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ARMY RDT&E BUDGET ITEM JUSTIFICATION (R-2 Exhibit)								DATE February 1999		
BUDGET ACTIVITY 2 - Applied Research				PE NUMBER AND TITLE 0602618A Ballistics 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	36678	27229	36287	37687	38462	39218	34461	35865	Continuing	Continuing
AH37 Liquid Propellant Technology	3779	0	0	0	0	0	0	0	0	11026
AH75 Electric Gun Technology	9020	3972	5457	5468	5415	5720	3670	3931	Continuing	Continuing
AH80 Ballistics Technology	20350	21958	30830	32219	33047	33498	30791	31934	Continuing	Continuing
AH81 Armor/Anti-Armor Technology	3529	1299	0	0	0	0	0	0	0	4828

A. Mission Description and Budget Item Justification: This program element (PE) provides ballistic technologies required for armaments and armor to allow US dominance in future conflicts across a full spectrum of threats in a global context. Project AH37 completed the Army's work in liquid propellant technology. Project AH75 focuses on pulsed power technologies for electric armaments which offer the potential to field leap-ahead capability in providing hypervelocity and hyperenergy launch well above the ability of the conventional cannon. It also includes work in hypervelocity penetrator effectiveness and electrothermal chemical (ETC) technology that will greatly increase anti-armor capabilities. Project AH80 is focused on applied research in ballistics technology to enhance the lethality and survivability of future weapons. Focus areas included advanced solid propellants, launch and flight dynamics, weapons concepts for light forces, warheads and projectiles, armor and munition-target interactions. It also supports applied research for a new class of vehicle control that will enable an unmanned land combat vehicle to intelligently follow a manned combat vehicle. Project AH81 ends in FY 1999 because armor technology development has been consolidated in PE 0602601A, Project DC05. Work in this program element has been coordinated with the other military services through the Weapons Technology Area Plan to prevent duplication of effort and to maximize the return on investment. One result of this process is the Army's leveraging of Navy and Defense Special Weapons Agency investments for ETC technology demonstrations. Work in this program element is consistent with the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan, and Force XXI.

UNCLASSIFIED

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R-2 Exhibit)	DATE February 1999
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BUDGET ACTIVITY 2 - Applied Research	PE NUMBER AND TITLE 0602618A Ballistics Technology
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B. Program Change Summary	<u>FY 1998</u>	<u>FY 1999</u>	<u>FY 2000</u>	<u>FY 2001</u>
Previous President's Budget (<u>FY 1999</u> PB)	40042	31115	34900	38352
Appropriated Value	41317	27475		
Adjustments to Appropriated Value				
a. Congressional General Reductions	-1275	-246		
b. SBIR / STTR	-486			
c. Omnibus or Other Above Threshold Reductions	-128			
d. Below Threshold Reprogramming	-2750			
e. Rescissions				
Adjustments to Budget Years Since <u>FY 1999</u> PB			+1387	+665
Current Budget Submit (<u>FY 2000 / 2001</u> PB)	36678	27229	36287	37687

Change Summary Explanation: Funding – FY 1999 program reduced by Congress (-3640).

UNCLASSIFIED

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R-2A Exhibit)	DATE February 1999
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BUDGET ACTIVITY 2 - Applied Research	PE NUMBER AND TITLE 0602618A Ballistics Technology	PROJECT AH37
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COST <i>(In Thousands)</i>	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
AH37 Liquid Propellant Technology	3779	0	0	0	0	0	0	0	0	11026

Mission Description and Justification: This is a Congressionally Funded program; not part of the Army's core mission funded program. This project focuses on maturation of liquid propellant (LP) technology with the intent to evaluate LP as a means of achieving increased lethality and/or survivability for future weapons systems applications. Technology challenges including pressure oscillations, material compatibility, and reliability/durability of the propellant in a battlefield environment will be addressed and advantages of an LP weapon will be explored. The LP technology program is managed by the Army Research Laboratory - Aberdeen Proving Ground, MD with contractual efforts at General Dynamics Defense Systems (GDDS) - Pittsfield, MA and Burlington, VT; Wright-Malta Corp. - Malta, NY; Princeton Combustion Research Laboratory - Monmouth Junction, NJ; Institute for Defense Analysis (IDA) - Alexandria, VA; and Penn State University - University Park, PA.

