

UNCLASSIFIED

FY 2000 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET

DATE: February 1999

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602270N

PROGRAM ELEMENT TITLE: Electronic Warfare Technology

(U) COST: (Dollars in Thousands)

PROJECT NUMBER & TITLE	FY 1998 ACTUAL	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
Electronic Warfare Technology	16,982	22,743	24,659	25,462	27,049	27,777	28,469	29,195	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 (IW). 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).

(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 world-wide 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 programs and Advanced Technology Demonstrations (ATDs) which can produce prototypes suitable for naval force

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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 1998 ACCOMPLISHMENTS: FY 1998 funding reflected an enhanced program to address stand-off jamming (SOJ) technology for next generation support jamming. Work continued on shipboard sensor and weapons response involved in operations in littoral regions. Programs concerning combat identification, precision strike and information dominance continued.

- (U) (\$3,218) 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 electro-optical/infrared (EO/IR) technologies to provide early warning of hostile action, either surveillance or attack, to United States military platforms and to assist in identifying and countering the threat.
 - (U) Coordinated development and packaging of a 12-bit analog-to-digital converter to provide a 24 decibel increase in dynamic range for the extraction of signals and of processing hardware for use in a miniature Specific Emitter Identification (SEI) system for tactical aircraft, Unmanned Air Vehicles (UAVs), and portable

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systems and making it attractive for application in weapons systems such as High Speed Anti-Radiation Missile (HARM).

- (U) Field tested the double delta direction finding system to provide a passive high precision direction finder comparable to multi-channel phase interferometers for air and surface platforms.
 - (U) Improved de-interleaver algorithms and designed a prototype system which 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 an airborne counterfire system which detects mortar, artillery, and other large caliber weapon firings, and, via a satellite or radio link, communicates their location to counterfire units.
 - (U) Developed an improved signal processing concept providing capability for detecting frequency modulated, continuous wave (FMCW) signal with a signal-to-noise ratio of zero decibels to address the Advanced Integrated Electronic Warfare System (AIEWS) program requirement of detecting and identifying certain FMCW signals to provide early warning and cueing of ship self-defense weapons systems.
- (U) (\$7,628) 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 Space and Electronic Warfare (SEW) Intelligence. The entire radar RF frequency band from high frequency (HF) to millimeter wave (MMW) 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 infrared (IR) materials for decoys and new deployment concepts and the development of technologies for laser based jammers.
 - (U) Evaluated robustness of jamming techniques and smart jam codes and timelines for causing optical breaklock for the integrated onboard/offboard countermeasures (CM) solution to laser-guided threats that will challenge Navy and Marine surface vessels operating in littoral areas.
 - (U) Tested waveforms to determine timeline effectiveness of directional infrared countermeasures (IRCM) against Anti-Ship Cruise Missile (ASCM) threats and use optical augmentation and Moving Target Indicator sensors to determine which smart waveforms seduce missiles and minimize chance of reacquisition after initiating directional lock transfer to enhance capability of the AIEWS system against advanced IR guided anti-ship threats.
 - (U) Added and tested a floating component to the Multi-cloud decoy which will increase the lifetime of the device thus enhancing ship self-defense against IR guided anti-ship threats.
 - (U) Concluded Kinematic Special Material Decoy effort with a final report and transfer of concept design and technologies to programs in Navy 6.3 Electronic Warfare Advanced Technology program and Air Force 6.2 EW program that are developing thrusting infrared countermeasure decoys.

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- (U) Improved antenna isolation model to represent antennas mounted on flat surfaces coated with Radar Absorbing Material for any decoy platform and implemented interference cancellation techniques to achieve higher decoy effective radiated power through improved antenna isolation.
 - (U) Demonstrated final integration and flight-tested the AN/ALQ-167 pod mounted Mini-URANUS system (a modular, fully coherent jammer capable of jamming multiple simultaneous threats) for standoff and self-protection of aircraft, helicopters, and potentially UAVs, as part of the next generation electronic attack function.
 - (U) Integrated electronic attack (EA) subsystems with electronic support (ES) subsystem and performed lab test of the Small Ship Jammer developed for physically small surface patrol craft that have no active onboard EA self-protection capability (e.g., the PC-1 and MK V Special Operation Craft) and are currently involved in fleet littoral warfare operations.
 - (U) Performed susceptibility analysis and developed final cooperative IRCM techniques to focal plane arrays (FPAs) on selected foreign and domestic FPAs as part of a tri-service planned and funded program to assess the susceptibility of imaging seeker components for the development of CM against advanced imaging IR missiles.
- (U) (\$6,136) 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 (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) Selected design configuration, and built and tested a baseline model 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) Evaluated tri-service field tests of countermeasures against modern cellular radio communication systems and transition countermeasure techniques into the EA-6B jamming system.
 - (U) Integrated the use of the real-time software bridge in next generation, dynamic information fusion systems as part of a visually rich command and control warfare simulator capable of synthesizing realistic operations found in modern combat missions for assessing Naval operational situations, planning future operations, and evaluating system effectiveness.

