ARMY RDT&E BUDGET ITEM JUSTIFICATION (R-2 Exhibit)

DATE: February 1999

BUDGET ACTIVITY: 2 - Applied Research

PE NUMBER AND TITLE: 0602624A Weapons and Munitions Technology

COST (*In Thousands*)	FY1998 Actual	FY 1999 Estimate	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY2004 Estimate	FY2005 Estimate	Cost to Complete	Total Cost
Total Program Element (PE) Cost	27962	28913	34687	37487	38180	39412	39968	41815	Continuing	Continuing
AH18 Artillery & Combat Support Technology	9857	11231	12645	14062	14326	14720	15279	15611	Continuing	Continuing
AH19 Close Combat Weaponry	6131	8613	11409	11714	11735	12136	11935	12697	Continuing	Continuing
AH28 Munitions Technology	7291	9069	10633	11711	12119	12556	12754	13507	Continuing	Continuing
J03 Plastic Cased Ammunition	4683	0	0	0	0	0	0	0	0	4683

A. Mission Description and Budget Item Justification: The objective of this Program Element (PE) is to perform applied research of advanced direct and indirect fire weapons (except small arms) and munitions. The PE funds several efforts, including advanced weapon concepts and analysis supporting the Rapid Force Projection Initiative (RFPI) Advanced Concept Technology Demonstration (ACTD) to increase anti-armor capabilities and increase survivability for Early Entry Forces and the Direct Fire Lethality Initiative which develops technologies to provide tank main armament upgrade opportunities for fielded and future ground combat systems. The PE funds efforts to develop precision and extended range munitions and alternative defeat mechanisms of advanced artillery, mortars, area denial and armor systems for Army XXI and technology supporting Army After Next (AAN) capabilities. The PE also funds modeling and analytic codes for thermal analysis and high impetus low flame temperature propellants to reduce wear on gun tubes (which degrades accuracy and increases the system cost); high energy explosive technologies that increase projectile and warhead lethality; advanced armament fire control, and decision aids and software architecture; advanced acoustic sensor technology to enhance performance of smart munitions, technology advances in acoustic sensors and anti-armor anti-personnel area denial systems, and smart materials to improve accuracy and reduce operational and support (O&S) costs. This PE also includes work on thermal management of high performance, high rate of fire, large caliber guns, and advanced air-to-air guns in enhanced rotary wing aircraft (e.g., Apache and Comanche) armaments, as well as ways to make artillery systems more flexible and deployable through range extension and weight reduction technologies. The work in this PE is consistent with Army Vision 2010, Army After Next, the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan, and Project Reliance. This program is primarily managed by the U.S. Army Armament Research, Development and Engineering Center (ARDEC), Picatinny Arsenal, NJ. Work in this PE is related to, and fully coordinated with, efforts in PE 0602618A (Ballistics Technology), PE 0602623A (Joint Service Small Arms Program), and transitions to work performed in PE 0603004A (Weapons and Munitions Advanced Technology), PE 0603607A (Joint Service Small Arms Program) and PE 0603802A (Weapons and Munitions Advanced Development).

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R-2 Exhibit)

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PE NUMBER AND TITLE: 0602624A Weapons and Munitions Technology

B. Program Change Summary	FY 1998	FY 1999	FY 2000	FY 2001
Previous President's Budget (FY 1999 PB)	29905	29489	33112	34768
Appropriated Value	30876	28189		
Adjustments to Appropriated Value				
a. Congressional General Reductions	-971	-276		
b. SBIR / STTR	-227			
c. Omnibus or Other Above Threshold Reductions	-75			
d. Below Threshold Reprogramming	-1641			
e. Rescissions				
Adjustments to Budget Years Since FY 1999 PB			+1575	+2719
Current Budget Submit (FY 2000 / 2001 PB)	27962	28913	34687	37487

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R-2A Exhibit)

DATE: February 1999

BUDGET ACTIVITY: 2 - Applied Research

PE NUMBER AND TITLE: 0602624A Weapons and Munitions Technology

PROJECT: AH18

COST (*In Thousands*)	FY1998 Actual	FY 1999 Estimate	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY2004 Estimate	FY2005 Estimate	Cost to Complete	Total Cost
AH18 Artillery & Combat Support Technology	9857	11231	12645	14062	14326	14720	15279	15611	Continuing	Continuing