FY 1998 Accomplishments:

- 3779 - Completed Identification and testing of concept for reliable ignition in a high performance liquid propellant gun.
 - Completed materials compatibility testing for specific gun hardware.
 - Completed medium-caliber liquid propellant gun firings to establish design of a high performance, regenerative liquid propellant gun.
 - Completed evaluation of Army user needs, technology pay-off for liquid propellant guns, and identified windows of opportunity.
- Total 3779

FY 1999 Planned Program: Project not funded in FY 1999

FY 2000 Planned Program: Project not funded in FY 2000

FY 2001 Planned Program: Project not funded in FY 2001

UNCLASSIFIED

UNCLASSIFIED

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R-2A Exhibit)								DATE February 1999		
BUDGET ACTIVITY 2 - Applied Research				PE NUMBER AND TITLE 0602618A Ballistics Technology				PROJECT AH75		
COST <i>(In Thousands)</i>	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
AH75 Electric Gun Technology	9020	3972	5457	5468	5415	5720	3670	3931	Continuing	Continuing
<p>Mission Description and Justification: This project provides oversight and accountability for the Army electric armaments technology program, which is managed by the Army Research Laboratory at Aberdeen Proving Ground, MD. Future armored combat vehicles will require more lethal, yet compact main armament systems capable of defeating protection levels greatly in excess of currently experienced values. Electric armaments offer the potential to field a leap-ahead capability by providing hypervelocity and/or hyperenergy launch greatly above the ability of the conventional cannon. Electric armaments potentially can be fully integrated with electric propulsion and electromagnetic armor systems to provide the efficient, highly mobile, and deployable armored force required by the nation. This project focuses on addressing technical challenges associated with developing electric armament, in particular with developing pulse power for electromagnetic (EM) launch and advanced propellant performance for electrothermal chemical (ETC) weapon systems. This project funds a contractual effort to develop an efficient pulsed power system for electromagnetic (EM) launch. The goal is to demonstrate pulse power technology (rotating machines) with energy density of three Joules per gram (J/g) and to identify a clear potential for growth to ten J/g. Efforts in EM pulsed power systems are conducted by SAIC - Minneapolis, MN; CEM - Austin, TX; CAES - Cumberland, MD; and R-Cubed - Salt Lake City, UT. In addition, this project supports the development of electrothermal chemical (ETC) technology which is a joint effort with the Defense Special Weapons Agency (DSWA) with contractual efforts by SAIC - San Diego, CA; UDLP - Minneapolis, MN; Thiokol - Northeast, MD; and Olin - St. Marks, FL. The goal of the ETC effort is to demonstrate 14MJ from the 120mm, M256 Cannon. Following this demonstration ETC will be applied to medium caliber cannon with a goal of increasing muzzle energy by 25%.</p> <p>FY 1998 Accomplishments:</p> <ul style="list-style-type: none"> • 9020 - Demonstrated sub-scale compulsator at full design limits into an EM (electromagnetic) gun. <ul style="list-style-type: none"> - Demonstrated substantial muzzle energy growth from a 120-mm, M256 cannon. - Designed EM launcher for next generation compulsator. - Tested advanced switch prototypes on sub-scale machines. <p>Total 9020</p> <p>FY 1999 Planned Program:</p> <ul style="list-style-type: none"> • 3872 - Measure electromagnetic signature of subscale compulsator. <ul style="list-style-type: none"> - Test effects of electromagnetic shielding on subscale compulsator performance. - Demonstrate 14 MJ muzzle energy from a 120-mm, M256 ETC cannon. • 100 - Small Business Innovation Research/Small Business Technology Transfer (SBIR/STTR) Programs <p>Total 3972</p>										
Project AH75			Page 4 of 10 Pages				Exhibit R-2A (PE 0602618A)			

UNCLASSIFIED

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R-2A Exhibit)		DATE
BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
2 - Applied Research	0602618A Ballistics Technology	AH75
FY 2000 Planned Program:		
•	5457 - Design and build switch array for multi-phase, multi-pole control of compulsator. - Test single switch array at required peak current. - Build EM railgun test fixture. - In close coordination with ARDEC, design ETC ignition and propelling charge for medium caliber cannon. - Demonstrate scalability, ballistic tailorability, and temperature compensation of ETC technology in medium caliber cannon. - Identify ETC tailored propellants with reduced vulnerability.	
Total	5457	
FY 2001 Planned Program:		
•	5468 - Test complete switch array to control compulsator discharge into EM railgun test fixture. - Demonstrate controlled step-up toward increased muzzle energy goal in medium caliber ETC cannon using tailored solid propellants. - Demonstrate ETC compatibility with medium caliber conventional and cased telescope cartridges.	
Total	5468	
Project AH75	Page 5 of 10 Pages	Exhibit R-2A (PE 0602618A)