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- (U) Conducted validation of heat transfer, sea clutter, and surface reflectance sub-models and incorporated these into 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) Implemented modifications to the Little Monopulse Information Signal Processing Element (LMISPE) system and tested those against surrogate cellular communication test sets to develop a system capable of fingerprinting modern cellular radio communication systems from airborne platforms.

2. (U) FY 1999 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) (\$3,902) 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 the ability of the miniaturized SEI system to perform within the confines of a platform such as a small UAV, providing specific target homing and discrimination capabilities for tactical aircraft, UAVs, and portable systems and making it attractive for application in weapons systems such as HARM.
 - (U) Design and fully demonstrate prototype unit which 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) Develop 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) Evaluate digital signal processing using wavelets, optical processing, and electrical micro-circuit realization of the wavelet filter bank, selecting the most promising approach for demonstrating an improved signal processing capability for detecting FMCW signals with a signal-to-noise ratio of zero decibels to address the AIEWS program requirement of detecting and identifying certain FMCW signals to provide early warning and cueing of ship self-defense weapons systems.
- (U) (\$10,749) 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 RF

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frequency band from HF to MMW is covered under this project. It also includes the protection of U.S. Naval platforms against IR/EO 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) Conduct preliminary designs of onboard laser guided weapons detection/protection systems and field test prototype developmental systems for the integrated onboard/offboard CM solution to laser-guided threats that will challenge Navy and Marine surface vessels operating in littoral areas.
 - (U) Determine most efficient jam codes against steering array sensors and transition selected robust seductive waveforms to enhance capability of the AIEWS system against advanced IR guided anti-ship threats.
 - (U) Improve antenna isolation model to represent antennas mounted on random access memory coated curved surfaces for any decoy platform and finalize isolation improvement techniques and document analysis methods to achieve higher decoy effective radiated power through improved antenna isolation.
 - (U) Perform 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.
- (U) (\$8,050) 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 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, ECM 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 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) Develop 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) Validate the IR ship target and scene model for the CM EW simulation to address the shortcomings of previous IR ship predictive codes.
 - (U) Plan and conduct tri-service field demonstration of the modified LMISPE system capable of fingerprinting modern cellular radio communication systems from airborne platforms.

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- (U) (\$42) Portion of extramural program reserved for Small Business Innovative Research assessment in accordance with 15 USC 638.

3. (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 SOJ work continue to be of importance.

- (U) (\$5,533) 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 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) Optimize wavelet filterbank parameters and digital signal processing algorithms which extract 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 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.

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- (U) (\$10,528) 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 HF to MMW is covered under this project. It also includes the protection of U.S. Naval platforms against IR/EO 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) Improve the spectral performance of the IR Special Materials and incorporate with the vehicle autopilot and sensor control for the development of a containerized vertically launched decoy to counter the advanced Imaging Infrared ASCM seekers.
 - (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) (\$8,598) 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, ECM 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) Develop the final jamming payload and 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.
 - (U) Based on results of the STARCROSS studies, develop and test a high speed analog-to-digital and DSP intercept system to establish jamming requirements against mobile radio communications systems potentially employed by enemy forces.

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- (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.

B. (U) PROGRAM CHANGE SUMMARY:

	FY 1998	FY 1999	FY 2000
(U) FY 1999 President's Budget	21,164	23,849	25,460
(U) Appropriated Value		22,849	
(U) Adjustments from FY 1999 PRESBUDG	-4,182	-1,106	-801
(U) FY 2000 PRESBUDG Submission	16,982	22,743	24,659

(U) Funding: The FY 1998 adjustment reflects a Small Business Innovation Research reduction (-76), and Actual Update adjustment (-4,106). FY 1999 adjustment reflects a program reduction (Fiscal Constraints) (-1,000), Undistributed reductions (-106). FY 2000 reflects Program Re-balancing (-1,074), Navy Working Capital Fund adjustments (+480), Civilian Pay Rates (+149), and Non Pay Inflation (-356).

(U) Schedule: Not applicable.

(U) Technical: Not applicable.

C. (U) OTHER PROGRAM FUNDING SUMMARY:

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(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 0603270A (Advanced Electronic Warfare Technology)
- (U) PE 0605604A (Survivability and Lethality Analysis)

This program is also closely associated with the following Navy PEs:

- (U) PE 0601153N (Defense Research Sciences)
- (U) PE 0602315N (Mine Countermeasures, Mining and Special Warfare Technology)
- (U) PE 0602234N (Materials, Electronics and Computer Technology)
- (U) PE 0602232N (Communications, Command and Control, Intelligence, Surveillance & Reconnaissance (C3ISR))
- (U) PE 0602111N (Air and Surface Launched Weapons Technology)
- (U) PE 0603270N (Advanced Electronic Warfare Technology)
- (U) PE 0603792N (Advanced Technology Transition)
- (U) PE 0604270N (EW Development)

D. (U) SCHEDULE PROFILE: Not applicable.

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