tool with intelligence.

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Date: February 2000

UDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603712N

PROJECT NUMBER: R1910

PROGRAM ELEMENT TITLE: Environmental Quality  
& Logistics Advanced Technology

PROJECT TITLE: Logistics Engineering Advanced  
Demonstration (LEAD)

- (U) Submersible Cache:

- (U) Develop a near-shore submersible fuel and dry cargo cache to provide immediate moveable logistics facility, extend range of Sea Base transporters, and provide uninterrupted supply for troops ashore.

• FY 2001 PLAN

- (U) High Sea State Shipboard Crane Technology

- (U) Continue to develop enhanced capabilities and reduced training requirements for advanced shipboard crane to facilitate loading/unloading operations in sea states 3 and above. In particular, the control system will be refined.

- (U) SEAWAY

- (U) Continue to develop adaptive command and control to planning and execution of Joint Logistics Over-the-Shore/maritime logistic operations by applying the Integrated Cooperative Decision-Making (ICDM) framework. This task responds to the demand for responsive sea-based support to Joint Vision 2010, particularly the requirement to enable ship-to-objective maneuver (STOM), deep inland operations, and a reduced logistic footprint ashore. A fully capable working system suitable for use and evaluation in CinC exercises will be completed.

- (U) AIRWAY

- (U) Continue to develop adaptive command and control to planning and execution of Joint Logistics Over-the-Shore/aircraft logistic operations by applying the Integrated Cooperative Decision-Making (ICDM) framework. A demonstration is planned for proof of feasibility.

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

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UDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603712N

PROJECT NUMBER: R1910

PROGRAM ELEMENT TITLE: Environmental Quality

PROJECT TITLE: Logistics Engineering Advanced Demonstration (LEAD)

& Logistics Advanced Technology

- (U) Ship-Based Theatre Logistics Management and Distribution
- (U) Continue the development of a maritime logistic and sea basing support system for the management of theatre logistics using agent-based collaborative planning technology. This task would: project, plan and direct the flow of supplies during sea base operations within the sea base, from ship to shore, and/or from ship to inland objectives; visualize cargo items on a theater-wide basis; project availability ashore of any item stowed in vessels destined for or located within the contingency area. This task in conjunction with SEAWAY will provide support to Cinc exercises.
- (U) AutoLog Advanced Model Development and Demonstration
- Continue to develop a land- and sea-based container handling capability through a new class of Large Cable Array Robots (LCARs). The task will provide an approach to controlling the motion of containers suspended from cranes in sea state 3 and higher. The developed algorithms will be demonstrated, both on land and aboard ship.
- (U) Collaborative Infrastructure Assessment Tool
- (U) Apply port infrastructure planning tool to Norfolk Naval Station and Naval Shipyard Bremerton. This technology would optimize operations and Navy infrastructure, lowering operational costs.
- (U) Arc Fault Wire Protection
- (U) Continue to develop the ability to detect a 400Hz power wire insulation failure which could ignite a fire on the ground or in the air. Prevent the occurrence of an Arc Fault through the use of sensors and specially tailored circuit breakers.
- (U) Technology Assessment Management Tool

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BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603712N

PROJECT NUMBER: R1910

PROGRAM ELEMENT TITLE: Environmental Quality  
& Logistics Advanced Technology

PROJECT TITLE: Logistics Engineering Advanced  
Demonstration (LEAD)

- Refine the capability to proactively manage all aspects of support and sustainment of military systems through the use of intelligent agents, whether the system or support is government derived or commercial.
- (U) Submersible Cache
  - Select the structure most suitable for a near-shore submersible fuel and dry cargo cache to provide immediate moveable logistics facility, extend range of Sea Base transporters, and provide uninterrupted supply for troops ashore.
- (U) Magnetostrictive Actuators
  - (U) Demonstrate magnetostrictive actuators for cargo/weapons elevator doors, reducing the quantity of components by 50%, eliminate hydraulic fluids, reduce maintenance hours, and reduce total ownership costs.
- (U) Shipboard Integrated Logistics System (SILS)
  - (U) Demonstrate integrated system of processes, sensors, diagnostics, condition-based maintenance and technical manuals to improve the quality, timeliness, and accuracy of logistics as well as decrease the cost by automating manpower-intensive tasks.
- (U) Strategic and Tactical Integrated Logistics System (STILS)
  - (U) Demonstration of a strategic and tactical integrated logistics system.
- (U) Integration of Logistics with Operations Planning
  - (U) This project will develop the support tools needed to identify the logistics requirements of the planned operation, as well as present and future readiness of the available logistic assets and processes. Intelligent

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PROGRAM ELEMENT: 0603712N

PROJECT NUMBER: R1910

PROGRAM ELEMENT TITLE: Environmental Quality  
& Logistics Advanced Technology

PROJECT TITLE: Logistics Engineering Advanced  
Demonstration (LEAD)

agents will search the appropriate databases created by the Strategic and Tactical Integrated Logistics System and will provide to the program planner the feasible options, with their specific costs while paying attention to the details of the planned operations.

(U) PROGRAM CHANGE SUMMARY: See total program change summary for P.E.  
(U) OTHER PROGRAM FUNDING SUMMARY: Not applicable.

(U) RELATED RDT&E:

(U) PE 0601153N (Defense Research Sciences)

(U) PE 0602233N (Human Systems Technology)

(U) PE 0602234N (Materials, Electronics, and Computer Technology)

(U) PE 0603792N (Advanced Technology Transition)

(U) SCHEDULE PROFILE: Not applicable.

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UDGET ACTIVITY: 3      PROGRAM ELEMENT: 0603712N  
 PROGRAM ELEMENT TITLE: Environmental Quality & Logistics Advanced Technology

U) COST (Dollars in Thousands)

PROJECT NUMBER & TITLE	FY 1999 ACTUAL	FY 2000 ESTIMATE	FY 2001 ESTIMATE	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	TO COMPLETE PROGRAM	TOTAL
2206 Environmental Requirements Advanced Technology (ERAT)	4,145	5,194	5,322	5,961	5,902	5,849	5,767	CONT.	CONT.

(U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: This project develops enabling technologies to support vital and integral Joint Mission Areas, specifically in Support & Infrastructure and Readiness for environmental protection. Science and Technology (S&T) investment in environmental technologies assures lowering operational costs, minimizing future adverse environmental impacts, enhancing deployment capabilities and attaining acceptable environmental standards in the production and use of platforms. Only by reducing or eliminating hazardous materials and those processes that generate hazardous by-products can the Department of Defense begin to lower overall compliance and cleanup costs. This project also addresses defense Technology Area Plan (DTAP) concerns relating to restriction on peacetime Naval operations and the cost of complying with environmental protection laws. This project is essential to fulfilling the DTAP goals including: reducing the volume of shipboard and facility hazardous waste disposal by 50 percent by the year 2000; demonstrating advanced biological treatment of organic waste to reduce costs by 50 percent and accurately monitoring and predicting noise impacts on marine species by the year 2002; and eliminating all polluted waste water discharges from ships and exceeding Marine Pollution (MARPOL) criteria worldwide by the year 2005.

U) This project supports near-term advances in support of the four Project Reliance environmental quality pillars: Pollution prevention, Clean-up, Conservation, and Compliance. Primary focus will be on minimizing shipboard pollution, remediation of harbors and shore facilities, and improved methods of industrial waste treatment.

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Date: February 2000

UDGET ACTIVITY: 3 PROGRAM ELEMENT: 0603712N  
PROGRAM ELEMENT TITLE: Environmental Quality & Logistics Advanced Technology

PROJECT NUMBER: R2206  
PROJECT TITLE: Environmental Requirements Advanced Technology

## (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

### 1. (U) FY 1999 ACCOMPLISHMENTS:

- (U) Initiated demonstration of new generation, low leaching, self-polishing, copper anti-fouling (AF) coatings for use as Marine Pollution Control Devices (MPCD) under the Uniform National Discharge Standards (UNDS) initiative.
- (U) Continued multi-national program for full-scale pierside treatment demonstration of shipboard-generated blackwater and graywater by advanced combined aeration and membrane technologies.
- (U) Continued demonstration of thermoacoustic technology for shipboard cooling applications. The 3-ton thermoacoustic cooler eliminates the dependence on ozone-depleting substances and global warming substances for cooling and has only one moving part for enhanced reliability.
- (U) Continued demonstration of mitigation technologies for minimizing the impact of Navy acoustic operations on protected marine mammals and development of safety criteria for marine mammals and other endangered species.
- (U) Completed integration and demonstration of hull sensors, cleaning tools and toxic paint capture and treatment technologies with an underwater hull maintenance vehicle (UHMV); transition to Advanced Development Program (PE 0603721N) for further integration (NAVSEA 03R) and implementation (SEA 00C).
- (U) Completion of the Living Marine Resources Information System for tracking and prediction of marine mammal occurrences; transition to the Oceanographic and Atmospheric Master Library, CNO 45, NAVOCEANO & CNMOC, and PE 0603721N for enhanced development.

### 3. (U) FY 2000 PLAN:

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Date: February 2000

UDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603712N

PROJECT NUMBER: R2206

PROGRAM ELEMENT TITLE: Environmental Quality &  
Logistics Advanced Technology

PROJECT TITLE: Environmental Requirements  
Advanced Technology

- (U) Initiate demonstration of air pollutant emission control and containment technologies as substitutes for open burning/open detonation and non-contained rocket testing, and for reduced NOx, Sox (types of nitrogen and sulfur compounds) and hazardous airborne particulates (HAP) emissions from Navy jet engines. These tasks are in support of establishing environmentally-compliant platforms and shore support operations.
- (U) Initiate demonstration of embedded sensor technology for hazardous material shelf life assessment and extension. This technology demonstration supports Navy requirements to reduce hazardous waste generation, disposal costs and environmental liability.
- (U) Initiate demonstration of drydock automated painting, overspray capture and treatment technologies for the elimination of VOC and HAP emissions during ship painting operations and to comply with environmental pollutant emissions regulations.
- (U) Initiate demonstration of active/passive sonobuoy technology for the detection of marine mammals. This technology mitigates the impact of fleet activities on marine mammals for compliance with the Marine Mammal Protection Act and Endangered Species Act.
- (U) Continued demonstration of new generation, low leaching, self-polishing, copper anti-fouling (AF) coatings for use as Marine Pollution Control Devices (MPCD) under the Uniform National Discharge Standards (UNDS) initiative.
- (U) Completed multi-national program for full-scale pier-side treatment demonstration of shipboard-generated blackwater and graywater by advanced combined aeration and membrane technologies.
- (U) Completed demonstration of thermoacoustic technology for shipboard cooling applications. The 3-ton thermoacoustic cooler eliminates the dependence on ozone-depleting substances and global warming substances for cooling and has only one moving part for enhanced reliability.

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Budget Item Justification  
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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

Date: February 2000

UDGET ACTIVITY: 3      PROGRAM ELEMENT: 0603712N      PROJECT NUMBER: R2206  
PROGRAM ELEMENT TITLE: Environmental Quality & Logistics Advanced Technology      PROJECT TITLE: Environmental Requirements Advanced Technology

- (U) Demonstration of mitigation technologies for minimizing the impact of Navy acoustic operations on protected marine mammals and development of acoustic safety criteria for marine mammals and other endangered species; transition to CNO N45, NAVOCEANO & CNMOC, and PE 0603712N for enhanced development.
- 3. (U) FY 2001 PLAN
  - (U) Initiate demonstration of shipboard pollution prevention technologies for suitability as Marine Pollution Control Devices (MPCD) in support of the Uniform National Discharge Standards (UNDS).
  - (U) Initiate demonstration of advanced technologies for the mitigation of harmful effects of Navy operations on threatened marine mammals and other endangered species in order to insure unimpeded Fleet training, testing, and deployment.
  - (U) Continue demonstration of air pollutant emission control and containment technologies as substitute for open burning/open detonation and non-contained rocket testing, and for reduced NOx, SOx and HAP emissions from Navy jet engines. These tasks are in support of establishing environmentally-compliant platforms and short support operations.
  - (U) Continue demonstration of embedded sensor technology for hazardous material shelf life assessment and extension. This technology demonstration supports Navy requirements to reduce hazardous waste generation, disposal costs and environmental liability.
  - (U) Continue integration and demonstration of dry-dock automated painting, overspray capture and treatment technologies for the elimination of VOC and HAP emissions during ship painting operations and to comply with environmental pollutant emissions regulations.
  - (U) Continue demonstration of active/passive sonobuoy technology for the detection of marine mammals. This technology mitigates the impact of fleet activities on marine mammals for compliance with the Marine Mammal Protection Act and Endangered Species Act.

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Budget Item Justification  
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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

Date: February 2000

BUDGET ACTIVITY: 3 PROGRAM ELEMENT: 0603712N

PROJECT NUMBER: R2206

PROGRAM ELEMENT TITLE: Environmental Quality &  
Logistics Advanced Technology

PROJECT TITLE: Environmental Requirements  
Advanced Technology

- (U) Complete demonstration of new generation, low-leaching, self-polishing, copper anti-fouling (AF) coatings for use as Marine Pollution Control Devices (MPCD) under the Uniform National Discharge Standards (UNDS) initiative; transition to SEA 03M for qualification and implementation.

• (U) PROGRAM CHANGE SUMMARY: See total program change summary for P.E.  
• (U) OTHER PROGRAM FUNDING SUMMARY: Not applicable.

(U) RELATED RDT&E:

- (U) PE 0601153N (Defense Research Sciences)
- (U) PE 0602121N (Surface Ship Technology)
- (U) PE 0602233N (Human Systems Technology)
- (U) PE 0602234N (Materials, Electronics, and Computer Technology)
- (U) PE 0603792N (Advanced Technology Transition)

• (U) SCHEDULE PROFILE: Not applicable.

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Budget Item Justification  
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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603727N

PROGRAM ELEMENT TITLE: Joint Experimentation

PROJECT NUMBER & TITLE	FY 1999 ESTIMATE	FY 2000 ESTIMATE	FY 2001 ESTIMATE	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	TO COMPLETE	TOTAL PROGRAM
R2497 Joint Warfighting Experimentation	*33,900	43,498	49,506	53,660	63,737	64,020	64,403	CONT.	CONT.
*Is being executed through OSD P.Es. in FY 1999.									

(U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: The Chairman of the Joint Staff's Joint Vision (JV) 2010, the Services' 21st Century visions and the Revolution in Military Affairs (RMA) all stress the critical role technology and joint operational concepts will play in meeting the needs of future Joint Force Commanders and achieving full spectrum force dominance. On 15 May 1998 the Secretary of Defense appointed Commander in Chief, United States Atlantic Command (CINCUSACOM) as the Department of Defense Executive Agent for Joint Experimentation (JE), effective 1 October 1998. Effective 1 October 1999 CINCUSACOM was redesignated as Commander in Chief, Joint Forces Command. The JE mission is to identify, explore and develop concepts and capabilities needed to maintain current dominance and achieve significant advances in future joint warfighting capabilities. This program Element directly supports that initiative. It provides funding to continue discovering, developing, analyzing and experimenting on new joint operational concepts which are key to meeting future military challenges. This effort will result in recommending Doctrine, Organization, Training, Material, Leadership, and Personnel (DOTMLP) changes to the Chairman of the Joint Chiefs of Staff and Secretary of Defense to enhance future joint service operational capabilities. United States Atlantic Command (USACOM) (now Joint Forces Command) received policy direction and technical guidance for executing the JE Program from the Secretary of Defense, Assistant Secretary of Defense for Strategy and Threat Reduction (ASD(S&TR)), Chairman of the Joint Chiefs of Staff and the 1999 Defense Planning Guidance.

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Budget Item Justification  
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FY 2000 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

UDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603727N

PROGRAM ELEMENT TITLE: Joint Experimentation

PROJECT NUMBER: R2497

PROJECT TITLE: Joint Experimentation

he sense of the Congress in the FY 98 Authorization Conference Report (H.R.3161) articulated the need for JE under the sponsorship of a Combatant Commander in order to integrate advances in technology and foster innovation to address future national security challenges. Joint Forces Command (JFCOM) has developed a Campaign Plan in support of the Secretary of Defense's JE Charter. Campaign plans are updated and released annually. Each campaign plan is intended to build upon, expand and capture the lessons learned from previous years' efforts. Generally, the focus of the Campaign Plan is on three main objectives. First is experimentation on how off-the-shelf technologies can be used to enhance current platforms and concepts of operations. Second is to focus experimentation on implementing the objectives of JV 2010. The third objective is to examine potentially revolutionary operational concepts and their supporting technologies in the continuation of exploring the implications of technology and the RMA.