Mission Description and Justification: This project focuses on the exploratory development of technology for cannon artillery, mortar weapon, fire control and combat support systems in support of next generation, Army Vision 2010, and Army After Next (AAN) systems. Also being pursued is technology for improving combat vehicle lethality and fire control while reducing life cycle costs with innovative applications of smart materials, advanced actuators, gearless electric drives, advanced digital stabilization and microelectromechanical technology for imbedded fire control sensors. Decision aid software technology is being developed to increase battlefield survivability of self-propelled howitzers, along with technologies for improving the effectiveness and affordability of next generation smart munitions. Global Positioning System (GPS) technology is being integrated into fuzing for mortar and artillery projectiles. This will significantly increase a projectile's overall delivery accuracy and also be readily applicable to the existing ammunition stockpile. Meteorological extraction algorithms are also being developed to further improve artillery projectile tracking accuracy. Technology for artillery projectile rotating and obturating bands is being pursued to address an impending shortcoming when firing from high performance cannons. Recoil management and lightweight materials technologies are being developed to create a more lethal, yet lightweight Advanced Technology Lightweight Artillery System (ATLAS). Such technologies will support mobility and deployability strategies envisioned for the AAN. The application of light-weight, high-strength composites to mortar projectiles is being pursued to significantly extend range while providing increased lethal effectiveness, such as the Extended Range Mortar Cartridge (ERMC) program. This project also supports a pulsed-power technology assessment of electric gun applications to support more energetic, lethal and longer range projectiles, and the development and evaluation of advanced area denial concepts as an alternative to current anti-vehicle/anti-personnel mining techniques. This project also funds technology to develop advanced acoustic sensors which will provide non-line of sight target queuing for a variety of weapons platforms. Technologies for reducing artillery target location error and providing real time targeting and battle damage assessment data to fire directions centers are also being developed to support information dominance strategies for both Army Vision 2010 and AAN. Development of the Distributed Interactive Fire Mission (DIFM) software supports Army XXI and AAN fire control systems. This software will enable groups of tanks, fighting vehicles, attack helicopters, etc. to fight in unison by coordinating their fires against targets; substantially improving battlefield survivability and operations tempo. Targets will be automatically assigned to individual shooters based on the most effective pattern to ensure rapid first-shot execution and progression to the next target assignment. Quicklook provides the brigade commander with real time target imagery, coordinates, and battle damage assessment (BDA). This system will utilize an artillery launched unmanned aerial vehicle that flies out to a maximum range of 50 km. and acquires and transmits targeting information (i.e., video, GPS) back to the tactical operations center (TOC) via a wireless link.

FY 1998 Accomplishments:

- 4398 - Integrated hardware onto Paladin howitzer as part of an auto-registration accuracy improvement program; investigated GPS fuze integration and anti-jam technologies with the Army Research Labs.
  - Analyzed SADARM Block II requirements for the next generation of smart artillery munitions; finalized sensor concepts and fabricate prototype hardware for sensor concept evaluation.

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R-2A Exhibit)	DATE February 1999
BUDGET ACTIVITY 2 - Applied Research	PE NUMBER AND TITLE 0602624A Weapons and Munitions Technology
	PROJECT AH18

FY 1998 Accomplishments: (continued)

- Demonstrated Meteorological (MET) extraction techniques for Crusader artillery system; defined baseline fire support targeting sensor system requirements and completed critical subsystem designs (sensor, GPS receiver/ guidance, airframe/control and data link/ground station) to achieve real time targeting and battle damage assessment for artillery in support of AAN strategies.
- Evaluated a deployment version of the area denial concept as an alternative to conventional mining techniques; tested alternate sensor technologies for personnel detection in realistic environments and lethal and non-lethal defeat mechanisms.

