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FY 2001 DON 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	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	6,936
TOTAL	53,152	59,625	58,296	59,666	57,024	56,682	55,735	CONT.	CONT.

(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 Anti-Submarine 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.

R-1 Line Item 26

Budget Item Justification
 (Exhibit R-2, page 1 of 23)

UNCLASSIFIED

UNCLASSIFIED

FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 3 PROGRAM ELEMENT: 0603747N
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(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

FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 3

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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	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.

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.

R-1 Line Item 26

Budget Item Justification
(Exhibit R-2, page 3 of 23)

UNCLASSIFIED

UNCLASSIFIED

FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 3

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) Transduction 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:

R-1 Line Item 26

Budget Item Justification
(Exhibit R-2, page 4 of 23)

UNCLASSIFIED

UNCLASSIFIED

FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 3

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 Tonpiliz 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 2.0 (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 (AEER/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.

R-1 Line Item 26

Budget Item Justification
(Exhibit R-2, page 5 of 23)

UNCLASSIFIED

UNCLASSIFIED

FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 3

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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:

R-1 Line Item 26

Budget Item Justification
(Exhibit R-2, page 6 of 23)

UNCLASSIFIED

UNCLASSIFIED

FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 3

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.

R-1 Line Item 26

Budget Item Justification
(Exhibit R-2, page 7 of 23)

UNCLASSIFIED

UNCLASSIFIED

FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 3

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 SURTASSS 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:

R-1 Line Item 26

Budget Item Justification
(Exhibit R-2, page 8 of 23)

UNCLASSIFIED

UNCLASSIFIED

FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 3

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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 conformal 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.

R-1 Line Item 26

Budget Item Justification
(Exhibit R-2, page 9 of 23)

UNCLASSIFIED

UNCLASSIFIED

FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 3

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.

R-1 Line Item 26

Budget Item Justification
(Exhibit R-2, page 10 of 23)

UNCLASSIFIED

UNCLASSIFIED

FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 2000

BUDGET ACTIVITY: 3

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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.

R-1 Line Item 26

Budget Item Justification
(Exhibit R-2, page 11 of 23)

UNCLASSIFIED

UNCLASSIFIED

FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

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BUDGET ACTIVITY: 3 PROGRAM ELEMENT: 0603747N
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(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
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

R-1 Line Item 26

Budget Item Justification
(Exhibit R-2, page 12 of 23)

UNCLASSIFIED

UNCLASSIFIED

FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

Date: February 2000

BUDGET ACTIVITY: 3

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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 21st 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-or-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.

R-1 Line Item 26

Budget Item Justification
(Exhibit R-2, page 13 of 23)

UNCLASSIFIED

UNCLASSIFIED

FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

Date: February 2000

BUDGET ACTIVITY: 3

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PROJECT NUMBER: R2142

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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 (ARPDD):
 - (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

R-1 Line Item 26

Budget Item Justification
(Exhibit R-2, page 14 of 23)

UNCLASSIFIED

UNCLASSIFIED

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

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)/Woods Hole 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 Shallow Water Directional, Command, Active, Sonobuoy System program to improve performance of active sonobuoys to be transited 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

R-1 Line Item 26

Budget Item Justification
(Exhibit R-2, page 15 of 23)

UNCLASSIFIED

UNCLASSIFIED

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

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 (COTS Air 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 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 done aboard P-3 aircraft and surface ships.

2. (U) FY 2000 PLAN:

- (U) Affordable Radar Periscope Detection and Discrimination (ARPDD):
 - (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.

R-1 Line Item 26

Budget Item Justification
(Exhibit R-2, page 16 of 23)

UNCLASSIFIED

UNCLASSIFIED

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) 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

R-1 Line Item 26

Budget Item Justification
(Exhibit R-2, page 17 of 23)

UNCLASSIFIED

UNCLASSIFIED

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

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:

R-1 Line Item 26

Budget Item Justification
(Exhibit R-2, page 18 of 23)

UNCLASSIFIED

UNCLASSIFIED

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) 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 (CSOPA))

R-1 Line Item 26

Budget Item Justification
(Exhibit R-2, page 19 of 23)

UNCLASSIFIED

UNCLASSIFIED

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) 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.

R-1 Line Item 26

Budget Item Justification
(Exhibit R-2, page 20 of 23)

UNCLASSIFIED

UNCLASSIFIED

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	FY 2000 ESTIMATE	FY 2001 ESTIMATE	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	TO COMPLETE	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.

R-1 Line Item 26

Budget Item Justification
(Exhibit R-2, page 21 of 23)

UNCLASSIFIED

UNCLASSIFIED

FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

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:

R-1 Line Item 26

Budget Item Justification
(Exhibit R-2, page 22 of 23)

UNCLASSIFIED

UNCLASSIFIED

FY 2001 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

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) 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.

R-1 Line Item 26

Budget Item Justification
(Exhibit R-2, page 23 of 23)

UNCLASSIFIED