U) The JE program funds experiments and supporting wargames, studies and simulations to evaluate potential systems, supporting concepts and their contributions toward achieving the JV 2010 and RMA objectives. The objective is to develop and assess innovative concepts and leap-ahead technologies that can generate the best value added capabilities to enhance joint warfighting. One principal objective in this endeavor is to develop an extensive and inclusive community to support and articulate in the JE program. This list includes the Combatant Commands, the Services, Department of Defense (DoD) and other defense Agencies. It will also include industry and academic organizations which can contribute to the transformation of the U.S. military force. The effort will be focused on the development and execution of the JV 2010 concepts of Information Operations (IO), Dominant Maneuver (DM), Precision Engagement (PE), Full Dimensional Protection (FDP) and Focused Logistics (FL) as well as other concepts outlined in the Defense Planning Guidance (DPG). The Advanced Battlespace Information System (ABIS) Task Force produced the most comprehensive assessment, vision and strategy to date for achieving the requisite grid, echnologies, and concepts to make JV 2010 possible. The 1999 edition of the Joint Warfighting Science and Technology Plan (JWSTP) provided to Congress in compliance with the Fiscal Year 1997 Defense Authorization Act (Section 270) presents the echnology investment plan consistent with JV 2010 and the ABIS recommendations. The JWSTP defines and maps the requisite echnology development and Advanced Concept Technology Demonstrations (ACTDs) to enable Information Superiority. The effort unded in this Program Element enables the joint warfighter and evolving Alliance of Battle Laboratories to work in

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Budget Item Justification  
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FY 2000 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

UDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603727N

PROJECT NUMBER: R2497

PROGRAM ELEMENT TITLE: Joint Experimentation

PROJECT TITLE: Joint Experimentation

onjunction with the CINCs and DoD Agencies as an integrated team with the objective to experiment with and quantify the impact of the ABIS/JWSTP information technologies and concepts, co-evolve organization and doctrine to optimize the Joint and service Warfighting mission. JFCOM will establish and deploy this integrated environment with Commercial Off the Shelf (COTS) hardware and existing software (COTS, Government Off the Shelf (GOTS), and applications), incurring minimal cost in set-up and operation.

U) Joint Experiments will rely on both advanced distributed simulation and limited live command post exercises that are examining future concepts. This effort will leverage, to the maximum extent possible, the DOD's significant investment in modeling and simulation. Distributed simulations also require a robust network to interconnect the various locations, Services and Agencies. Often times, these simulations press the state of the art in networking capability. To support joint experiments and other bandwidth intensive applications such as video teleconferencing and high definition television, an information technology Backplane (ITB) has been established as part of the JFCOM JE program. The ITB is a virtual network capitalizing on existing physical networks such as the Defense Information System Network (DISN), the Defense Information Systems Agency (DISA)-Defense Advanced Research Project Agency (DARPA) Leading Edge Services Network, and the experimental ATD et. The 21<sup>st</sup> Century Challenges roadmaps prepared by the Joint Staff identify a number of existing technical efforts that have the potential to feed Joint Experiments. JE funding is providing the means to change the scope of a technical demonstration to support experiments and implement the Joint Staff recommendations.

U) This program element is in direct response to the FY 1997 Authorization Act Report 104-267, which calls for "...a process to ensure that the emerging long-term visions of each of the Services will be melded into an affordable, coordinated series of operational concepts that will drive the Joint Warfighting Science and Technology Program (JWSTP) developed in the office of the Director, Defense Research and Engineering (DDR&E)" and FY 1998 Authorization Act Report 105-29 which requests a JE Plan to address: "how the fielding of advanced technologies are being synchronized across the military services" and "...how Command, Control, Communications, and Computers (C4) and Intelligence, Surveillance and Reconnaissance (ISR) capabilities are being integrated jointly to achieve information superiority." The National Defense Authorization Act for Fiscal Year 1999 (105-261)

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FY 2000 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603727N

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Experimentation

irected the Secretary of Defense to implement a "process of JET to investigate and test technologies and alternative forces and concepts in field environments."

U) In July 1999, the HAC-D directed that \$15.9M approved in an OSD reprogramming action be used only for Attack Operations against Critical Mobile Targets (AOACMT), the limited infrastructure needed to facilitate AOACMT, and participation in Office of the Secretary of Defense (OSD) weapon system reviews. JFCOM has obtained concurrence from the HAC-D Staff that AOACMT includes the four related joint concepts that are critical to our ability to find, identify, and track mobile targets and disseminate information across the joint and coalition force. These related joint concepts include Common Relevant Operational Picture (CROP), Joint Interactive Planning (JIP), Adaptive Joint Command and Control (AJC2), and Rapid Decisive Operations (RDO). FY00 Congressional direction restated the priority and the need to focus experimentation on a prioritized order of near, mid and far term accomplishments. The applicability of these concepts to AOACMT and joint force operations is as follows:

AOACMT establishes a system with advanced sensors, near-instantaneous sensor-to-shooter data flow, and high-speed, long-range accurate weapons. Contribution: allows the Joint Force Commander to shape the battle space and at the same time protect the force.

ROP provides timely, fused, accurate, consistent and relevant information in a readily understandable, scalable, and interactive format. Contribution: improve synchronization of joint operations and minimize fratricide.

IP seeks to combine open-source information with that from traditional military sources in a virtual, multi-level, collaborative information environment supporting parallel activities. Contribution: simultaneously access multiple worldwide planning efforts, at different organizational levels thus increasing the capacity for quicker decisions, faster response time and dynamic tasking and retasking efforts.

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DATE: February 2000

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JC2 when given a knowledge-based organization, determine how the Joint Force Command can organize the headquarters and task structure the joint force for operations. Contribution: smaller joint force headquarters footprint and improved synchronization of joint operations.

DO allows the Joint Force Commander, without a large-scale invasion of an adversary's territory, to conduct operations to coerce the adversary to our will or to prevent the adversary from achieving its objectives. Contribution: means to destroy adversary's will and his ability to use asymmetric means.

Specific objectives of these experimentation efforts and concepts include: determining what new ISR, command and control (C2) and attack weapons capabilities will contribute to a capability to destroy critical mobile targets; exploring how Joint oppression of Enemy Air Defenses (JSEAD), Joint Theater Air and Missile Defense (JTAMD), and offensive IO contribute to OACMT; exploring what changes to DOTMLP will be needed to expedite the joint targeting process; exploring how we best develop the capability to precisely engage and destroy finite targets; exploring how we determine which targets are the most significant to a Joint Commander's current campaign; and determining the process, procedures and technologies that will assist in allocating the most appropriate capabilities against the highest value and payoff targets.

U) JUSTIFICATION FOR BUDGET ACTIVITY: This program is budgeted within the APPLIED TECHNOLOGY Budget Activity because it encompasses design, development, simulation, and experimentation involving prototype hardware in order to validate technological feasibility of new operational concept's. This effort will reduce technological risk prior to initiation of a new acquisition program or transition to an ongoing acquisition program.

. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

. (U) FY 1999 ACCOMPLISHMENTS

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Budget Item Justification  
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FY 2000 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603727N

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PROGRAM ELEMENT TITLE: Joint Experimentation

PROJECT TITLE: Joint  
Experimentation

(U) The FY 99 objectives and goals were presented in the JFCOM JE Campaign Plan 99 (CPLAN 99). The Campaign Plan provided the methodology for laying out a strategy and schedule for FY99 experiments. CPLAN 99 provided the context for the JE program and for developing the experimentation strategy for each identified future Joint Warfighting concept. The concept of a Joint Experiment program to address future military challenges and the concurrent necessity for Joint interoperability is unique and never before examined through a comprehensive approach. Therefore, a central theme of CPLAN 99 was "proof of process." This "proof of process" strategy focused on development of an institutionalized approach which can support analysis and implementation of a diverse range of concepts, validation of the approach and the ability to rapidly re-focus efforts from the process to the content of the JE plan. CPLAN 99, the first campaign plan, permitted benchmarking the experimentation processes which will conduct with costing estimates established using historical Service metrics and previous experience. Part of this benchmarking process has been the development of a series of Baseline Collective Assessments (BCA) for each of the ten joint warfighting concepts. Each BCA will identify and document all activities throughout DoD (including the military departments and defense agencies) which address or are relevant to a specific concept. This will permit more effective leveraging of ongoing activities in the JE process and identify areas of non-productive duplication. To date three BCAs have been completed with two more scheduled for completion during the first part of FY00. The concepts selected for experimentation allowed the program to establish links with other DoD wide and individual Military Service experimentation activities thereby optimizing resource allocation through integration and leveraging ongoing activities. The program of experimentation set forth by approval of CPLAN 99 structured the JFCOM JE organization around investigating and developing new concepts and military capabilities. JE differs from other Research Development, Test and Evaluation (RDT&E) and acquisition efforts in that it is concept based instead of deficiency based. The concepts which have been selected for experimentation directly support the Chairman of the Joint Chiefs of Staff JV 2010 Implementation Master Plan and the RMA for 2010 and beyond. These concepts reflect the tenets and key points articulated in the RMA and address future, emerging military challenges. These experimentation efforts will support the Joint Warfighter across the full spectrum of military operational environments. JE at JFCOM seeks to identify and narrow redundancies and harmonize the experimentation efforts of the Services, non-DoD agencies and industry.

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FY 2000 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603727N

PROJECT NUMBER: R2497

PROGRAM ELEMENT TITLE: Joint Experimentation

PROJECT TITLE: Joint

Experimentation

(U) In FY99 JFCOM has sponsored a Futures Program which has focused on identifying Future Operational Capabilities (FOCs) critical to Joint Warfighting. These FOCs are the product of a series of Futures Seminars, Concepts Development Workshops and Senior Warfighter Reviews consisting of OSD, Joint Staff, Services and Component Commanders that were sponsored and executed by JFCOM starting in October 1999. Conferences and workshops have been attended by individual Service Battle Laboratory representatives, the Joint Staff, Unified CINCs and OSD who have nominated future warfighting experiments and cooperative approaches to support future experimentation partnerships. To date JFCOM has identified 10 concepts scheduled for experimentation starting in FY99 and continuing into FY00. These concepts are being evaluated in USACOM generated experiments or will leverage ongoing services, demonstrations/experiments, ACTDs, ATDs and JT&Es. They will include experiments which evaluate the following FOCs: RDO, Attack Operations Against Critical Mobile Targets, Joint Interactive Planning, Focused Logistics: Enabling Early Decisive Operations, Command Relevant Operational Picture, Adaptive Joint C2, Surveillance and Fires From Space, Information Operations, Forcible Entry Operations and Strategic Deployment. These ten concepts form the basis of the experimentation process JFCOM initiated in October 1998. As a result of this activity, Commander in Chief Joint Forces Command (CINCFJCOM) has designated Rapid Decisive Operations as the key, overarching concept. The other nine currently identified concepts are supportive of RDO. This action is reflected in the SECDEF's Defense Planning Guidance. This effort has also supported the independent assessment of the Joint Advanced Warfighting Program (JAWP). The results from the OSD sponsored JAWP have been integrated into the overarching JFCOM JE program.

(U) Expansion of the ongoing technical work for development of the ITB. Particular attention has been devoted to linking the capabilities of several ACTDs including Joint Logistics, Joint Planning, Rapid Battlespace Visualization, Battlefield Awareness Data Dissemination and Synthetic Theatre of War (STOW). Support was given to ACTD implementers at JFCOM and the individual Military Services to assist in the design and execution of information superiority and warfighting experiments.

(U) Experimentation Feeder Support: Experimentation Feeder Support provided resources to ensure that the joint experimentation program is consistent with the High Level Architecture (HLA) and Defense Modeling and Simulation Office

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Budget Item Justification  
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FY 2000 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

UDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603727N

PROJECT NUMBER: R2497

PROGRAM ELEMENT TITLE: Joint Experimentation

PROJECT TITLE: Joint Experimentation

(DMSO's) simulation roadmap and existing on-going demonstrations with the potential for enhancing military operational capability or cost effectiveness to participation in Joint Experiments.

(U) The JFCOM JE Implementation Plan (I-Plan) dated 14 July 98 is CINCJFCOM's concept and plan for executing the SECDEF Charter for JE. It establishes the experimentation process and described how JFCOM will organize to accomplish the mission. Leveraging existing resources and work accomplished by the Joint Staff and Joint Warfighting Center, JFCOM's FY 99 experimentation focus was to test and subsequently refine the "Proof of Process" envisioned for the experimentation process by designing J9901 Attack Operations Against Critical Mobile Targets (AOACMT) to initiate the experimentation program. J9901 tested emerging concepts and joint doctrine by utilizing advanced simulations, virtual environments, and wargames. J9901 took advantage of resources developed in the STOW ACTD to support a Virtual Attack Operations situation. The success of J9901 allowed the program to pursue experimentation objectives focused upon the future (2015) such as ISR, Command and Control (C2), Weapons Systems, Red Teaming and Future Threats. Significant progress has been made during the fiscal year in establishing and coordinating the efforts of the various experimentation and demonstration activities of the military services and of ACTDs with the JE initiative. In concert with J9901, JFCOM's "Futures Program" hosted workshops, seminars and symposiums as part of the far-term experimentation process. The Futures Program explored and will continue to examine future DOTMLP issues by reviewing emerging technologies and concepts and by bringing together warfighters, futurists, academics, and industry. Additionally Futures Program explored and will continue to explore the use of wargames, modeling and simulation and virtual environments in developing future concepts for experimentation. J9901 and the Futures Program will leverage the existing Information Technology (IT) Backplane to conduct experiments. However, it is anticipated that robust experimentation will require continued development of the existing IT Backplane capabilities.

(U) FY 2000 PLAN:

(U) JFCOM's business plan for experimentation is CAMPAIGN PLAN (CPLAN) 00. CPLAN 00 refines and extends JFCOM's JE program

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FY 2000 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603727N

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PROGRAM ELEMENT TITLE: Joint Experimentation

PROJECT TITLE: Joint  
Experimentation

designed to explore innovative concepts and "leap-ahead" capabilities and to exploit opportunities for transformation of the U.S. military. This program seeks new processes, organizations, and technologies that will provide future military leaders with a wider range of options to address national security issues. CPLAN 00 provides a high-level description of the ten concepts that will be explored during the six-year period FY 00-05 and the program of experimentation that has been planned to assess the concepts for their suitability, feasibility, acceptability, maturity, and potential impact on Joint Force operation capabilities. Among the principal experimentation events to be conducted are a major simultaneous supported experiments in exploring RDO and the supporting concepts. These experimentation events will also provide an operational environment to continue and expand the work initiated in FY 99 on Attack Operations Against Critical Mobile Targets. Increased coordination with the Services and other experimentation/demonstration activities will be a key objective in FY 00. The JE program at JFCOM will leverage ACTDs, the Army's Joint Contingency Force Advanced Warfighting Experiment, the Air Force's Joint Expeditionary Force Experiment, the Navy's Fleet Battle Experiment Hotel and Marine Corps' Capable Warrior Experiment. Additionally there will be emphasis place on including inter-agency, allied and coalition partners in the JE program. There will be an extensive wargaming program on force application, information superiority, force deployment and sustainment. Comprehensive evaluation of technologies to support the Joint Force After Next will also be initiated. The Baseline Collection Assessments and Vulnerability Assessments will also be continued. The long term objective of this endeavor is to focus annual Joint, Service and Agency efforts in a Major Joint Integrating Experiment beginning in FY 04. These experiments will be conducted in 12-24 month intervals and involve significant participation by forces in the field. Major Joint Integrating Experiments combine all four Services in a Joint Combined Force-Advanced Warfighting Experiment (JCF-AWE) that will use live and virtual elements to assess all 10 Identified Future Operation Concepts. JFCOM will also sponsor other technological-operational concept development studies and required Red Team technology vulnerability assessments.

(U) Advanced planning and support for development and coordination of scheduled FY 02 and FY 03 experiments will be conducted in parallel with on going FY 00 experiments.

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FY 2000 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603727N

PROJECT NUMBER: R2497

PROGRAM ELEMENT TITLE: Joint Experimentation

PROJECT TITLE: Joint  
Experimentation

(The growth between FY 99 and FY 00 is the result of the increased number of Joint Experiments and the coordination with the associated service and other Unified CINC experiments and demonstrations. With full funding and personnel JFCOM can conduct a sustained level of participation that includes: (1) two major simultaneous supported experiments; (2) five major JV 2010 and two major Joint Force After Next wargames; (3) multiple leveraged and limited objective experiments; (4) a technology assessment and vulnerability program

FY 2001 PLAN:

(U) CPLAN 00 management plan for FY01 experiments continues efforts initiated in FY99 and FY00. JFCOM will continue to experiment with processes, organizations, and technologies that possess the potential to provide future military leaders with a wide range of options with which to address national security issues. Through assessment of new doctrinal concepts, organizational structures, and technologies, the JE program seeks to enable the RMA. This funding will support continued activities by JFCOM as the Executive Agent for JE in the execution and assessment of ten JFCOM generated Joint Warfighting Experiments and sixteen Minor Leveraged Service experiments and demonstrations. JFCOM will also sponsor other technological-operational concept development studies and required Red Team technology vulnerability assessments.