• 3069
- Fabricated gearless azimuth drive and smart barrel actuators for improved accuracy combat vehicle gun systems; designed low cost, more accurate optical fiber based muzzle reference system; mounted optical fiber on 120mm gun.
- Developed baseline executable reference architecture software specification/ model for weapon systems; demonstrated application of a formal Reference Architecture specification for rapid component generation, integration and reuse; generation of this capability will provide long term benefits in support of AAN information dominance strategies.
- Conducted final gun testing of high performance rotating band and obturator designs under worse case conditions (worn-tubes, maximum muzzle velocity); evaluated design performance.
- Continued support of RFPI ACTD acoustic sensor effort; verify accuracy of acoustic sensor performance and propagation models; demonstrated 1) a preliminary tactical decision aid tool, 2) target acquisition and tracking capabilities of the Integrated Acoustic Sensor for RFPI and 3) acoustic propagation prediction capability using Defense Advanced Research Projects Agency (DARPA) internetted unattended ground (IUG) sensors.

• 2390
- Integrated knowledge base and rule development of decision aids utilizing digitized battlefield plans and procedures; integrated route planning and site selection decision aid modules into the distributed interactive simulation (DIS) environment for the Division Task Force XXI Advanced Warfighting Experiment (AWE).
- Performed interior ballistics modeling for ultra-lightweight direct support artillery weapon; created virtual prototype and model of 6750 lb. soft recoil test bed; developed an Army data base of electro-rheological fluids; development will support AAN mobility and deployability strategies.
- Completed ERMC rocket motor, fuzing and payload deployment designs; completed interior and exterior ballistic analyses.
- Conducted simulations in support of Battle Lab AWEs and Armament Research, Development and Engineering Center (ARDEC) RFPI programs; reviewed/updated Future Combat System (FCS) main armament system pulsed power technology alternatives.

Total 9857

FY 1999 Planned Program:

• 3387
- Fabricate a cannon for ultra lightweight 155mm ATLAS and modify soft recoil test bed; develop concepts for 5700 lb. electro-rheological fluid-controlled soft recoil weapon in support of AAN mobility strategies; design upper carriage and tipping parts for testbed.
- Gather area denial intrusion sensor data in various terrain and weather conditions; develop computer algorithms; conduct simulation to evaluate operational effectiveness.

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R-2A Exhibit)	DATE February 1999
BUDGET ACTIVITY 2 - Applied Research	PE NUMBER AND TITLE 0602624A Weapons and Munitions Technology
	PROJECT AH18

- 3238 - Develop and demonstrate a network accessible reference architecture data repository of reusable fire mission components; develop and demonstrate a baseline reusable voice natural language interface component for fire missions; develop process tools to support a "software component factory" approach to affordable embedded software development; this effort supports Army XXI and AAN information dominance strategies.

FY 1999 Planned Program: (continued)

- Complete implementation and battle lab evaluation of Technical Architecture-compliant fire mission and movement planning decision aid for an artillery chief-of-section.
- Complete capture of armament decision aid knowledge base; complete hardware, software and DIS integration efforts; test and verify operation of new decision aid components; conduct man-in-the-loop testing.
- Analyze and apply results of the Distributed Interactive Fire Mission (DIFM) Concept Experimentation Program conducted by the Mounted Maneuver Battle Space Battle Lab which will develop multi-shooter long range armored fighting vehicle battle scenarios for DIFM simulations.

- 2840 - Fabricate prototype components of weapons systems using smart materials and structures technology to significantly improve functionality, reduce size, costs, weight, improve or maintain existing lethality, jumpstart the development of AAN systems and DARPA investments.
- Establish preliminary concepts and conduct trade-off analyses of novel AAN era indirect fire systems.
- Refine acoustics tactical decision aid components for environmental characterization, propagation prediction and artificial intelligence rule-based acoustic sensor deployment planner. Develop algorithms and components for acoustic sensors to 1) detect, locate and cue fire finder radars to counter cannon artillery and artillery rocket fires and 2) locate snipers.
- Fabricate test hardware and lightweight rocket motor for ERMC; conduct interior ballistics tests; perform combat utility simulations.

- 1519 - Develop tactical targeting and battle damage assessment munition (i.e. Quicklook) operational architecture and procedures; perform studies on battlefield payoffs, target location, logistics, communication architecture and system design concept; develop system design.
- Develop retrofit obturator to improve projectile accuracy and minimize cannon wear for extended range weapon systems; conduct subscale testing of advanced polymer materials for obturator application.

- 247 - Small Business Innovation Research/Small Business Technology Transfer (SBIR/STTR) Programs.

Total 11231

FY 2000 Planned Program:

- 4834 - Fabricate hardware and conduct preliminary tower/Captive Flight Tests (CFT) to validate common aperture laser radar infrared (LADAR/IR) sensor performance against low observable targets; fabricate prototype sensor hardware for gun-hardening experiments. These sensors are applicable to munitions such as the Tank Extended Range Munition (TERM) and the XM982 Extended Range Guided Munition (ERGM), and information reconnaissance hardware such as tactical unmanned aerial vehicle (UAV).
- Conduct field test of prototype area denial hardware; evaluate weapons system and sensor performance; evaluate system effectiveness.
- Execute firing test of electro-rheological fluid control recoil system for ATLAS; complete design of 5700 lb. direct support firing platform.

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R-2A Exhibit)	DATE February 1999
BUDGET ACTIVITY 2 - Applied Research	PE NUMBER AND TITLE 0602624A Weapons and Munitions Technology
	PROJECT AH18

- 4200 - Extend the fire mission and movement planning decision aid to a fully Technical Architecture compliant suite of decision aid components to support sustainment, situational awareness and mission rehearsal for an artillery chief-of-section; establish a baseline decision aids application software component reuse library and link with specification data library to support follow-on software component factory technology.
  - Develop DIFM multi-shooter vs. multi-target algorithms.

FY 2000 Planned Program: (continued)

- Develop concepts and technologies for remotely deployed acoustic sensor to better detect, locate and classify airborne-ground targets and cannon and rocket artillery; demonstrate capability of environmental sensors such as wind speed and direction integrated with acoustic sensors as a decision aid tool to assist battlefield commanders in sensor deployment and estimation of sensor effectiveness in various weather conditions.

- 3611 - Fabricate Quicklook artillery fired unmanned aerial vehicle reconnaissance system hardware components and perform sub-system testing.
  - Complete ERMC rocket motor static testing; update interior and exterior ballistic models.
  - Demonstrate obturation effectiveness and improve system accuracy; investigate supplemental torque driving capability of design for higher muzzle energy launch.
  - Develop virtual/computer design of novel AAN era indirect fire system for Training and Doctrine Command (TRADOC) wargames; define preliminary architecture for distributed fire engagement.

Total 12645

FY 2001 Planned Program:

- 4500 - Conduct system trade-off studies, procure sensor hardware and perform captive flight tests on alternate sensor designs with a common aperture laser radar infrared (LADAR/IR) transducer for detection of Low Observables (LO).
  - Fabricate 5700 lb. ATLAS; perform limited firing tests to assess stability, precision and accuracy.
  - Conduct Area Denial System demonstration.
- 3299 - Complete implementation and feasibility demonstration of an architecture-based software component factory process for rapid generation of embedded fire mission application software.
  - Complete DIFM multi-shooter algorithms development; analyze and optimize DIFM using Distributed Interactive Simulation; quantify DIFM multi-agent performance.
  - Fabricate and demonstrate prototype hardware via flight test as the ERMC.
- 6263 - Integrate Quicklook system components and perform integrated CFT.
  - Complete technical assessment and operational requirements of novel AAN era concepts for indirect fires, develop architecture and technical feasibility for a massed, precision fire attack.
  - Demonstrate improved cannon wear life (Crusader) in wear testing; verify design improvements for stockpiled ammunition.
  - Fabricate and field test acoustic sensor system concepts to demonstrate detection, location, and classification of airborne/ground targets and cannon and rocket artillery; conduct modeling and simulation in support of Army Vision 2010 and AAN fire control, weapons and area denial systems.