(U) JFCOM will continue to sponsor the ongoing series of Futures Symposiums and Warfighter reviews of technologies and operational concepts which examine the development and prospects for technological innovation and their relationships to mid-term and future operational concepts. JFCOM initiates action to analyze branches and sequels to concepts discovered through experimentation and the Futures Program.

(U) JFCOM will support experimental technologies which are relevant to operational issues, including prototypes, advanced technologies, and surrogates required, along with the processes and materials which will be necessary to integrate these new capabilities. Modeling and simulation and wargames will continue to be an integral element of the FY 01 plan to develop, assess and generate new concepts and identify new technologies suitable for experimentation.

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FY 2000 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603727N

PROJECT NUMBER: R2497

PROGRAM ELEMENT TITLE: Joint Experimentation

PROJECT TITLE: Joint

Experimentation

(U) Advanced planning and support for development and coordination of scheduled FY 02 and FY 03 experiments will be conducted in parallel with on going FY 00 experiments.

(U) PROGRAM CHANGE FOR TOTAL Program Element:

	FY 2000	FY 2001
FY 2000 President's Budget		
Appropriated Value:	41,840	46,181
Adjustments from FY 2000 President's Budget	41,840	-
Program Adjustments	1,900	+3,790
Congressional Rescissions	-242	
Various Rate Adjustments		-465
FY 2000 PRESBDG Submission:	43,498	49,506

(U) CHANGE SUMMARY EXPLANATION:

(U) Schedule: Not applicable.

(U) Technical: The growth between FY 00 and FY 01 is the result of the increased number and complexity of Joint Experiments and the coordination with the associated service and other Unified CINC experiments and demonstrations.

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FY 2000 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603727N

PROJECT NUMBER: R2497

PROGRAM ELEMENT TITLE: Joint Experimentation

PROJECT TITLE: Joint  
Experimentation

(U) OTHER PROGRAM FUNDING SUMMARY: Not applicable.

## (U) RELATED RDT&E:

- (U) PE 0601153N Defense Research Sciences
- (U) PE 0602111N Air and Surface Launched Weapons Technology
- (U) PE 0602121N Ship, Submarine and Logistics Technology
- (U) PE 0602122N Aircraft Technology
- (U) PE 0602232N Communications, Command and Control, Intelligence, Surveillance and Reconnaissance (C3ISR)
- (U) PE 0602233N Human Systems Technology
- (U) PE 0602234N Materials, Electronics and Computer Technology
- (U) PE 0602270N Electronic Warfare Technology
- (U) PE 0602314N Undersea Warfare Surveillance Technology
- (U) PE 0602435N Oceanographic and Atmospheric Technology
- (U) PE 0602633N Undersea Warfare Weapon Technology
- (U) PE 0603750D Advanced Concept Technology

(U) SCHEDULE PROFILE: Not applicable.

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DATE: February 2000

FY 2001 DON RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

BUDGET ACTIVITY: 3 PROGRAM ELEMENT: 0603747N

PROGRAM ELEMENT TITLE: Undersea Warfare Advanced Technology

(U) COST: (Dollars in Thousands)

PROJECT NUMBER & TITLE	FY 1999 ACTUAL	FY 2000 ESTIMATE	FY 2001 ESTIMATE	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	TO COMPLETE	TOTAL PROGRAM
X1933 Undersea Warfare (USW) Advanced Technology Demonstration									
10,472	12,250	11,727	12,884	12,893	12,832	12,615		CONT.	CONT.
R2142 Shallow Water Surveillance Advanced Technology									
31,122	34,928	35,523	36,522	33,972	33,736	33,204		CONT.	CONT.
R2267 USW Weapons Advanced Technology									
9,611	10,458	11,046	10,260	10,159	10,114	9,916		CONT.	CONT.
R2485 Terfenol-D									
1,947	1,989	0	0	0	0	0	0	0	6,936
<b>TOTAL</b>	<b>53,152</b>	<b>59,625</b>	<b>58,296</b>	<b>59,666</b>	<b>57,024</b>	<b>56,682</b>	<b>55,735</b>	<b>CONT.</b>	<b>CONT.</b>

(U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: All Navy advanced technology development in undersea target detection, classification, localization, tracking and neutralization is funded through this Program Element (PE). In countering the troubling proliferation of quiet diesel submarines to third world country's and Russia's continued heavy investment in submarine technology, work within this PE provides an enabling capability for power projection and force sustainability. The approach protects the country's capital investment in submarine, surface ship and Air AntiSubmarine Warfare (ASW) assets both by developing commercial off-the-shelf (COTS) upgrade options for today's ASW suites and by exploring those high risk/high payoff technologies that promise to provide capabilities of exceptionally high military value in three to five years. Emphasis is on development of fieldable prototypes, components and systems necessary to demonstrate and validate concepts and techniques previously developed in 6.1 and 6.2 or developed and suggested by industry/academia.

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Budget Item Justification  
(Exhibit R-2, page 1 of 23)

# UNCLASSIFIED

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DATE: February 2000

FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

BUDGET ACTIVITY: 3 PROGRAM ELEMENT: 0603747N

PROGRAM ELEMENT TITLE: Undersea Warfare Advanced Technology

(U) This research directly supports the Department of Defense Joint Warfighting Science and Technology Plan and the Defense Technology Area Plans. Within the Navy the effort supports the following Navy Joint Mission Areas: Littoral Warfare; Intelligence, Surveillance, and Reconnaissance; and Strategic Mobility.

(U) While the program addresses technical issues associated with a broad range of high interest operational areas, the emphasis is on shallow water environments.

(U) The Navy Science and Technology (S&T) program includes projects that focus on or have attributes that enhance the affordability of warfighting systems.

(U) JUSTIFICATION FOR BUDGET ACTIVITY: This program is budgeted within the ADVANCED TECHNOLOGY DEVELOPMENT Budget Activity because it encompasses design development, simulation, or experimental testing of prototype hardware to validate technological feasibility and concept of operations and reduce technological risk prior to initiation of a new acquisition program or transition to an ongoing acquisition program.

(U) PROGRAM CHANGE FOR TOTAL PE:

	<u>FY 1999</u>	<u>FY 2000</u>	<u>FY 2001</u>
(U) FY 2000 President's Budget:	\$57,341	\$57,956	\$58,712
(U) Appropriated Value:	-	59,956	-
(U) SBIR/STTR Transfers:	-1,060	-	-
(U) Inflation Adjustments:	-266	-	-
(U) Execution Adjustment:	-2,863	-	-
(U) Congress Add		2,000	
(U) Congressional Rescissions:	-	-331	-
(U) Minor Program Adjustments:	-	-	87
(U) Various Rate Adjustments:	-	-	-266
(U) Strategic Sourcing Adjustments:	-	-	-237
(U) FY 2001 PRESBUDG Submission:	\$53,152	\$59,625	\$58,296

(U) Schedule: Not Applicable.

(U) Technical: Not Applicable. (U) COST: (Dollars in thousands)

R-1 Line Item 26

Budget Item Justification  
(Exhibit R-2, page 2 of 23)

# UNCLASSIFIED

# UNCLASSIFIED

BUDGET ACTIVITY: 3      FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET      DATE: February 2000  
PROGRAM ELEMENT: 0603747N  
PROGRAM ELEMENT TITLE: Undersea Warfare Advanced Technology

PROJECT NUMBER & TITLE	FY 1999 ESTIMATE	FY 2000 ESTIMATE	FY 2001 ESTIMATE	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	TO COMPLETE PROGRAM	TOTAL
X1933 Undersea Warfare (USW) Advanced Technology Demonstration	10,472	12,250	11,727	12,884	12,893	12,832	12,615	CONT.	CONT.

## A. (U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION:

(U) This project develops and demonstrates prototype Undersea Warfare (USW) system components that build on concepts, algorithms and technologies initiated within 6.1 and 6.2 programs. It supports the advanced development of sensors, arrays, signal processing, active sources and Anti-Submarine Warfare (ASW) Command, Control, Communications, Computers, and Intelligence (C4I) system improvements. The major components in this project are: Advanced Acoustic Source Technology (AST), Advanced Full Spectrum Processing (FSP) and Integrated Anti-Submarine Warfare (IASW) Technology. Joint Mission Areas supported by this project include: Littoral Warfare, Intelligence, Surveillance, and Reconnaissance, and Strategic Mobility. Specifically:

(U) The Advanced Acoustic Source Technology Initiative focuses on developing smaller, lighter-weight, and lower-cost broadband transducers and arrays including associated components for use in both wide-area and tactical undersea surveillance applications against projected submarine threats operating in shallow waters. This work addresses intelligence, surveillance, and reconnaissance issues of real-time detection, localization, classification and tracking of undersea threats. The intent is to enable our forces to dominate the local undersea battlespace in the vicinity of logistic and replenishment forces.

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Budget Item Justification  
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BUDGET ACTIVITY: 3      FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET      DATE: February 2000  
PROGRAM ELEMENT: 0603747N      PROJECT NUMBER: X1933  
PROGRAM ELEMENT TITLE: Undersea Warfare Advanced Technology      PROJECT TITLE: Undersea Warfare Advanced Technology Demonstration

(U) The Full Spectrum Processing work within this project supports joint littoral warfare by developing signal processing capable of detecting and classifying acoustic signals that emanate from both diesel-electric and nuclear threat submarines as well as active sonar echoes from these targets. This work also helps meet Intelligence, Surveillance, and Reconnaissance needs associated with passive acoustic detection systems.

(U) The Integrated ASW technology effort develops and demonstrates USW inter-system communications protocols, data and information processing technologies that will enable warfighters to cooperatively detect, classify and engage undersea threats. This work addresses undersea intelligence, surveillance and reconnaissance issues of real-time detection, localization, classification and tracking of undersea threats.

(U) These efforts also support the Navy's joint warfare strategy by providing an improved capability to dominate the surface and undersea battlespace.

## (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

### 1. (U) FY 1999 ACCOMPLISHMENTS:

- (U) Advanced Acoustic Source Technology:
  - (U) Initiated/Continued:

- (U) Development of an improved slotted cylinder shell technology proposed by industry during the FY 1998 Joint Office of Naval Research/Program Executive Office/Systems Commands (ONR/PEO/SYSCOMs) Tranduction Workshop. The intent was to conduct a proof-of-concept demonstration of a single-element source technology in support of the Littoral Low Frequency Active (LLFA) program. Successful results will allow a significant reduction in the cost of slotted cylinder sources applicable to a broad range of users and will provide a proven source technology applicable to SURTASS/LLFA requirements under PE 0204311N.

- (U) Development of "A" size, Lead Zirconate Titanate (PZT)-driven, slotted cylinder sources with a "33" drive mode designed to increase acoustic power output at the request of Naval Air Systems Command (NAVAIR) PMA 264. Continued refinement of the technology with new boot designed to address shallow-water cavitation issues per NAVAIR PMA 264 requirements.

- (U) Continued:

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Budget Item Justification  
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BUDGET ACTIVITY: 3      FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET      DATE: February 2000  
PROGRAM ELEMENT: 0603747N      PROJECT NUMBER: X1933  
PROGRAM ELEMENT TITLE: Undersea Warfare Advanced Technology      PROJECT TITLE: Undersea Warfare Advanced Technology Demonstration

- (U) Development of the hybrid Terfenol-D/PZT Tompiliz acoustic source (initiated in FY 1998) element and array segment that generate a high-power broadband signal; demonstrated single-element performance.
- (U) Design analysis of the Light Weight Sound System (LWSS) impulsive omni-charge source technology for application to the SH-60R platform and other air platforms. Characterized acoustic performance of the explosive source during the FY 1999 Littoral Warfare Advanced Development (LWAD) 99-2 sea test.
- (U) Demonstrated performance of a prototype PZT slotted cylinder mini-array (initiated in FY 1998) to support the acoustic source requirements of the SURTASS/Compact LFA (CLFA) program under PE 0204311N.
- (U) Completed:
- (U) Development and demonstrated performance of low frequency slotted cylinder elements utilizing Lead Magnesium Niobate (PMN) transduction material technology
- (U) Development and demonstrated performance of the Mobile In-Shore Undersea Warfare (MIUW) sparker array (initiated in FY 1998) in a bistatic enhancement demonstration with a MIUW passive receive system. The intent of this demonstration was to assess the utility/performance by fleet units that will ultimately utilize this asset.
- (U) Full Spectrum Processing:
- (U) Initiated/Developed:
  - (U) Multi-dimensional Interactively Trainable Passive Acoustic Classifier (IPAC) Version 20 (e.g., sensors, features, active/passive, track/beam, range time) processing for improved autodetection/classification and false alarm performance for air, submarine, and surveillance systems.
  - (U) 3-Dimensional (3-D) Full Spectrum Normalizer (FSN) to facilitate increased Probability of Detection (Pd) and reduced false alarm rates for application to surveillance, surface, and submarine platforms.
- (U) Initiated/Developed/Completed:
  - (U) Advanced Extended Echo Ranging/Improved Extended Echo Ranging (AER/IEER) active processing developments.
  - (U) Preliminary assessment of bistatic, impulsive active classification processing techniques (i.e., for Sparker Plasma and Omni-Charge) addressing undersea warfare for application to the Mobile In-shore Undersea Warfare (MIUW), air, submarine, and surveillance communities.

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Budget Item Justification  
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BUDGET ACTIVITY: 3      FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET      DATE: February 2000  
PROGRAM ELEMENT: 0603747N      PROJECT NUMBER: X1933  
PROGRAM ELEMENT TITLE: Undersea Warfare Advanced Technology      PROJECT TITLE: Undersea Warfare Advanced Technology Demonstration

- (U) Lightweight Sound System (LWSS) Feasibility Study.
- (U) Continued:
  - (U) Development of IPAC Version 1.0 and the SXXX autodetector/classifier for evaluation on the submarine adjunct COTS processor (Advanced Processing Builds) under PE 0604503N.
  - (U) Characterization of the difference between threat signals and environmental clutter to enable more robust performance of automatic active and passive acoustic detection and classification schemes.
  - (U) Development of Ridge Distance Measurement (RDM) classification, Single-Ping Range Rate detection, Single-Ping Cluster (Version 1.0) Improved Feature Space classification, and the Single-Ping Hyperbolic Frequency Modulation (HFM) Cluster 2.0 pre-detection processing techniques.
- (U) Transitioned:
  - (U) The Striation detector, the IPAC Version 1.0, the SXXX autodetector/classifier, the Dynamics Detector, the Low Frequency/Mid Frequency (LF/MF) detector, and the FSN passive processing techniques to the submarine adjunct COTS processor (Advanced Processing Build 00) in PE 0604503N.
  - (U) The Striation detector processing technique to the Littoral Sea Mine Program under PE 0603782N.
  - (U) The IPAC Version 1.0 processing technique to the submarine adjunct COTS processor Augmentation Enhancement Package in PE 0604503N.
- (U) Integrated ASW:
  - (U) Initiated:
    - (U) Development of tactical IASW data-fusion and data-distribution architectures.
    - (U) Development of improved message and signal-event data-fusion technologies for generating inputs to the common tactical/environmental picture (CT/EP).
    - (U) Conducted data collection efforts in Fleet Battle Experiment-E (FBE-E) in support of IASW technology developments.
  - (U) Demonstrated IASW collaborative technologies/methodologies utilizing ASW sea-test programs.
  - (U) Completed/Transitioned:
    - (U) Website technologies to the Integrated Undersea Surveillance System, PE 0204311N
    - (U) Selection of prospective Measures of Performance (MOPs) for net-centric ASW warfare.