	DATE **February 1999**
BUDGET ACTIVITY **2 - Applied Research**	PE NUMBER AND TITLE **0602624A Weapons and Munitions Technology**

Total 14062

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R-2A Exhibit)

DATE: February 1999

BUDGET ACTIVITY: 2 - Applied Research

PE NUMBER AND TITLE: 0602624A Weapons and Munitions Technology

PROJECT: AH19

COST (*In Thousands*)	FY1998 Actual	FY 1999 Estimate	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY2004 Estimate	FY2005 Estimate	Cost to Complete	Total Cost
AH19 Close Combat Weaponry	6131	8613	11409	11714	11735	12136	11935	12697	Continuing	Continuing

Mission Description and Justification: The objective of this project is to exploit and advance new technologies which will demonstrate significant improvements in direct fire weapon performance for ground and air combat vehicles. Principal efforts support the Direct Fire Lethality program. Included are technologies for the tank projectile precursor defeat of explosive reactive armor (ERA), composites for sabots and gun structures, and trajectory correction mechanisms. In addition, this project develops technologies in the areas of weapon stabilization, projectile design and fabrication, means to increase gun life by reducing barrel wear, thermal management of high rate launch mechanisms and munition auto-loaders, feeders and storage mechanisms. The project also develops extended range munitions and alternative defeat mechanisms of advanced armor systems for Army After Next. This project provides opportunities for longer range, more accurate and more lethal cannon systems for armored vehicle upgrades (e.g., Abrams, Bradley Fighting Vehicle System (BFVS), Future Combat System, Future Scout and Cavalry system) and for future systems. The approach will be to develop both the hardware and analytical tools necessary to assess system performance, identify problem areas and to develop solutions

FY 1998 Accomplishments:

- 3031 - Conducted performance simulations of novel penetrator capabilities against advanced armors for development of advanced armor defeat mechanisms applicable for both near term and Army After Next (AAN).
  - Performed 120mm kinetic energy (KE) projectile dispersion test for enhanced accuracy.
- 800 - Evaluated and downselected extended range munitions designs.
- 1300 - Completed assessment of bursting munitions and KE penetrator technologies for enhanced lethality for future scout and aviation platform applications.
- 1000 - Evaluated results of coating adhesion, morphology and thickness distribution of 25mm gun tubes for increased wear life.

Total 6131

FY 1999 Planned Program:

- 5791 - Demonstrate KE radial thruster technology capability to measure and counter flight disturbances to enhance accuracy up to 70%.
  - Conduct analytical evaluation of extended range munition capabilities.
  - Demonstrate novel penetration defeat of future threat complex armors.
- 1738 - Develop lightweight, high performance armament systems technology for Army After Next applications (e.g., Multi-Role Aviation Weapon System).
- 979 - Complete adhesive test of sputter coated 25mm gun barrels.
- 105 - Small Business Innovation Research/Small Business Technology Transfer (SBIR/STTR) Programs.

Total 8613

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R-2A Exhibit)	DATE February 1999
BUDGET ACTIVITY: 2 - Applied Research	PE NUMBER AND TITLE: 0602624A Weapons and Munitions Technology
	PROJECT: AH19

FY 2000 Planned Program:

•	1500	- Deposit tantalum coating by cylindrical magnetron sputtering process on test coupons, cylindrical sections and a full length 25mm gun barrel.
•	2297	- Conduct simulation of existing and conceptual target defeat techniques (i.e., Institute of Advanced Technology (University of Texas), Armament Research, Development and Engineering Center (ARDEC), and Army Research Laboratory).
•	2849	- Analyze, simulate and select lethality package for electro-thermal-chemical and other conventional propulsion systems for future combat system.
	2203	- Complete design of precision electric turret drive system as part of the Multi-Role Aviation Weapon System.
•	460	- Complete preliminary concept design(s) for variable lethality munitions.
•	2100	- Issue broad area announcement to develop medium caliber munition concepts that will provide future combat vehicles with close-in self-defense capability by deterring threat sensors.
Total	11409	

FY 2001 Planned Program:

•	1500	- Test fire a full length 25mm gun barrel with tantalum coating to validate wear performance.
•	1890	- Demonstrate control capabilities of a precision electric turret drive system.
•	6039	- Complete fabrication of lightweight/low impulse hybrid electrothermal-chemical launcher.
		- Demonstrate ammunition and defeat of future combat system target arrays representing the threat (100% increase over M829A2).
•	1100	- Fabricate and test sub-systems for variable lethality munitions.
•	1185	- Design competing threat sensor deterring munitions for technology demonstration.
Total	11714	

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R-2A Exhibit)