2. (U) FY 2000 PLAN:

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Budget Item Justification  
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BUDGET ACTIVITY: 3      FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET      DATE: February 2000  
PROGRAM ELEMENT: 0603747N      PROJECT NUMBER: X1933  
PROGRAM ELEMENT TITLE: Undersea Warfare Advanced Technology      PROJECT TITLE: Undersea Warfare Advanced Technology Demonstration

- (U) Advanced Acoustic Source Technology:
  - (U) Initiate:
    - (U) Development of a prototype PZT slotted cylinder element to address LLFA source requirements. The result of this development will support the decision for follow-on development of a mini-array in FY 2001.
    - (U) Development and demonstrate performance of a PZT-driven X-Spring Tonpilz broadband source as an alternative source for hull arrays and other applications.
  - (U) Continue:
    - (U) Development and demonstrate "A"-size, PZT-driven, slotted cylinder sources with a "33" drive mode and new boot designed to address shallow water cavitation issues for application to the Air Deployable Low Frequency Projector (ADLFP) program.
    - (U) Design analysis of omni-charge source technology for application to the SH-60R and other air platforms.
    - (U) Development and demonstration of the hybrid Terfenol-D/PZT Tonpilz broadband array segment for application as a hull array sonar and potential candidate transition to the DD-21 program. Investigate performance requirements and assess source technology development effort for the submarine conformal bow array.
  - (U) Complete/Transition:
    - (U) - (U) Single-element development of an improved PZT slotted cylinder shell technology toward LLFA performance requirements proposed by industry during the FY 1998 joint ONR/PEO/SYSCOM Transduction Workshop.
- (U) Full Spectrum Processing:
  - (U) Initiate:
    - (U) Development and demonstrate the cavitation autodetector processing technique for detection of submarines and weapons in response to the Office of Naval Intelligence (ONI) vulnerability assessment.
    - (U) Identification of Lightweight Sound System (LWSS) requirements (e.g., Probability of Correct Alert, Probability of False Alert) and initiate development of preliminary CONOPS for SH-60R platform.
    - (U) Development of Lightweight Sound System (LWSS) signal processing techniques for use with the impulsive omni-charge source technology.

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BUDGET ACTIVITY: 3      FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET      DATE: February 2000  
PROGRAM ELEMENT: 0603747N      PROJECT NUMBER: X1933  
PROGRAM ELEMENT TITLE: Undersea Warfare Advanced Technology      PROJECT TITLE: Undersea Warfare Advanced Technology Demonstration

- (U) Initiate/Develop:
- (U) Cable Strum Mitigation for Submarine and SURTASS.
- (U) Continue:
- (U) Development and assess the SXXX Autodetector 2.0 processing technique.
- (U) Characterization of the difference between threat signals and environmental clutter to enable more robust performance of automatic detection and classification schemes.
- (U) Development and demonstrate the multi-dimensional IPAC Version 2.0 (e.g., sensors, features, track/beam, range, time) processing for improved autodetection/classification and false alarm performance for air, submarines, and surveillance systems.
- (U) Development and demonstrate the 3-D Full Spectrum Normalizer to the Advanced Processing Builds for submarine platforms under PE 0604503N and IUSS community.
- (U) Performance assessment of the RDM Classification, Single-Ping Range Rate detection, Single-Ping Cluster (Version 1.0), Improved Feature Space classification, and the Single-Ping Hyperbolic Frequency Modulation Cluster 2.0 pre-detection processing techniques for application to the SURTASSSS LFA program (PE 0204311N).
- (U) Integrated ASW:
- (U) Initiate:
- (U) Development and performance assessment of advanced IASW data-fusion technology.
- (U) Development of FY 2001 IASW sea-test plans.
- (U) Transition planning for IASW data-fusion technologies to the Advanced Undersea Warfare Concept (AUSWC) initiative.
- (U) Continue:
- (U) Development of tactical IASW data-fusion and data-distribution architecture.
- (U) Development of improved message and signal-event data fusion technologies for generating inputs to the common tactical/environmental picture (CT/EP).
- (U) Conduct:
- (U) Data collection efforts and perform post-sea test analysis to evaluate IASW technologies/methodologies.

- 3. (U) 2001 PLAN:
- (U) Advanced Acoustic Source Technology:

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Budget Item Justification  
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BUDGET ACTIVITY: 3      FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET      DATE: February 2000  
PROGRAM ELEMENT: 0603747N      PROJECT NUMBER: X1933  
PROGRAM ELEMENT TITLE: Undersea Warfare Advanced Technology      PROJECT TITLE: Undersea Warfare Advanced Technology Demonstration

- (U) Initiate:
  - (U) Development of high-energy density (PMN or Terfenol-D) source technologies such as slotted cylinders or other mechanisms for application to off-board sources of compact size and limited energy storage deployable by submarine, surface ship, Multi-Purpose Aircraft (MPA), or Unmanned Underwater Vehicles (UUVs).
- (U) Continue:
  - (U) Development of source elements/array design to support NAVAIR PMA 264 requirements for the Air Deployable Low Frequency Projector (ADLFP) program.
  - (U) Design analysis of the impulsive, omni-charge source technology for application to the SH-60R and other air platforms.
  - (U) Development of the hybrid Terfenol-D/PZT Tonpilz technology for application to the submarine conformation bow array.
  - (U) Demonstrate performance of an improved slotted cylinder shell technology to address LLFA performance requirements.
  - (U) Conduct Joint FY 2001 ONR/PEO/SYSCOM Transduction Workshop to evaluate promising source technology developments proposed by industry.
  - (U) Complete:
    - (U) Development and demonstrate performance of a prototype PZT slotted cylinder mini-array to address LLFA requirements. The result of this demonstration will assist in the decision to proceed with a full-scale array under the SURTASS/LLFA program in PE 0204311N.
- (U) Full Spectrum Processing:
  - (U) Initiate:
    - (U) Assessment of automated signal processing architecture and development.
    - (U) Development of the Multi-Dimensional Interactively Trainable Passive Acoustic Classifier (IPAC) Version 3.0 incorporating improved data-fusion techniques for improved Probability of Detection with lower Probability of False Alarm.
    - (U) Development of the adapted SXXX processing technique for detection of Motor Slot Rate (MSR).
  - (U) Continue:
    - (U) To characterize the difference between threat signals and environmental clutter to enable more robust performance of automatic detection and classification schemes.

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BUDGET ACTIVITY: 3      FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET      DATE: February 2000  
PROGRAM ELEMENT: 0603747N      PROJECT NUMBER: X1933  
PROGRAM ELEMENT TITLE: Undersea Warfare Advanced Technology      PROJECT TITLE: Undersea Warfare Advanced Technology Demonstration

- (U) Development and demonstrate the cavitation autodetector processing technique for detection of submarines and weapons in response to the Office of Naval Intelligence (ONI) vulnerability assessment.
- (U) Development and demonstrate the 3-D Full Spectrum Normalizer to the Advanced Processing Builds and transition to submarine platforms under PE 0604503N and IUSS Community.
- (U) Development of Cable Strum Mitigation signal processing technique for submarine and surveillance (SURTASS) applications.
- (U) Development of Light Weight Sound System (LWSS) signal processing techniques for SH-60R and other air platforms.
- (U) Development of the multi-dimensional IPAC Version 2.0 (e.g., sensors, features, track/beam, range, time) processing for improved autodetection/classification and false alarm performance for air, submarines, and surveillance systems.
- (U) Complete/Transition:
  - (U) SXXX 2.0 Auto Detector to the submarine and IUSS communities.
  - (U) Identification of the Lightweight Sound System (LWSS) requirements (e.g. Probability of Correct Alert, Probability of False Alert) and complete development of preliminary CONOPS for SH-60R.
  - (U) Performance assessment and transition Ridge Distance Measurement (RDM) classification, Single-Ping Range Rate detection, Single-Ping Cluster (Version 1.0), Improved Feature Space classification, and the Single-Ping Hyperbolic Frequency Modulation Cluster 2.0 pre-detection processing techniques to the SURTASS LFA program (P.E. 0204311N).
- (U) Integrated ASW:
  - (U) Initiate:
    - (U) Development of FY 2000 IASW sea-test plans.
  - (U) Continue:
    - (U) Development of signal-event data fusion technologies for generating inputs to the common tactical/environmental picture (CT/EP).
    - (U) Transition planning for IASW technologies to PEO (USW) Advanced Undersea Warfare Concept (AUSWC).
  - (U) Demonstrate:
    - (U) Advanced IASW data-fusion capabilities at sea.

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Budget Item Justification  
(Exhibit R-2, page 10 of 23)

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BUDGET ACTIVITY: 3      FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET      DATE: February 2000  
PROGRAM ELEMENT: 0603747N      PROJECT NUMBER: X1933  
PROGRAM ELEMENT TITLE: Undersea Warfare Advanced Technology      PROJECT TITLE: Undersea Warfare Advanced Technology Demonstration

- (U) Complete:
- (U) Development of FY 2001 IASW sea-test plans.

B. (U) PROGRAM CHANGE SUMMARY: See program change summary for total PE.

C. (U) OTHER PROGRAM FUNDING SUMMARY: Not applicable.

(U) RELATED RDT&E:

- (U) PE 0601153N (Defense Research Sciences)
- (U) PE 0602314N (Undersea Warfare Surveillance Technology)
- (U) PE 0602315N (MCM, Mining, and Special Warfare Technology)
- (U) PE 0602435N (Ocean and Atmospheric Technology)
- (U) PE 0603254N (Air ASW Systems Development)
- (U) PE 0603553N (Surface ASW)
- (U) PE 0603792N (Advanced Technology Transition)
- (U) PE 0604261N (Acoustic Search Sensors (Eng))
- (U) PE 0604311N (Integrated Undersea Surveillance System)

D. (U) SCHEDULE PROFILE: Not applicable.

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Budget Item Justification  
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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

Date: February 2000

BUDGET ACTIVITY: 3      PROGRAM ELEMENT: 0603747N  
 PROGRAM ELEMENT TITLE: Undersea Warfare Advanced Technology

(U) COST: (Dollars in Thousands)

PROJECT NUMBER & TITLE	FY 1999 ACTUAL ESTIMATE	FY 2000 ESTIMATE	FY 2001 ESTIMATE	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	TO COMPLETE	TOTAL PROGRAM
R2142 Shallow Water Surveillance Advanced Technology	31,122	34,928	35,523	36,522	33,972	33,736	33,204	CONT.	CONT.

A. (U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: This project develops and demonstrates technologies designed to maintain near-perfect, real-time knowledge of the enemy and communicate pertinent information to platform, battlegroup and area commanders. Three efforts are ongoing: Airborne/Shipborne Periscope Detection, Lightweight Broadband Variable Depth Sonar, and Littoral Warfare Advanced Development. Three efforts will be initiated as the preceding developments are completed and the associated technology is transitioned to acquisition programs. These efforts are Environmentally Adaptive Sonar Technology (FY 2000), Deployable Array Technology (FY 2000) and Robust Passive Sonar Technology (FY 2001).

(U) The Airborne/Shipborne Radar Periscope Detection effort is developing and demonstrating technologies that will make reliable radar detection of an intermittently exposed periscope feasible for maritime patrol aircraft and surface combatants. Operators of current radar systems are swamped with false alarms caused by sea returns and confusion targets such as small craft and debris. This problem is most acute in the littoral environment. This technical effort automates the detection and discrimination process to remove false alarms without degrading the probability of detection. Transitions are planned for P-3 aircraft and the DD-21. The design could also be readily implemented on current destroyers, cruisers and aircraft carriers.

(U) The Lightweight Broadband Variable Depth Sonar (LBVDS) effort is developing and demonstrating a high-risk/high-payoff technical approach to detecting quiet submarines. The effort is focused on a new, high energy-dense transducer material that can be used to make small, lightweight, broadband, acoustic projectors. Studies and sea tests to date

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

Date: February 2000

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603747N

PROJECT NUMBER: R2142

PROGRAM ELEMENT TITLE: Undersea Warfare Advanced Technology

PROJECT TITLE: Shallow Water Surveillance Advanced Technology

indicate that the approach will yield an immediate performance improvement and will be readily upgradeable for an even greater improvement with additional development. Because of its promised performance and its relatively low life cycle cost, the technology was highlighted as a key requirement in the Cost and Operational Effectiveness Analysis (COEA) conducted for the Surface Combatant of the 21<sup>st</sup> Century (DD-21). The system will interoperate with and complement the SQS-53C, which is optimized for detecting quiet submarines [operating above the acoustic layer].

(U) The Littoral Warfare Advanced Development (LWAD) effort sponsors cost-effective, proof-of-concept, at-sea experiments for undersea warfare science and technology initiatives that show promise for transition to fleet systems. The effort concentrates on technologies associated with detection, classification, and localization of quiet diesel electric submarines and mines in shallow water. Experiments are conducted in areas known to be the most environmentally challenging. Fleet representatives, system command program managers, and science and technology program officers jointly establish the technical and operational focus of each experiment. These representatives also assist in crafting the transition strategy for successfully tested technologies. Experiments span the spectrum of cost and effort from major experiments or System Concept Validations (SCV), to smaller scale, quick response Focused Technology Experiments (FTE).

(U) The Environmentally Adaptive Sonar Technologies effort will develop and demonstrate a high-risk/high-payoff technical approach to sonar system automation. The goal is to reduce sonar watchstander requirements by a factor of three while improving the probability of detection and reducing the false alarm rate. The approach will combine predictive models with feedback control algorithms, to optimize system performance in highly variable shallow water environments. Initially the effort will focus on the mid-frequency active acoustic challenge. Transitions will be to the DD-21, SH-60R and the new attack submarine.

(U) The Deployable Array Technologies effort will develop and demonstrate a family of deployable systems including active, multi-static, passive acoustic and non-acoustic sensors with associated signal processing, communications connectivity and data fusion technologies. All systems will be evaluated in the Littoral ASW spike process for demonstration in FY 2003 through FY 2005. Initial emphasis will be on establishing shallow-water ASW barriers. Later variants will focus on multi-static fields. Battery packs will be included to provide three to thirty day sensor operations as dictated by the operational scenario. The goal is to provide an affordable, survivable network of sensors that can be readily deployed by submarines, surface ships, or aircraft to provide instantaneous detection and continuous tracking. Connectivity will be implemented via a low-profile gateway buoy on the ocean surface to a low-earth orbiting satellite to a remote shore processing facility. The primary transition will be to the Advanced Deployable System acquisition program.

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Budget Item Justification  
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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

Date: February 2000

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603747N

PROJECT NUMBER: R2142

PROGRAM ELEMENT TITLE: Undersea Warfare Advanced Technology

PROJECT TITLE: Shallow Water Surveillance Advanced Technology

(U) In addition to current submarine quieting trends, the requirement for the Navy to operate in acoustically noisy littoral environments, severely limits the performance of Anti-Submarine Warfare systems that are currently in the fleet. The Robust Passive Sonar Technology (FY 2001) will explore the limits of passive acoustics to determine the utility and design of future passive sonars. This program will develop affordable technologies that provide significant passive sonar performance improvements through the use of adaptive interference cancellation algorithms that operate effectively in dynamic environments and by exploiting vertical noise directionality in the water column.

(U) This research directly supports the Department of Defense Joint Warfighting Science and Technology (S&T) Plan and the Defense Technology Area Plans. Within the Navy the effort supports the following Navy Joint Mission Areas (JMAs): Littoral Warfare; Intelligence, Surveillance, and Reconnaissance; and Strategic Mobility.

## (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

### 1. (U) FY 1999 ACCOMPLISHMENTS:

- (U) Affordable Radar Periscope Detection and Discrimination (ARFDD):
  - (U) Completed:
  - (U) Flight testing of the brassboard system onboard operational P-3 aircraft. During these tests, data will be collected to establish that motion compensation and land exclusion are working properly, as well as establishing airborne detection performance with reduced false alarm rates against periscopes.
  - (U) Fleet demonstration of real-time performance which meets full operational requirements.
- (U) Lightweight Broadband Variable Depth Sonar (LBVDS):
  - (U) Continued detailed system and sub-system design, integration and verification.
  - (U) Conducted final design review.
- (U) Littoral Warfare Advanced Development (LWAD):
  - (U) Completed:
  - (U) Investigation of the tactical utility of the Distant Thunder system, which employs broadband explosive sources used in conjunction with a neural network-based processor and cross-platform communications. This effort explored the impact of the shallow-water acoustic propagation environment and the effects of target variability on the Distant Thunder system performance by

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Date: February 2000

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PROGRAM ELEMENT: 0603747N

PROJECT NUMBER: R2142

PROGRAM ELEMENT TITLE: Undersea Warfare Advanced Technology

PROJECT TITLE: Shallow Water Surveillance Advanced Technology

testing in tactically significant Fleet operating areas and also by participating in a LWAD sea trial.

(U) Analysis of FY-98 sea tests. Transition validated technologies and incorporate analysis results in future planning.

(U) Advisory Board meeting of Fleet, Office of Chief of Naval Operations, Systems Command, and S&T representatives to best match S&T requirements with transition opportunities and shape the FY01 at-sea test schedule.

(U) Demonstrated:

(U) LWAD 99-1 Sea Test. An integrated sea test to support:

1. (U) Evaluation of the capability of the Acoustic Communications (ACOMMS) ATD (Advanced Technology Demonstration) to operate in shallow water, using fleet hardware.

2. (U) Evaluation of Naval Postgraduate School's Inversion Techniques applied research algorithm to extract environmental characteristics from fleet sonar operations to improve sonar performance.

3. (U) Basic research of shallow water propagation by Office of Navy Research (ONR's)/WoodsHole Oceanographic Institute's Modal Mapping Experiment.

4. (U) Evaluation of the capability of an applied research algorithm (Bidynamics) to actively detect and localize submarines in shallow water using large time-bandwidth signals transmitted from fleet sonar.

5. (U) Evaluation of NAVSEA's new shallow water waveforms designed for Echo Tracker Classifier in preparation for transition to a version of the SQQ-89 ASW combat system.

(U) LWAD 99-2 Sea Test. An integrated sea test to support:

1. (U) Evaluation of the ability of ONR's Advanced Radar Periscope Discrimination and Detection (airborne version) to detect a small diesel/electric submarine in the littoral environment.

2. (U) Evaluation of the relative shallow water performance of air-deployed, coherent, acoustic sources for NAVAIR's Advanced Extended Echo Ranging (AEER) program in preparation for fleet transition in the next decade.

3. (U) Evaluation of the detection capability of new waveform designed for NAVAIR's ShallowWater Directional, Command, Active, Sonobuoy System program to improve performance of active sonobuoys to be transitioned to the fleet in the next decade.

4. (U) Evaluation of NAVSEA's new shallow water waveforms designed for Echo Tracker Classifier in preparation of transition to a version of the SQQ-89 ASW combat system.

5. (U) Evaluation of NAVAIR/NAWC Light Weight Sound System (LWSS) (PE 0603747N, Project X1933) as a helo-deployed incoherent acoustic source in shallow water submarine detection in preparation for accelerated transition to the fleet

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PROGRAM ELEMENT TITLE: Undersea Warfare Advanced Technology

PROJECT TITLE: Shallow Water Surveillance Advanced Technology

6. (U) Evaluation of NAVAIR's new shallow water processing algorithms for impulsive systems to improve performance of submarine detection of air deployed Improved Extended Echo Ranging systems.

- (U) LWAD 99-3 Sea Test. An integrated sea test to support:

1. (U) Evaluation of the ability of Canada's Wideband Active Sonar System (WASS) to detect submarines in shallow water using active acoustic incoherent sources and new processing algorithms. This effort is being conducted under the auspices of The Technical Cooperation Panel (TTCP), Maritime Systems Group.

2. (U) Evaluation of the ability of ONR's Multistatic ASW Capability Enhancement (MACE) system to detect submarines in shallow water.

3. (U) Evaluation of ability of the United Kingdom's Energy Mapping and Active Adjunct technology to detect submarines in shallow water using new processing algorithms for acoustic/non-acoustic tracking systems and active acoustic incoherent sources. This effort is being conducted under the auspices of the TTCP.

4. (U) Evaluation of the ability of the Multistatic Multipulse Airguns source technology (COTSAir Gun) to detect submarines in shallow water.

5. (U) Evaluation of the detection capability of new waveforms designed for NAVAIR's Shallow Water Directional, Command, Active Sonobuoy program to improve performance of active sonobuoys to be transitioned to the fleet in the next decade.

6. (U) Evaluation of forward-scatter signal processing proof-of-concept adaptive control algorithms as part of NRL's core program.

7. (U) Evaluation of the effectiveness of the Distant Thunder System, utilizing impulsive source used in conjunction with a neural network based processor. Processing will be done aboard P-3 aircraft and surface ships.

2. (U) FY 2000 PLAN:

- (U) Affordable Radar Periscope Detection and Discrimination (ARPPD):
  - (U) Conduct analysis of results from FY99 Fleet demonstrations. Develop and publish a final report of results to-date. Identify techniques to reduce FAR in airborne operation
- (U) Lightweight Broadband Variable Depth Sonar (LBVDS):
  - (U) Continue system integration and verification in preparation for the initial at-sea engineering shakedown and operational test in FY 2001.

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PROGRAM ELEMENT: 0603747N

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PROGRAM ELEMENT TITLE: Undersea Warfare Advanced Technology

PROJECT TITLE: Shallow Water Surveillance Advanced Technology

- (U) Littoral Warfare Advanced Development (LWAD):
  - (U) Conduct:
    - (U) Advisory Board meeting of Fleet, Office of Chief of Naval Operations, Systems Command, and S&T representatives to best match S&T requirements with transition opportunities and shape the FY01/02 at-sea test schedule.
    - (U) Three sea tests to address emerging technology issues and transition opportunities identified by the Undersea Warfare (USW) community and the analysis of previous LWAD at-sea testing.
  - (U) Demonstrate:
    - (U) NAVSEA's new shallow water waveforms designed for Echo Tracker Classifier in preparation for transition to a version of the SQQ-89 ASW combat system.
    - (U) Passive acoustic capabilities and limitations in concert with Supreme Allied Commander Atlantic Center Research Vessel (R/V) Alliance; quantify results.
    - (U) Complete the analysis of FY-99 sea tests. Transition validated technologies and incorporate analysis results in future planning.
- (U) Environmentally Adaptive Sonar Technologies (EAST):
  - (U) Initiate:
    - (U) Design and procurement of environmentally adaptive, active sonar system controller hardware suitable for integration with the combat system on an SQS-53C(V) equipped surface ship combatant.
    - (U) Integration and checkout of environmentally adaptive, active sonar software under development in Undersea Surveillance Technology (PE 0602314N). This effort will make use of a Land Based Integration and Test System (LBITS).
  - (U) Complete:
    - (U) Design and procurement of environmentally adaptive, active sonar system controller hardware suitable for integration with the combat system on an SQS-53C(V) equipped surface ship combatant.
- (U) Deployable Array Technology (DAT):
  - (U) Initiate advanced development of a rapidly deployable, shallow water, autonomous distributed system. The dsystem will be capable of detecting, classifying, and tracking submarine contacts at short range. An undersea acoustic communications network capable of determining node position, establishing network primary and secondary communication paths, and adjusting protocols and power to the environmental conditions will also be demonstrated. An environmental measurement capability coupled with modeling will select node laydown and predict performance. Periodic communication gateway buoys will relay contact

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PROGRAM ELEMENT: 0603747N

PROJECT NUMBER: R2142

PROGRAM ELEMENT TITLE: Undersea Warfare Advanced Technology

PROJECT TITLE: Shallow Water Surveillance Advanced Technology

reports from the undersea sensor network to shore/ship. Finally, a system management station will display node positions and perform contact management on reported contacts.

3. (U) FY 2001 PLAN:

- (U) Affordable Radar Periscope Detection and Discrimination (ARPDD):
  - (U) Conduct development, test and evaluation of techniques to reduce False Alarm Rate in airborne operation. Develop and publish a report of results.
- (U) Lightweight Broadband Variable Depth Sonar (LBVDS):
  - (U) Continue integration and testing of subsystems in preparation for the final fleet operational system demonstration in FY 2002.
  - (U) Conduct at-sea engineering shakedown and structured operational test.
- (U) Littoral Warfare Advanced Development (LWAD):
  - (U) Conduct:
    - (U) Advisory Board meeting of Fleet, Office of Chief of Naval Operations Systems Command, and Science and Technology (S&T) representatives to best match S&T requirements with transition opportunities and shape the FY 01/02 at-sea test schedule.
    - (U) Four sea tests to address emerging technology issues and transition opportunities identified by the USW community and the analysis of previous LWAD at-sea testing.
  - (U) Demonstrate:
    - (U) USW performance enhancements through the data fusion of available USW sensing technologies and quantify results.
    - (U) Complete analysis of FY 00 sea tests. Transition validated technologies and incorporate analysis results in future planning.
- (U) Environmentally Adaptive Sonar Technologies (EAST):
  - (U) Initiate:
    - (U) Procurement and integration of environmentally adaptive, passive sonar system controller for the surface combatant SQR-19 towed array.
    - (U) Integration and checkout of environmentally adaptive software for passive sonar developed in Undersea Surveillance Technology (PE 0602314N). This effort will make use of LBITS.
  - (U) Conduct:

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PROGRAM ELEMENT: 0603747N

PROJECT NUMBER: R2142

PROGRAM ELEMENT TITLE: Undersea Warfare Advanced Technology

PROJECT TITLE: Shallow Water Surveillance Advanced Technology

- (U) An at-sea demonstration of the environmentally adaptive SQS-53C(V) active sonar system on the IUSW-21 fleet test platform.
- (U) Complete:
- (U) Integration and checkout of environmentally adaptive, active sonar software under development in Undersea Surveillance Technology (PE 0602314N). This effort will make use of a Land Based Integration and Test System (LBITS).

- (U) Deployable Array Technology (DAT):

- (U) Initiate advanced development of bottom mounted autonomous acoustic/magnetic barrier arrays with onboard classification and reporting by acoustic modems to an undersea network with gateways to commercial Personal Communications Systems satellites.
- (U) Demonstrate the technical feasibility of several node designs and select technologies for operational performance demonstration in FY 2003 to gain feedback from fleet participants. This demonstration supports the build-test-build design philosophy.

- (U) Robust Passive Sensor Technology:

- (U) Initiate:
- (U) Design and installation of high resolution, fixed-array sensors to collect long-term data to support future passive system designs and explore the limits of passive acoustics.

B. (U) PROGRAM CHANGE SUMMARY: See program change summary for total PE.

C. (U) OTHER PROGRAM FUNDING SUMMARY: Not applicable.

(U) RELATED RDT&E:

- (U) PE 0601153N (Defense Research Sciences)
- (U) PE 0602314N (Undersea Warfare Surveillance Technology)
- (U) PE 0602435N (Ocean and Atmospheric Technology)
- (U) PE 0603254N (Air ASW Systems Development)
- (U) PE 0603553N (Surface ASW)
- (U) PE 0603785N (Combat Systems Oceanographic Performance Assessment (CSOFA))

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Date: February 2000

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603747N

PROGRAM ELEMENT TITLE: Undersea Warfare Advanced  
Technology

PROJECT NUMBER: R2142

PROJECT TITLE: Shallow Water Surveillance  
Advanced Technology

- (U) PE 0603792N (Advanced Technology Transition)
- (U) PE 0604221N (P-3 Modernization Program)
- (U) PE 0604261N (Acoustic Search Sensors (ENG))
- (U) PE 0604311N (Integrated Undersea Surveillance System)
- (U) PE 0604503N (Submarine System Equipment Development)
- (U) PE 0604784N (Distributed Surveillance Systems)

D. (U) SCHEDULE PROFILE: Not applicable.

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DATE: February 2000

BUDGET ACTIVITY: 3      PROGRAM ELEMENT: 0603747N  
 PROGRAM ELEMENT TITLE: Undersea Warfare Advanced Technology

(U) COST: (Dollars in Thousands)

PROJECT NUMBER & TITLE	FY 1999 ACTUAL ESTIMATE	FY 2000 ESTIMATE	FY 2001 ESTIMATE	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	TO COMPLETE PROGRAM	TOTAL PROGRAM
R2267 USW Weapons Advanced Technology	9,611	10,458	11,046	10,260	10,159	10,114	9,916	CONT.	CONT.

A. (U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: This project addresses issues associated with maintaining a technology base for future torpedo production. It will be integrated with the existing Undersea Warfare Weapon Technology Applied Research Program (PE 0602633N) and will enhance undersea weapon related Advanced Technology Demonstrations by sponsoring component prototyping efforts which will subsequently be available for transition to future weapon upgrade and acquisition programs. The project focuses on life-cycle affordability initiatives including simulation-based design, increased hardware and software commonality across weapon types, and the use of Commercial-Off-The-Shelf (COTS) hardware. Cost effective design opportunities in the area of warheads, guidance and control units and propulsion packages for both lightweight and heavyweight weapons will be explored.

(U) PROGRAM ACCOMPLISHMENTS AND PLANS:

1. (U) FY 1999 ACCOMPLISHMENTS:
  - (U) Completed manufacturing, operations, and maintenance cost analysis model. Completed performance optimization model to be used in torpedo cost effectiveness studies.
  - (U) Initiated development of a test bed for high-speed, vehicle system evaluation; evaluated guidance system concepts for high-speed weapons; and developed options for full-scale control surfaces.
  - (U) Conducted turbine-silencing analysis and investigate integration with high-rate propulsion systems. Examined safety issues associated with the use of lithium-based power systems for undersea applications.
  - (U) Completed evaluation of quieting approach. Identified candidate quieting techniques for early transition to both Lightweight and ADCAP torpedo programs (PE's 0708011N and 0603506N respectively).
  - (U) Completed system implementation for frequency agile, broadband, acoustic algorithms using COTS hardware. Demonstrated initial broadband algorithms in ADCAP shallow water environments.
  - (U) Assessed design options for small 6 1/4 inch diameter warhead for multiple, close-in threats.

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DATE: February 2000

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603747N

PROJECT NUMBER: R2267

PROGRAM ELEMENT TITLE: Undersea Warfare Advanced Technology

PROJECT TITLE: USW Weapons Advanced Technology

- (U) Built and tested affordable countermeasure components.
  - (U) Developed and demonstrated Guidance and Control (G&C) and mobile countermeasure technology supporting current fleet mission requirements in platform connectivity and torpedo defense.
  - (U) Completed signal processor/tactical computer interface specification and integration to the digital torpedo simulation model.
2. (U) FY 2000 PLAN:
- (U) Continue development of high-speed, supercavitating test bed; conduct preliminary wire-riding model tests.
  - (U) Demonstrate frequency-agile, broadband-processing techniques in complex (countered) littoral engagements. (U) Initiate rechargeable battery, fuel cell, or other low-rate, long endurance power source development supporting undersea vehicle propulsion requirements.
  - (U) Integrate affordable countermeasure components in MK3 configuration and perform at-sea testing.
  - (U) Complete tactical control behavior design and coding representing full Anti-Submarine functionality.
3. (U) FY 2001 PLAN
- (U) Demonstrate frequency agility/optimum frequency selection using adaptive cancellation and low resolution imaging against countermeasures.
  - (U) Establish payoff in torpedo effectiveness of the baseline and Prototype Intelligent Controllers; complete port of architecture to all hardware systems.
  - (U) Continue development of high-speed, supercavitating test bed.
  - (U) Continue rechargeable battery, fuel cell, or other low-rate, long endurance power source development supporting undersea vehicle propulsion requirements.
  - (U) Integrate affordable countermeasure components in MK4 configuration and perform at-sea testing.
- B. (U) PROGRAM CHANGE SUMMARY: See program change summary for total PE.
- C. (U) OTHER PROGRAM FUNDING SUMMARY: Not applicable.  
(U) RELATED RDT&E:

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PROGRAM ELEMENT: 0603747N

PROJECT NUMBER: R2267

PROGRAM ELEMENT TITLE: Undersea Warfare Advanced Technology

PROJECT TITLE: USW Weapons Advanced Technology

- (U) PE 0601153N (Defense Research Sciences)
- (U) PE 0602314N (Undersea Warfare Surveillance Technology)
- (U) PE 0602435N (Ocean and Atmospheric Technology)
- (U) PE 0603254N (Air ASW Systems Development)
- (U) PE 0603553N (Surface ASW)
- (U) PE 0603792N (Advanced Technology Transition)
- (U) PE 0603506N (Surface Ship Torpedo Defense)
- (U) PE 0604310N (Arsenal Ship)
- (U) PE 0604503N (Submarine System Equipment Development)
- (U) PE 0604784N (Distributed Surveillance Systems)
- (U) PE 0603763E (Marine Technology)
- (U) PE 0603739E (Advanced Electronics Technologies)
- (U) PE 0602702E (Tactical Technology)
- (U) PE 0602173C (Support Technologies - Applied Research)

D. (U) SCHEDULE PROFILE: Not applicable.

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

UDGET ACTIVITY: 3 PROGRAM ELEMENT: 0603782N  
 PROGRAM ELEMENT TITLE: Mine and Expeditionary Warfare Advanced Technology

U) COST: (Dollars in Thousands)

PROJECT NUMBER & TITLE	FY 1999 ESTIMATE	FY 2000 ESTIMATE	FY 2001 ESTIMATE	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	TO COMPLETE	TOTAL PROGRAM
2226 Mine and Expeditionary Warfare Advanced Technology	41,546	48,442	45,618	46,417	47,139	45,574	46,683	CONT.	CONT.
2499 ALLISS	978	0	0	0	0	0	0	0	978
2720 Ocean Modeling for Mine Sub Warfare	42,524	57,393	45,618	46,417	47,139	45,574	46,683	CONT.	8,951 CONT.
TOTAL									

(U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: This program supports demonstrations of technologies for Naval Expeditionary Forces performing the missions of Mine and Expeditionary Warfare. The technologies support a range of capabilities enabling Naval Expeditionary Forces to influence operations ashore.