DATE: February 1999

BUDGET ACTIVITY: 2 - Applied Research

PE NUMBER AND TITLE: 0602624A Weapons and Munitions Technology

PROJECT: AH28

COST (*In Thousands*)	FY1998 Actual	FY 1999 Estimate	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY2004 Estimate	FY2005 Estimate	Cost to Complete	Total Cost
AH28 Munitions Technology	7291	9069	10633	11711	12119	12556	12754	13507	Continuing	Continuing

Mission Description and Justification: This project supports advanced technologies in gun propellants with wear reducing additives, explosives, warheads, insensitive munitions (IM) and advanced materials for anti-armor warheads in support of next generation and Army After Next systems. Advances in warhead technology will provide improved explosively formed penetrators (EFP), shaped charges (SC) and advanced warhead liners to defeat as well as protect current and future systems. High energy/density explosives are needed to increase lethality. New, improved energetic materials have numerous transition opportunities for weapons system upgrades. The IM efforts conducted in this project will increase the survivability of tanks, artillery, helicopters and infantry fighting vehicles, as well as safety in manufacturing plants, storage depots, and air and sea transport.

FY 1998 Accomplishments:

- 2780 - Scaled up more powerful explosives and planned study for anti-armor warhead loading; new CL-20 formulations showed promise for performance and sensitivity.
- 3207 - Demonstrated selective warhead design to defeat heavy armored targets (15-20% increase in performance over state-of-the-art warheads) or lightly armored targets (four fold increase in lethal area over current shaped charges).
- 1304 - Demonstrated high energy high performance gun propellant in live firings (impetus values 10-20% over JA2).

Total 7291

FY 1999 Planned Program:

- 3030 - Conduct static warhead tests using high power explosives to show an increase in energy performance for next generation and Army After Next systems of up to 25%.
- 3027 - Build on warhead designs demonstrated in FY 1998 to develop advanced lightweight/compact warhead concepts to defeat current and future advanced armor.
- 1818 - Conduct studies on the processibility of thermoplastic elastomers and the effect of binder/plasticizer type and ratio on energetic materials to provide higher energy, safer gun propellant; investigate additives to reduce gun tube wear.
- 1065 - Design multiple explosively formed penetrator warhead for active protection against chemical energy and kinetic energy threats.
- 129 - Small Business Innovation Research/Small Business Technology Transfer (SBIR/STTR) Programs.

Total 9069

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R-2A Exhibit)	DATE February 1999
BUDGET ACTIVITY 2 - Applied Research	PE NUMBER AND TITLE 0602624A Weapons and Munitions Technology
	PROJECT AH28

FY 2000 Planned Program:

- 3080 - Synthesize more powerful explosives, including tetrazatetranitrocubane (TATNC), and scale-up other viable formulations.
- 3823 - Conduct testing of combined ant-armor/anti-bunker warheads.
- 1930 - Formulate and test CL-20 based advanced propellants.
- 1800 - Design/fabricate/test an EFP warhead for active protection system.

Total 10633

FY 2001 Planned Program:

- 3471 - Characterize TATNC and develop formulations.
- 4520 - Demonstrate compact/multiple effects warhead and design/optimize the co-linear explosively formed penetrator warhead.
- 1920 - Demonstrate significant propulsion performance increase in scaled and large caliber guns.
- 1800 - Conduct dynamic tests of EFP warhead for active protection system against chemical and kinetic energy threats.

Total 11711

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R-2A Exhibit)

DATE: February 1999

BUDGET ACTIVITY: 2 - Applied Research

PE NUMBER AND TITLE: 0602624A Weapons and Munitions Technology

PROJECT: J03

COST (*In Thousands*)	FY1998 Actual	FY 1999 Estimate	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY2004 Estimate	FY2005 Estimate	Cost to Complete	Total Cost
J03 Plastic Cased Ammunition	4683	0	0	0	0	0	0	0	0	4683

Mission Description and Justification: This project is a Congressional plus-up for the development and certification of small caliber plastic cased ammunition. In accordance with guidance from Congress, funds were transferred to the U.S. Navy for execution of program.

FY 1998 Accomplishments:

- 4683 Program execution by U.S. Navy in accordance with guidance from Congress.

Total 4683

FY 1999 Planned Program: This project is not funded in FY 1999**.**

FY 2000 Planned Program: This project is not funded in FY 2000.

FY 2001 Planned Program: This project is not funded in FY 2001.

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