(U) This Program Element (PE) transitions technologies responding to high-priority Naval Expeditionary Warfare mission requirements. The emphasis is on simulating and testing prototypes of technologies with the potential for providing Naval capabilities in six major areas:

- Organic Mine Countermeasure (MCM) technologies for organic minehunting and clearance; and organic ship protection.
- Mine Countermeasures technologies for Ship to Objective Maneuver
- Offensive Sea Mining
- Battlefield surveillance, reconnaissance, and targeting.
- Naval fire support.
- Command, control, communications, information processing, and mission planning supporting land battles.
- Force mobility and survivability.

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DATE: February 2000

UDGET ACTIVITY: 3 PROGRAM ELEMENT: 0603782N  
 PROGRAM ELEMENT TITLE: Mine and Expeditionary Warfare Advanced Technology

- U) Due to the sheer volume of efforts included in this PE, the programs described in the Accomplishments and Plans section are representative selections of the work included in this PE.
- U) The Navy Science and Technology program includes projects that focus on or have attributes that enhance the affordability of warfighting systems.
- U) JUSTIFICATION FOR BUDGET ACTIVITY: This program is budgeted within the ADVANCED TECHNOLOGY DEVELOPMENT Budget Activity because it encompasses design, development, simulation, or experimental testing or prototype hardware to validate technological feasibility and concept of operations and reduce technical risk prior to initiation of a new acquisition program or transition to an ongoing acquisition program.

PROGRAM CHANGE SUMMARY:	<u>FY 1999</u>	<u>FY 2000</u>	<u>FY 2001</u>
(U) FY 2000 President's Budget	44,220	48,711	45,869
(U) Appropriated Value:		57,711	
(U) Adjustments from PRESBUDG:			
(U) SBIR/STTR Transfer	- 512		
(U) Various Rate Adjustments			- 240
(U) Congressional Plus up		9,000	
(U) SPP Adjustment			- 11
(U) Execution Adjustment	- 990		
(U) Inflation Adjustment	- 194		
(U) Congressional Rescission		- 318	
(U) FY 2001 PRESBUDG Submission	42,524	57,393	45,618

- (U) Schedule: Not applicable.
- (U) Technical: Not applicable.

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Budget Item Justification  
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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

UDGET ACTIVITY: 3 PROGRAM ELEMENT: 0603782N  
PROGRAM ELEMENT TITLE: Mine and Expeditionary Warfare Advanced Technology

U) COST: (Dollars in Thousands)

ROJECT NUMBER & TITLE	FY 1999 ESTIMATE	FY 2000 ESTIMATE	FY 2001 ESTIMATE	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	TO COMPLETE	TOTAL PROGRAM
2226 Mine and Expeditionary Warfare Advanced Technology	41,546	48,442	45,618	46,417	47,139	45,574	46,683	CONT.	CONT.

(U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: This program supports demonstrations of technologies for Naval Expeditionary Forces performing the missions of Mine and Expeditionary Warfare. The technologies support a range of capabilities enabling Naval Expeditionary Forces to influence operations ashore.

(U) PROGRAM ACCOMPLISHMENTS AND PLANS:

1. (U) FY 1999 ACCOMPLISHMENTS:

- (U) ADVANCED DEGAUSSING: Completed all efforts in advanced deperming, closed loop degaussing, and algorithm development. Completed documentation of algorithms and demonstration results. Transitioned degaussing technologies to PE 0603513N, PE 0603502N, and the LPD-17 construction program.
- (U) ADVANCED SURVEILLANCE/RECONNAISSANCE: Continued focused efforts on environmental parameters, including offshore bathymetry, optical clarity, and other essential elements of information appropriate to amphibious assaults. Continued transitioning critical battle space products to the Naval Oceanographic Office. Demonstrated littoral remote sensing products during Fleet Battle Experiment (FBE) Echo (Kernal Blitz).

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DATE: February 2000

UDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603782N

PROGRAM ELEMENT TITLE: Mine and Expeditionary

Project Number: R2226

Project Title: Mine and Expeditionary Warfare Advanced Technology

Warfare Advanced Technology

- (U) MODELING AND SIMULATION: Continued simulation based concept, based assessment focusing on assessment of technologies for naval surface fire support and Future Naval Capabilities in Organic Mine Countermeasures. The effort continues to emphasize warfighter-technologist interaction and warfighter driven simulation based technology assessment to explore in detail current and advanced technologies in tandem with relevant concepts of operations. Initiated concept visualization of future naval surface fire support and organic mine warfare technologies.
- (U) Joint Countermine Advanced Concept and Technology Demonstration (JCM ACTD): Completed post exercise analysis of JCM ACTD Demonstration II and documentation of demonstration results (incorporating "user" comments). Continued logistics support for ACTD "residual" equipment left with operational forces. Completed documentation of Joint Countermine Operational Simulation (JCOS) and Command, Control, Communication and Computer Intelligence (C4I). Demonstrated C4I and JCOS during FBE-Echo (Kernal Blitz) as part of the residual phase, collecting additional data on military utility.
- (U) ADVANCED AIRBORNE TARGET DESIGNATOR: Completed field tests and demonstrations with live fires to determine accuracy of targeting to resulting fire locations. Continue documentation of field test results and quantification of localization accuracy for transition of airborne target designator technology to Marine Corps Systems Command Ground Weapons for integration in UH-1N helicopter and Unmanned Aerial Vehicles (UAVs).
- (U) EXPEDITIONARY WARFARE COMMUNICATIONS NETWORKING: Continued demonstration of advanced high capacity radio frequency links between ships at sea, focusing on beyond line of sight communications between ships and objectives ashore. Completed assessment of high capacity radio technologies between ships at sea.
- (U) SURFACE SURVEILLANCE, TARGET ACQUISITION, FIRE CONTROL, AND ORDNANCE: Initiated development of component technologies for demonstration of a low cost, high speed guided projectile for Naval guns. Began development of actuated aerodynamic control surfaces for control of high velocity projectiles. Initiated warhead lethality study against hard and soft targets.
- (U) MINE IDENTIFICATION: Began integration of component technologies together in the laboratory. Began fabrication of final design suitable for tow-body configuration. Conducted laboratory and field tests of integrated system components.

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DATE: February 2000

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603782N

PROGRAM ELEMENT TITLE: Mine and Expeditionary

Project Number: R2226

Project Title: Mine and Expeditionary  
Warfare Advanced Technology

- (U) LITTORAL SEA MINE: Initiated design of littoral sea mine technology demonstration model. Initiated fabrication/testing of individual components. Began development of data fusion algorithms and assured communication algorithms.
- (U) VERY SHALLOW WATER/EXPLOSIVE ORDNANCE DISPOSAL (VSW/EOD) RECONNAISSANCE: Initiated development of diver-portable detection, classification, and identification technologies and autonomous underwater vehicles for VSW reconnaissance. Initiated development of a simulation which provides for the evaluation of the approach and effectiveness of Unmanned Underwater Vehicles (UUVs) under varying environmental conditions to perform critical Mine Countermeasure VSW missions including search and inspection. Initiated trade-off studies of technical and operational concepts to include directed versus autonomous operation, deployment, recovery, command, control and communication. Began development of prototype low-cost acoustic and magnetic induction navigation transponders and receivers to enable localization in VSW. Began demonstration of VSW technologies during training exercises to assess operational effectiveness.
- (U) ORGANIC MINEHUNTING AND NEUTRALIZATION OF MINES: Began demonstration of advanced technologies for organic mine countermeasures during Fleet training exercises to assess operational effectiveness and develop concept of operations. Demonstrated rapid, organic mine identification using electro-optic sensor (laser line scan technology) and synthetic aperture sonar during FBE Echo (Kernal Blitz). Demonstrated high speed influence minesweeping using ALISS technologies during FBE Echo (Kernal Blitz). Demonstrated control of a high speed, unmanned surface vehicle using an interoperable tactical control system during FBE Echo (Kernal Blitz).
- (U) SURF ZONE (SZ) NEUTRALIZATION OF MINES AND OBSTACLES: Initiated development a system of small, autonomous minehunting vehicles capable of detection, classification of mines and obstacles in the SZ environments. Began development of air delivered, reactive, intermetallic darts for neutralization of mines on the beach. Developed baseline dart design and began testing of dart lethality against key mine types. Initiated development of Inverse Guidance Law concept which allows guidance of air dropped ordnance with Global Positioning System (GPS) position and velocity state data only.

2. (U) FY 2000 PLAN

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Budget Item Justification  
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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603782N

PROGRAM ELEMENT TITLE: Mine and Expeditionary

Warfare Advanced Technology

Project Number: R2226

Project Title: Mine and Expeditionary

Warfare Advanced Technology

- (U) ADVANCED SURVEILLANCE/RECONNAISSANCE: Continue focused algorithm refinement efforts on critical environmental parameters, including offshore bathymetry, optical clarity, and other essential elements of information appropriate to amphibious operations. Continue transition of critical battle space products to the naval oceanographic office.
- (U) MODELING AND SIMULATION: Continue simulation based assessment of technologies for naval surface fire support and Future Naval Capabilities in Organic Mine Countermeasures. Continue concept visualization of naval surface fire support technologies focusing on air space deconfliction. Continue concept visualization and assessment of organic mine countermeasures technologies focusing on the future Marine Corps warfighting concept of Ship to Objective Maneuver. Participate in Fleet Battle Laboratory experiments and expeditionary warfare wargaming.
- (U) JCM ACTD: Continue logistics support for select ACTD "residual" equipment left with operational forces for further evaluation.
- (U) ADVANCED AIRBORNE TARGET DESIGNATOR: Complete documentation of field test results and quantification of localization errors. Complete transition of airborne target designator technology to Marine Corps Systems Command Ground Weapons for integration in UH-1N and UAVs.
- (U) EXPEDITIONARY WARFARE COMMUNICATIONS NETWORKING: Continue evaluation of advanced high capacity communications links between ships at sea and ship to objectives ashore through assessment during Amphibious Ready Group deployments. Complete analysis and assessment of high capacity radio linkages between ships at sea and ships to objective ashore.
- (U) SURFACE SURVEILLANCE, TARGET ACQUISITION, FIRE CONTROL, AND ORDNANCE: Complete development of actuated control surface for high speed projectile. Conduct wind tunnel tests. Complete development of ultracompact, high G GPS/Inertial Measuring Unit guidance package for high speed projectile. Integrate components and demonstrate guidance and control of an inert, high velocity 5 inch projectile. Begin development of composite metal flechette and packaging and distribution warhead.
- (U) MINE IDENTIFICATION: Complete integration of component Streak Tube Imaging Laser (STIL) technologies in airborne minehunting sonar (AQS-20) towbody. Initiate development of automated mine identification algorithms.

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Budget Item Justification  
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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

UDGET ACTIVITY: 3 PROGRAM ELEMENT: 0603782N

Project Number: R2226

PROGRAM ELEMENT TITLE: Mine and Expeditionary Warfare Advanced Technology

Project Title: Mine and Expeditionary Warfare Advanced Technology

- Demonstrate mine identification at operational speeds from a surface ship tow. Quantify performance as a function of operational parameters. Demonstrate mine identification from a helicopter tow. Begin transition of STIL mine identification technology to PE 0603502N and PE 0604373N (Airborne Mine Countermeasures).
- (U) LITTORAL SEA MINE: Demonstrate and evaluate assured communications between an underwater testbed and an external surface and subsurface control authority. Demonstrate and evaluate long baseline target detection and tracking sensor hardware and algorithms against quiet underwater targets.
  - (U) VSW/EOD RECONNAISSANCE: Develop search strategies which are optimized based on information provided by environmental survey data acquired by search and reconnaissance UUVs. Develop sensing technologies and capability to conjunctively employ sensed information between communicating platforms employing independently acquired sensed data. Demonstrate coordinated navigation and positioning in very shallow water through actual deployments of a search vehicle and inspection vehicle.
  - (U) ORGANIC MINEHUNTING AND NEUTRALIZATION OF MINES: Complete analysis of Fleet Battle Experiment demonstration of advanced technologies for organic minehunting. Demonstrate and evaluate the use of a scaleable, interoperable tactical control system common to both UAVs and remote minehunting vehicles. Initiate development of a prototype H-60 compatible, conductively cooled, low temperature superconducting magnetic solenoid for organic sweeping of influence mines.
  - (U) SZ NEUTRALIZATION OF MINES AND OBSTACLES: Demonstrate coordinated navigation and positioning in the SZ through actual deployments of an unmanned bottom crawling vehicle. Demonstrate autonomous detection and classification of threat-like bottom objects in the presence of natural and man-made clutter in the SZ. Demonstrate group search (up to 5 vehicles), report back of target information, and marking of targets.
  - (U) BEACH ZONE (BZ) NEUTRALIZATION OF OBSTACLES: Complete development of Inverse Guidance Law concept which allows guidance of air dropped ordnance with GPS position and velocity state data only. Assess performance of conventional GPS updated inertial navigation concepts. Continue development and lethality testing of intermetallic darts for neutralization of beach and surf zone mines.

(U) FY 2001 PLAN

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Budget Item Justification  
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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

UDGET ACTIVITY: 3 PROGRAM ELEMENT: 0603782N

PROGRAM ELEMENT TITLE: Mine and Expeditionary

Project Number: R2226

Project Title: Mine and Expeditionary Warfare Advanced Technology

- (U) ADVANCED SURVEILLANCE/RECONNAISSANCE: Complete algorithm development efforts on critical environmental parameters, including offshore bathymetry, optical clarity, and other essential elements of information for amphibious operations. Assess performance of algorithms against ground truth data. Transition results to the Naval Oceanographic Office.
- (U) MODELING AND SIMULATION: Continue simulation/visualization based concept assessment of technologies for naval surface fire support and Future Naval Capabilities in organic MCM. Continue participation in Fleet Battle Laboratory experiments and expeditionary warfare wargaming.
- (U) EXPEDITIONARY WARFARE COMMUNICATIONS NETWORKING: Complete evaluation/assessment of high capacity communications links between ships and objectives ashore. Complete documentation of all deployment assessments.
- (U) SURFACE SURVEILLANCE, TARGET ACQUISITION, FIRE CONTROL, AND ORDNANCE: Complete development of composite metal flechettes and delivery system. Begin integration of guidance, control and warhead technologies into 5 inch projectile.
- (U) MINE IDENTIFICATION: Complete analysis of helicopter towed STILL mine identification technology demonstration. Complete development of automated mine identification algorithms and assess performance utilizing data obtained during ship/helicopter towed technology demonstration. Transition STILL mine identification technology to PE 0603502N and PE 0604373N (Airborne Mine Countermeasures).
- (U) LITTORAL SEA MINE: Integrate target detection/tracking long baseline sensors, detection/tracking algorithms, underwater communications, and test bed weapons system (hybrid lightweight torpedo). Demonstrate target detection, tracking and fire control.
- (U) VSW/EOD RECONNAISSANCE: Demonstrate and evaluate capability to communicate VSW target information to a control authority by one or more methods including surface piercing Radio Frequency technology. Demonstrate asset redirection and command detonation by a remote control. Demonstrate integrated search, marking, bathymetry mapping, threat objects and gaps and report back in test-bed minefields in VSW environments. Demonstrate capability to enable diver teams to efficiently and accurately reacquire previously targeted areas and individual targets. Evaluate covertness of operation and capability to provide complete coverage.

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Budget Item Justification  
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FY 2001 RDT&E, N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 3 PROGRAM ELEMENT: 0603782N

Project Number: R2226

PROGRAM ELEMENT TITLE: Mine and Expeditionary Warfare Advanced Technology

Project Title: Mine and Expeditionary Warfare Advanced Technology

- (U) ORGANIC MINEHUNTING AND NEUTRALIZATION OF MINES: Develop and demonstrate adaptive, shallow water reconnaissance and minehunting sampling strategies which are optimized based on information provided by environmental survey data and through in-situ environmental measurements. Complete development of conductively cooled, low temperature superconducting magnetic solenoid for organic mine sweeping. Demonstrate magnet functionality and transition to Airborne Mine Countermeasures acquisition program.
- (U) SZ NEUTRALIZATION OF MINES AND OBSTACLES: Demonstrate and evaluate capability to communicate SZ target information to a control authority by one or more methods to include surface piercing RF technology. Demonstrate asset redirection by a remote control authority. Assess neutralization capability for small targets which are predominant in the SZ.
- (U) BZ NEUTRALIZATION OF OBSTACLES: Complete development of GPS only guidance component. Demonstrate accuracy of warhead deployment utilizing GPS only inverse guidance technology. Complete development of intermetallic darts for neutralization of beach and surf zone mines. Initiate development of air delivered, explosively formed impactor for neutralization of beach obstacles. Begin integration of guidance and warhead technologies for demonstration.
- (U) ADVANCED AIRBORNE MINE DETECTION: Initiate development of advanced electro-optic technologies for detection of near surface mines from a maritime UAV. Technologies include Laser Imaging Detection and Ranging, STILL, and hyperspectral imaging. Actual system concept and design will be determined based upon technical maturity, operational viability, and anticipated total ownership cost.

(U) OTHER PROGRAM FUNDING SUMMARY: Not applicable.

(U) RELATED RDT&E:

- (U) PE 0601153N (Defense Research Sciences)
- (U) PE 0602131M (Marine Corps Landing Force Technology)
- (U) PE 0602314N (Undersea Warfare Surveillance Technology)
- (U) PE 0602315N (MCM, Mining and Special Warfare Technology)
- (U) PE 0602435N (Oceanographic and Atmospheric Technology)

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Budget Item Justification  
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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 3 PROGRAM ELEMENT: 0603782N Project Number: R2226  
PROGRAM ELEMENT TITLE: Mine and Expeditionary Warfare Advanced Technology Project Title: Mine and Expeditionary Warfare Advanced Technology

- (U) PE 0603502N (Surface and Shallow Water MCM)
- (U) PE 0603513N (Shipboard System Component Dev)
- (U) PE 0603528N (Non-Acoustic ASW)
- (U) PE 0603640M (Marine Corpse Advanced Technology)
- (U) PE 0604373N (Airborne Mine Countermeasures)
- (U) PE 0604784N (Distributed Surveillance System)
- (U) PE 0602712A (Countermine Systems)
- (U) PE 0603606A (Landmine WF and Barrier Advanced Technology)

. (U) SCHEDULE PROFILE: Not Applicable.

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Budget Item Justification  
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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 3 PROGRAM ELEMENT: 0603792N  
 PROGRAM ELEMENT TITLE: Advanced Technology Transition

PROJECT NUMBER & TITLE	FY 1999 ACTUAL	FY 2000 ESTIMATE	FY 2001 ESTIMATE	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	TO COMPLETE	TOTAL PROGRAM
R1889 Advanced Technology Demonstration	63,043	75,217	76,333	78,908	76,399	75,924	74,650	CONT.	CONT.
R2382 Fast Patrol Boat	0	4,973	0	0	0	0	0	0	14,473
R2411 SWATH Technology Development	9,267	5,967	0	0	0	0	0	0	19,979
R2721 Vectored Thrust Ducted Propeller	0	5,868	0	0	0	0	0	0	5,868
R2722 Low Observable Multi-Function Stack	0	7,956	0	0	0	0	0	0	7,956
R2724 Advanced Hull Form In-Shore Demonstrator	0	9,945	0	0	0	0	0	0	9,945
<b>TOTAL</b>	<b>72,310</b>	<b>109,926</b>	<b>76,333</b>	<b>78,908</b>	<b>76,399</b>	<b>75,924</b>	<b>74,650</b>	<b>CONT.</b>	<b>CONT.</b>

A. (U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION This program demonstrates high-risk/high-payoff technologies

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Budget Item Justification  
(Exhibit R-2, page 1 of 9)

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 3 PROGRAM ELEMENT: 0603792N

PROGRAM ELEMENT TITLE: Advanced Technology Transition

that could significantly improve the warfighting capabilities of the fleet and joint forces, and provides the opportunity to identify and move emerging technologies quickly and efficiently from the laboratory to the fleet. Advanced Technology Demonstration (ATD) programs are selected for a match between technological potential and Navy requirements which are derived from operational issues of concern to the fleet. Risk-reducing ATDs cover integrating and assessing technology in a realistic operational environment and are focused on laying the technical foundations for acquiring improvements to future joint warfighting capabilities. Each demonstration is designed to assess the extent to which the technology is feasible, joint affordable, and compatible with operational concepts and projected force structure.

(U) JUSTIFICATION FOR BUDGET ACTIVITY: This program is budgeted within the Advanced Technology Development Budget Activity because it encompasses design, development, simulation, experimental testing and/or prototype hardware to validate technological feasibility and concept of operations, and reduce technological risk prior to initiation of a new acquisition program or transition to an ongoing acquisition program.

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Budget Item Justification  
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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 3 PROGRAM ELEMENT: 0603792N  
PROGRAM ELEMENT TITLE: Advanced Technology Transition

(U) PROGRAM CHANGE SUMMARY FOR TOTAL PROGRAM ELEMENT (PE):

	FY 1999	FY 2000	FY 2001
(U) FY 2000 President's Budget			
(U) Appropriated Value	73,652	75,635	77,756
(U) Adjustments From President's Budget		110,535	
(U) Congressional Plus-ups		+34,900	
(U) Congressional Rescissions		-609	
(U) SBIR/STTR Transfer	-1,365		
(U) Execution Adjustments	356		-392
(U) Various Rate Adjustments	-334		-1,031
(U) Program Adjustments			76,333
(U) FY 2001 President's Budget Submission	72,309	109,926	

(U) CHANGE SUMMARY EXPLANATION:

(U) Schedule: Not applicable.

(U) Technical: Not applicable.

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Budget Item Justification  
(Exhibit R-2, page 3 of 9)

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 3 PROGRAM ELEMENT: 0603792N  
PROGRAM ELEMENT TITLE: Advanced Technology Transition

PROJECT NUMBER & TITLE	FY 1999 ACTUAL	FY 2000 ESTIMATE	FY 2001 ESTIMATE	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	TO COMPLETE PROGRAM	TOTAL PROGRAM
R1889 Advanced Technology Demonstration	63,042	75,217	76,333	78,908	76,399	75,924	74,650	CONT.	CONT.

A. (U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: This program demonstrates high-risk/high-payoff technologies that could significantly improve the warfighting capabilities of the fleet and joint forces, and provides the opportunity to identify and move emerging technologies quickly and efficiently from the laboratory to the fleet. ATD programs are selected for a match between technological potential and Navy requirements which are derived from operational issues of concern to the fleet. Risk-reducing ATDs cover integrating and assessing technology in a realistic operational environment and are focused on laying the technical foundations for acquiring improvements to future joint warfighting capabilities. Each demonstration is designed to assess the extent to which the technology is feasible, affordable, and compatible with operational concepts and projected force structure.

(U) PROGRAM ACCOMPLISHMENTS AND PLANS:

(U) FY 1999 ACCOMPLISHMENTS:

- (U) SMART SKINS ARRAY -- Completed ATD: conducted F/A-18 testing to demonstrate operational utility.
- (U) LOW COST MISSILE SYSTEM -- Documented completed activities of terminated ATD.

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 3 PROGRAM ELEMENT: 0603792N

PROJECT NUMBER: R01889

PROGRAM ELEMENT TITLE: Advanced Technology Transition

PROJECT TITLE: Advanced Technology Demonstration

- (U) COMPETENT MUNITIONS FOR THE 5 INCH GUN -- Completed ATD: conducted flight testing demonstration.
- (U) BEST BUY -- Continued ATD: demonstrated two-piece composite projectile gun auto-loading and conducted successful two-piece rocket motor static test firing.
- (U) ADVANCED TACTICAL ACOUSTIC COMMUNICATIONS -- Completed ATD: demonstrated multi-net connectivity between submarines, ships, and unmanned undersea vehicles.
- (U) ADVANCED COMINT VOICE PROCESSING -- Completed ATD: performed system integration with EP-3 aircraft in preparation for flight demonstration of automated voice processing system.
- (U) ANTI-TORPEDO TORPEDO (ATT) TECHNOLOGY FOR SURFACE AND SUBMARINE APPLICATIONS -- Continued ATD, as coupled with NATO effort, with at-sea tests in realistic environments.
- (U) DNA VACCINES FOR COMPLEX MULTISTAGE ORGANISMS AND OTHER ORGANISMS OF MILITARY IMPORTANCE -- Continued ATD: completed safety, toxicity and immunogenicity studies for one gene vaccine in humans, and preclinical (animal) studies for five gene vaccine.
- (U) RAMICS -- Continued ATD: conducted critical tests to demonstrate lethality, validate system performance models and determine critical parameters.
- (U) AFFORDABLE ARRAY TECHNOLOGY -- Continued ATD: conducted preliminary design reviews for acoustic modules and optoelectronic receiver.
- (U) LOW OBSERVABLE MULTI-FUNCTION STACK -- Continued ATD: exhaust gas suppressor concepts developed, RF and IR coating systems selected and antenna sub-arrays built and tested.
- (U) PLASMA-ARC PYROLYSIS OF SHIPBOARD SOLID WASTE -- Initiated ATD to demonstrate full-scale plasma-arc pyrolysis system for controlled thermal destruction of shipboard wastes. Performed preliminary design.
- (U) LONG-ENDURANCE, LOW FREQUENCY ACOUSTIC SOURCE (LELFAS)-- Initiated ATD to demonstrate a low-cost, affordable, rapidly deployable, long-endurance, low frequency acoustic source. Performed initial system design and analysis. Developed high-energy density thermal power source.
- (U) ADVANCED LINEAR MOTOR -- Initiated ATD to demonstrate an aircraft recovery system using linear motor technology. Developed preliminary concept and conducted design evaluations.

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 3 PROGRAM ELEMENT: 0603792N

PROJECT NUMBER: R01889

PROGRAM ELEMENT TITLE: Advanced Technology Transition

PROJECT TITLE: Advanced Technology Demonstration

- (U) REDUCED SHIPS' CREW BY VIRTUAL PRESENCE (RSVP) -- Initiated ATD to demonstrate an automated system providing environmental, machinery, structural and personnel situational awareness. Requirements have been defined, system architecture developed, feasibility demonstrations conducted for RF and sensor subsystems.
  - (U) SHIPBOARD HIGHBAND MULTIFUNCTION RECEIVE SYSTEM (HBMR) - Initiated ATD to develop and demonstrate radar, electronic warfare and communication functions in a phased array. Performed prototype design; designed, fabricated and tested sub-array transmit/receive modules.
  - (U) Conducted independent reviews of on-going and planned FY00 new start ATDs.
- (U) FY 2000 PLAN:
- (U) BEST BUY -- Continue ATD: conduct long-range firing demonstration of unguided projectile airframe.
  - (U) ANTI-TORPEDO TORPEDO (ATT) TECHNOLOGY FOR SURFACE AND SUBMARINE APPLICATIONS -- Complete ATD with at-sea tests.
  - (U) DNA VACCINES FOR COMPLEX MULTISTAGE ORGANISMS AND OTHER ORGANISMS OF MILITARY IMPORTANCE -- Complete ATD: complete clinical trials.
  - (U) RAMICS -- Complete ATD: demonstrate system targeting on an operational platform.
  - (U) AFFORDABLE ARRAY TECHNOLOGY -- Complete ATD: complete development of prototype array and conduct research vessel tow tests.
  - (U) LOW OBSERVABLE MULTI-FUNCTION STACK -- Continue ATD: conduct land-based demonstration of antenna hardware. Install stack suppresser and shroud/antennas on test ship.
  - (U) PLASMA-ARC PYROLYSIS OF SHIPBOARD SOLID WASTE -- Continue ATD design and test feed subsystem in lab-scale reactor; demonstrate process control with various waste feed mixtures.
  - (U) LONG-ENDURANCE, LOW FREQUENCY ACOUSTIC SOURCE (LELFAS)-- Continue ATD finalize system design and initiate system fabrication.
  - (U) ADVANCED LINEAR MOTOR -- Continue ATD: complete prototype design; conduct critical component testing and complete test site design.

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Budget Item Justification  
(Exhibit R-2, page 6 of 9)

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 3 PROGRAM ELEMENT: 0603792N

PROJECT NUMBER: R01889

PROGRAM ELEMENT TITLE: Advanced Technology Transition

PROJECT TITLE: Advanced Technology Demonstration

- (U) REDUCED SHIPS' CREW BY VIRTUAL PRESENCE (RSVP) -- Continue ATD perform lab prototype system development, integration and demonstration and conduct system development Final Acceptance Tests.
- (U) SHIPBOARD HIGHBAND MULTIFUNCTION RECEIVE SYSTEM (HBMRS) -- Continue ATD perform software development; fabricate and test beamformer; and conduct shared aperture system integration.
- (U) REACTIVE MATERIAL ADVANCED WARHEAD -- Initiate ATD: objective is to demonstrate capability of solid reactive materials to extend mission kill in air, cruise missiles and ship self-defense arenas. Characterize materials and parameterize fragment design. Develop initial warhead concept and conduct initial vulnerability tests and analyses.
- (U) ADVANCED SHIPBOARD CRANE MOTION CONTROL SYSTEM: Initiate ATD: objective is to develop and demonstrate a crane control system that combines recent advances in nonlinear control system technologies with existing strategic Auxiliary Crane Ship electro-hydraulic cranes.
- (U) BUOYANT CABLE ANTENNA FOR HIGH DATA RATE SUB COMMS: Initiate ATD: objective is to develop and demonstrate an advanced Buoyant Cable Antenna (BCA) System to provide a submerged submarine with two-way, higher data rate Ultra High Frequency Fleet Satellite Communications and line-of-sight (LOS), L-band (Iridium) and K-band communications, as well as accessory sensor functions - Global Positioning System, Video, and Radar Early Warning.
- (U) MULTI-PLATFORM BROADBAND PROCESSING: Initiate ATD: objective is to develop and demonstrate a common, broadband integrated processing architecture for submarine, surface ship, and weapon sonar system platforms.
- (U) COMPOUND HELICOPTER CONCEPT: Initiate ATD: objective is to demonstrate reduction in fatigue loads, vibration levels and maintenance requirements through use of a ducted propeller for forward thrust with vectoring vanes at the tail, aimed at Airborne Mine Countermeasures (MCM) towing missions.
- (U) Conduct independent reviews of on-going ATD programs.

(U) FY 2001 PLAN:

- (U) BEST BUY -- Complete ATD: conduct long range guided projectile test firing.
- (U) LOW OBSERVABLE MULTI-FUNCTION STACK -- Complete ATD: conduct shipboard testing.

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 3 PROGRAM ELEMENT: 0603792N

PROJECT NUMBER: R01889

PROGRAM ELEMENT TITLE: Advanced Technology Transition

PROJECT TITLE: Advanced Technology Demonstration

- (U) PLASMA-ARC PYROLYSIS OF SHIPBOARD SOLID WASTE -- Complete ATD: conduct full-scale system demonstration.
- (U) LONG-ENDURANCE, LOW FREQUENCY ACOUSTIC SOURCE (LELFAS) -- Complete ATD: conclude system integration testing and fabricate two units for at sea demonstration.
- (U) REDUCED SHIPS' CREW BY VIRTUAL PRESENCE (RSVP) -- Complete ATD install system, demonstrate at sea, and assess performance.
- (U) SHIPBOARD MULTIFUNCTION/MULTIBAND RECEIVE SHARED APERTURE -- Complete ATD install, integrate and conduct field test demonstration.
- (U) ADVANCED LINEAR MOTOR -- Continue ATD: complete prototype development and test-site installation. Conduct full-scale prototype demonstration.
- (U) REACTIVE MATERIAL ADVANCED WARHEAD -- Continue ATD: complete explosive launch and impact analysis. Complete initial vulnerability tests and analyses. Conduct component integration tests, and fragment explosive launch and impact tests. Continue warhead system design. Initiate safety and lethality testing.
- (U) ADVANCED SHIPBOARD CRANE MOTION CONTROL SYSTEM: Continue ATD: develop control system/machine integration and ship motion stimulator. Initiate control system simulations and ship motion stimulator installation.
- (U) BUOYANT CABLE ANTENNA FOR HIGH DATA RATE SUB COMMS: Continue ATD: develop antenna, cable and supporting electronics. Develop deployment system and initiate development of demonstration system.
- (U) MULTI-PLATFORM BROADBAND PROCESSING: Continue ATD: continue development of broadband algorithms and embedded broadband processing software. Complete development of real-time processing and fiber optic communication link hardware. Initiate system integration and conduct initial multi-platform at-sea demonstrations.
- (U) COMPOUND HELICOPTER CONCEPT: Continue ATD: complete flight control system detail design, fabrication and test; complete drive system detail design, fabrication and initiate endurance testing; complete airframe structural analysis and initiate structural certification testing; and initiate flight test planning.
- (U) Conduct independent reviews of on-going ATD programs.

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 3 PROGRAM ELEMENT: 0603792N

PROJECT NUMBER: R01889

PROGRAM ELEMENT TITLE: Advanced Technology Transition

PROJECT TITLE: Advanced Technology Demonstration

B. (U) PROGRAM CHANGE SUMMARY: See Total Program Change Summary for PE.

C. (U) OTHER PROGRAM FUNDING SUMMARY: Not applicable.

D. (U) SCHEDULE PROFILE: Not applicable.

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(Exhibit R-2, page 9 of 9)

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET      DATE      February 2000

PROGRAM ELEMENT: 0603794N  
PROGRAM ELEMENT TITLE: C3 Advanced Technology

BUDGET ACTIVITY: 3

(U) COST: (Dollars in Thousands)

PROJECT NUMBER & TITLE	FY 1999 ACTUAL	FY 2000 ESTIMATE	FY 2001 ESTIMATE	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	TO COMPLETE	TOTAL PROGRAM
X2091 Space and Electronic Warfare (SEW) Advanced Technology	20,240	21,903	21,228	22,170	22,273	22,196	21,871	CONT.	CONT.
R2239 Advanced Targeting (C3I)	5,541	1,776	8,445	3,735	3,390	5,800	5,844	CONT.	CONT.
R2601 Dominant Battlespace Command Initiative	2,905	5,967	0	0	0	0	0	0	8,872
R2602 National Technology Alliance	14,528	9,945	0	0	0	0	0	0	24,473
R2575 National Advanced Telecommunications and Applications Center	0	1,989	0	0	0	0	0	0	1,989
TOTAL	43,214	41,580	29,673	25,905	25,663	27,996	27,715	CONT.	CONT.

A. (U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: This Program Element (PE) develops Command, Control and Communications (C<sup>3</sup>) technologies which enhance battle targeting for naval forces in Navy, Joint and Coalition operations. The tasking of this PE is executed in accordance with the Information Technology Management Reform Act (ITMRA) of 1996. This PE has been restructured to support the Navy's high priority technology needs for Navy implementation of network centric warfare and Joint Vision 2010. Primary products include technology for dynamic, reconfigurable, secure, radio frequency networks; high data rate, radio frequency communications; multi-function apertures; high assurance systems; distributive, collaborative, planning and execution; complex information processing support for deliberate precision weapons engagements; and algorithms for specific target identification.

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE February 2000

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603794N

PROGRAM ELEMENT TITLE: C3 Advanced Technology

(U) This PE primarily supports the following Joint Mission Areas and Support Areas: Land Attack (comprised of precision strike and naval surface fire support functions), Amphibious Warfare, Information Warfare, Anti Air Warfare, Maritime Dominance, Theater Ballistic Missile Defense and Readiness/Training. The focus is on development and demonstrations of next-generation C systems with high quality and certifiable quality of service to support joint war fighting operations, involving land units, ships, aircraft, and submarines. C capabilities in the 21st century are key to the success of all aspects of military operations including force level planning and rehearsal quality as well as unit level battlespace awareness and weapons engagement execution.

1. (U) SEW Advanced Technology (X2091) -- This project is pursuing work in dynamic, reconfigurable, secure, radio frequency networks; high data rate, radio frequency communications; multi-band wireless RF network physical layers and multi-function apertures. Efforts will develop:
  - (a) Low observable, high data rate apertures. Ships, aircraft and submarines in the 21st century must have signature controlled apertures to enhance operational effectiveness. Apertures must provide connectivity between satellites, ships, aircraft and submarines and land units.
  - (b) The advanced multifunction radio frequency (RF) system will provide the capability to radiate and receive communications, surveillance and targeting capabilities for airborne, ground, and shipbased forces.
2. (U) Advanced Targeting (R2239) -- This project is pursuing evaluation of current and emerging technologies to improve (a) The Precision Sigint Targeting System (PSTS) is a Joint Service/Defense Agency effort to develop and demonstrate the capability to provide tactical users with near-real-time target identification and precision targeting information, sensor-to-shooter target updating, and Battle Damage Assessment. PSTS will enhance the tactical utility/applicability of existing national assets and provide the tactical commander with performance improvements in terms of targeting accuracy, targets of interest, timeliness, and target identification. Technical challenges include development of advanced signal processing and data fusion algorithms for target detection and classification; and exploitation of multiple signal characteristics for specific emitter identifications.
- (b) The advanced multifunction radio frequency (RF) system will provide the capability to radiate and receive

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE February 2000

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603794N

PROGRAM ELEMENT TITLE: C3 Advanced Technology

arbitrary communications, electronic warfare, and radar waveforms from common apertures which will reduce the plethora of antennas on Naval platforms, reduce life cycle costs, increase stealth characteristics of platforms, and enhance the effectiveness of the RF capabilities of the platforms for warfighting.

3. (U) Dominant Battlespace Command (R2601) - This project is pursuing evaluation of visualization software and computer technologies to improve battle space awareness, shorten the command and control decision-making cycle and interface with existing C4ISR systems, data links, and networks. Efforts include: networks that will provide the Command and Control (C2) operator with a real time interactive 3 dimensional (3D) visualization of the battlespace; timely and dynamic management of intelligence, surveillance and reconnaissance (ISR) resources; and rapid and dynamic replanning.
4. (U) National Technology Alliance (R2602) - This project is pursuing identification and application of current and emerging satellite, commercial and consumer technologies to enhance Naval warfighting systems performance and capability while reducing costs. Navy decision-makers need to understand the impact of these technologies in order to employ the best solutions, plot a technology development course, and map out procurement strategies. The end result will be to develop systems that will support joint and future naval operations in the 21st Century by providing seamless access to tailorable information for warfighters, planners, decision makers and analyst at all echelons.
5. (U) National Advanced Telecommunications and Applications Center (R2725): Funds provided for NATAC will be used to develop new telecommunications capabilities and information technology for use by naval forces.

(U) JUSTIFICATION FOR BUDGET ACTIVITY: This program is budgeted within the Advanced Technology Budget Activity because it encompasses design, development, simulation, or experimental testing of prototype hardware and software to validate technological feasibility and concept of operations and reduce technological risk prior to initiation of a new acquisition program or transition to an ongoing acquisition program.

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE February 2000

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603794N

PROGRAM ELEMENT TITLE: C3 Advanced Technology

	FY 1999	FY 2000	FY 2001
B. (U) PROGRAM CHANGE SUMMARY:			
FY 2000 President's Budget			
Appropriated Value	39,686	23,808	29,015
Inflation Savings	-183	41,808	
Congressional Rescissions		-228	
Congressional Plus Ups		18,000	
Various Rate Adjustments			-1,100
Execution Adjustment	4,466		
SBIR/STTR Adjustment	-755		
Program Adjustment			1,758
FY 2001 PRESBUDG Submission	43,214	41,580	29,673

(U) CHANGE SUMMARY EXPLANATION:

- (U) Schedule: Not applicable.
- (U) Technical: Not applicable.

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE February 2000

PROGRAM ELEMENT: 0603794N  
PROGRAM ELEMENT TITLE: C3 Advanced Technology

BUDGET ACTIVITY: 3

(U) COST: (Dollars in thousands)

PROJECT NUMBER & TITLE	FY 1999 ACTUAL	FY 2000 ESTIMATE	FY 2001 ESTIMATE	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	TO COMPLETE	TOTAL PROGRAM
X2091 Space and Electronic Warfare (SEW) Advanced Technology	20,240	21,903	21,228	22,170	22,273	22,196	21,871	CONT.	CONT.

(U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: This project demonstrates advanced technology components, subsystems and systems that will improve the Navy's management and operational use of time-critical command, control, communications, computers, intelligence sensors and reconnaissance (C4ISR) data with certifiable assurance functionality, high data rates, optimization and automation of network resources, multi-level access and security of databases and the ability to transmit and receive multi-media data (voice/data/video) over high data rate communication circuits. Capabilities realized from these efforts will contribute to the Navy's ability to maintain an accurate situation assessment and tactical picture with required accuracy and timeliness to allow all forces to have detailed knowledge of the battlespace. This project is restructured to support the Navy's high priority technology needs for Navy implementation of network centric warfare and Joint Vision 2010. Primary technology focus areas include dynamic reconfigurable secure radio frequency networks, high data rate radio frequency communications, and multi-function apertures.

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET  
PROGRAM ELEMENT: 0603794N  
PROGRAM ELEMENT TITLE: C3 Advanced Technology

DATE: February 2000  
PROJECT: X2091  
PROJECT TITLE: (SEW)  
ADVANCED TECHNOLOGY

BUDGET ACTIVITY: 3

## U) PROGRAM ACCOMPLISHMENTS AND PLANS:

### . (U) FY 1999 ACCOMPLISHMENTS:

- (U) HIGH ASSURANCE SYSTEM: The focus of this technology is verification and validation of mission critical systems.
  - Initiated design to integrate additional surveillance info into Intelligence (INTEL) system initiated by Army.
- (U) MULTI-FUNCTION APERTURES: This technology addresses a unique Navy need for improved antenna aperture, reduced radar cross-section, and reduced numbers of shipboard antennas.
  - Completed design UHF&L, K&Q Band Planar Phased Array SATCOM antennas.
  - Initiated development of UHF&L, K&Q Band Planar Phased Array SATCOM antennas.
  - Initiated construction of lightweight, low signature Multi-function Electromagnetic Radiating System (MERS) antenna that integrates into a compact design the functions of the existing UHF line of sight (LOS) Communications, Joint Tactical Information Distribution System (JTIDS), Combat Direction Finding (DF), and Identification Friend/Foe (IFF) apertures to permit platform space for Cooperative Engagement Concept (CEC).
  - Completed design of an advanced multifunction radio frequency (RF) system which will enable all RF functions: Radar, Communications, and Electronic Warfare to be integrated into common apertures.

- (U) DYNAMIC RECONFIGURABLE SECURE RF NETWORKS: This activity focus on the Navy's critical need for management of heterogeneous network environments supporting mobile forces and land units in maritime operations.
  - Completed demonstration of a secure, wireless, reconfigurable wireless technology and military security features adapted to shipboard and littoral warfare network environments. Demonstration built on and integrates with Army/Marine Corps wireless networks.

### . (U) FY 2000 PLAN:

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603794N

PROGRAM ELEMENT TITLE: C3 Advanced Technology

DATE: February 2000  
PROJECT: X2091  
PROJECT TITLE: (SEW)  
ADVANCED TECHNOLOGY

- (U) MULTI-FUNCTION APERTURES: This technology addresses a unique Navy need for improved antenna aperture, reduced radar cross-section, and reduced numbers of shipboard antennas.
  - Complete development and land-based demonstration of UHF&L, K&Q Band Planar Phased Array SATCOM antennas.
  - Complete development and land-based demonstration of a lightweight, low signature Multi-function Electromagnetic Radiating System (MERS) antenna that integrates into a compact design the functions of the existing UHF line of sight (LOS) Communications, Joint Tactical Information Distribution System (JTIDS), Combat Direction Finding (DF), and Identification Friend/Foe (IFF) apertures
- (U) FY 2001 PLAN:
  - (U) HIGH ASSURANCE SYSTEMS: The focus of this technology is verification and validation of mission critical systems. Continue the expansion of LSS to add undersea and meteorological and oceanographic information.
  - (U) MULTI-FUNCTION APERTURES: This technology addresses a unique Navy need for improved antenna aperture, reduced radar cross-section, and reduced numbers of shipboard antennas.
    - Initiate communications and networking physical layer development for military and commercial SATCOM from S to Ka Band.
    - Complete the receive aperture for the advanced multifunction radio frequency system.
    - Complete the resource allocation manager.
- B. (U) PROGRAM CHANGE SUMMARY: See Total Program Change Summary for P.E.
- C. (U) OTHER PROGRAM FUNDING SUMMARY: Not applicable.

(U) RELATED RDT&E:

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FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET  
PROGRAM ELEMENT: 0603794N  
PROGRAM ELEMENT TITLE: C3 Advanced Technology

DATE: February 2000  
PROJECT: X2091  
PROJECT TITLE: (SEW)  
ADVANCED TECHNOLOGY

BUDGET ACTIVITY: 3

- (U) PE 0301567G (Computer Security Program)
- (U) PE 0303140N (Information Systems Security Plan)
- (U) PE 0601153N (Defense Research Sciences)
- (U) PE 0602232N (Space and Electronic Warfare (SEW) Technology)
- (U) PE 0602234N (Materials, Electronics and Computer Technology)
- (U) PE 0604231N (Tactical Command Systems)

D. SCHEDULE PROFILE: Not applicable

PROJECT NUMBER & TITLE	FY 1999 ACTUAL	FY 2000 ESTIMATE	FY 2001 ESTIMATE	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	TO COMPLETE	TOTAL PROGRAM
R2239 Advanced Targeting (C3I)	5,541	1,776	8,445	3,735	3,390	5,800	5,844	CONT.	CONT.

A. (U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: As addressed in the Director of Defense, Research and Engineering's Global Surveillance and Communications Thrust, the Precision Sigit Targeting System (PSTS) is a Joint Service/Defense Agency effort to develop and demonstrate the capability to provide tactical users with near-real-time precision targeting information and sensor-to-shooter target updating. The proposed system will enhance the tactical utility and application of existing national assets to provide the tactical commander involved in future conflicts with significant performance improvements, resulting in a total surveillance network which is more responsive to changing world economic and political threats in terms of targeting accuracy, targets of interest and timeliness. PSTS will develop Joint

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FY 2000/2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000  
PROJECT: R2239  
PROJECT TITLE:  
TARGETING (C3I)

BUDGET ACTIVITY: 3  
ADVANCED PROGRAM ELEMENT: 0603794N

PROGRAM ELEMENT TITLE: C3 Advanced Technology  
Service/Defense Agency cooperative precision targeting site enhancements and Global Concept of Operations (CONOPS) for optimal asset cooperative utilization and minimal operational impact. Technical challenges include development of advanced signal processing, data fusion algorithms, exploitation of multiple signal characteristics for target detection and precision geo-location, and modeling and simulation to assure optimal resource allocation for cooperative precision targeting and primary mission performance.

## (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

1. (U) FY 1999 ACCOMPLISHMENTS:
  - (U) LOGISTICS SUPPORT: Provided engineering, operations and maintenance support for deployed PSTS systems.
  - Initiated design concepts for advanced multifunction radio frequency (RF) system.
2. (U) FY 2000 PLAN:
  - (U) LOGISTIC SUPPORT: Provide engineering, operations and maintenance support for deployed PSTS systems.
  - (U) ADVANCED MULTIFUNCTION RADIO FREQUENCY SYSTEM: Design the advanced multifunction radio frequency system including all apertures, resource allocation manager and other subsystems. The initial test-bed is focused on the 1 to 5 GHz band including functions such as volume search radar, theater ballistic missile discrimination, Challenge Athena, receive noise jamming, deceptive jamming, and high probability of intercept electronic surveillance. Initial development will begin. The approach, which is applicable to functions at lower and higher frequencies, will provide the Navy with a low cross-section and low life cycle cost approach to the proliferation of apertures and antennae on Naval platforms.

3. (U) FY 2001 PLAN:

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FY 2000/2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000  
PROJECT: R2239  
PROJECT TITLE:  
TARGETING (C3I)

BUDGET ACTIVITY: 3  
ADVANCED

PROGRAM ELEMENT: 0603794N  
PROGRAM ELEMENT TITLE: C3 Advanced Technology

- (U) ADVANCED MULTIFUNCTION RADIO FREQUENCY SYSTEM: Complete the various subsystems and begin the major task of integrating these subsystems into the highly complex advanced multifunction radio frequency system which will have the ability to radiate and receive multiple beams per aperture whose waveform can be either communications, electronic warfare, or radar. Key issues to be addressed include analysis of broadband received signals, partitioning into specific signals and beam forming. The approach, which is applicable to functions at lower and higher frequencies, will provide the Navy with a low cross-section and low life cycle cost approach to the proliferation of apertures and antennae on Naval platforms.
- (U) GLOBAL POSITIONING SYSTEM: Improve antennas, receivers, and signal processing methods employed in GPS thereby making the system less vulnerable to interference. In addition, Hybrid GPS and INS systems will undergo development, and further, methods independent of GPS will be explored. The purpose is to provide Navigational functions with a broad technology base resistant to degrading effects.
- B. (U) PROGRAM CHANGE SUMMARY: See Total Program Change Summary for P.E.
- C. (U) OTHER PROGRAM FUNDING SUMMARY: Available above SECRET level of classification.
  - (U) RELATED RDT&E: Available above SECRET level of classification.
  - D. (U) SCHEDULE PROFILE: Not applicable.

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