UNCLASSIFIED

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R-2A Exhibit)	DATE February 1999
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BUDGET ACTIVITY 2 - Applied Research	PE NUMBER AND TITLE 0602618A Ballistics Technology	PROJECT AH80
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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
AH80 Ballistics Technology	20350	21958	30830	32219	33047	33498	30791	31934	Continuing	Continuing

Mission Description and Justification: This project produces key technologies required for armaments and armor to allow U.S. dominance in future conflicts across a full spectrum of threats. The program focuses on lethality technologies for more lethal and more deployable weapons and on survivability technologies to lighten and protect the force. These ballistic technologies will support advances in vehicle survivability, direct fire armament capabilities, indirect fire support and weapons effectiveness. This project continues to support extensive experimental programs to advance the state-of-the-art in ballistics technologies. This project also provides key technologies for a new class of vehicle control that will enable an unmanned land combat vehicle to intelligently follow a manned combat vehicle. This new capability will enable a manned crew in a lightly armored vehicle to simultaneously expand its survivability and area of influence, maneuvering and engaging enemy forces without disclosing its own location. The work is conducted at the Army Research Laboratory, Aberdeen Proving Ground, MD and provides required technologies for advanced development programs at the Armaments Research, Development and Engineering Center, Picatinny Arsenal, NJ; the Tank and Automotive Research, Development and Engineering Center, Warren, MI; and the Missile Research, Development and Engineering Center, Huntsville, AL.

FY 1998 Accomplishments:

- 14182 - Advanced technologies such as recoil mitigation and range correction for munitions that provide enhanced capabilities for light forces in operations across the threat spectrum.
 - Applied advanced guidance technology to artillery projectiles, missiles, and fire control concepts to provide improved weapon accuracy and associated relief from logistic burden.
 - Investigated advanced basal and applique armor technology to provide new approaches to armor lighter weight vehicles.
 - Demonstrated proof-of-principal of critical tracking and kill mechanism technologies for the Counter Kinetic Energy (KE) Active Protection (CKE AP) concept which extends the engagement envelope for the defeat of tank-fired KE rounds beyond the outer skin of the vehicle. This effort is fully integrated into the Tank-Automotive Research, Development, and Engineering Center (TARDEC) Full Spectrum Active Protection Program and is cooperatively managed.
 - Enhanced direct fire lethality by developing novel penetrator technologies, to include long standoff shaped charge jets, highly effective nose shapes for medium-caliber ammunition, and lethal mechanisms for hypervelocity missiles.
 - 4141 - Implemented blast damage algorithm for component damage from small warheads to optimize lethality/survivability of smart indirect-fire munitions/ground systems.
 - 2027 - Implemented physical models of vulnerability and weapons effects in real time for interactive simulations.
- Total 20350

UNCLASSIFIED

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R-2A Exhibit)		DATE February 1999
BUDGET ACTIVITY 2 - Applied Research	PE NUMBER AND TITLE 0602618A Ballistics Technology	PROJECT AH80
<p>FY 1999 Planned Program:</p> <ul style="list-style-type: none"> • 15684 - Develop performance tailoring and screening tools to enable future solid propellants with maximum energy and minimum vulnerability at affordable cost while balancing human factors, life cycle costs, erosivity and propellant performance in gun systems. <ul style="list-style-type: none"> - Identify and characterize launch disturbances to optimize guidance and flight technologies to extend range and improve accuracy of indirect fire weaponry. - Develop enabling technologies that will provide new operational capabilities to soldiers in low intensity conflicts and operations across the threat spectrum. - Enhance armor technologies to address the lethality of advanced threats and increase crew protection in lightweight vehicles. - Characterize and demonstrate dynamic, real-time operation of Passive IR Tracker (PIRT) vs. KE projectiles; test full-scale electromagnetically (EM) launched kill mechanism; evaluate initial compact high explosive (HE) launched kill mechanism design; conduct tests with depleted uranium and tungsten heavy alloy penetrators vs. improved blast warheads and select residual armor technology based on penetrator performance against medium-caliber threats. - Evaluate advanced lethality concepts including novel penetrators for missile systems, sheathed penetrators, shaped charge warhead concepts, new tungsten composites for penetrators, and LIDAR packaged for KE penetrator applications to increase the lethality of Army direct fire systems. • 6157 - Develop ammunition response algorithms for rocket motor ignition and explosion to more accurately predict the survivability and lethality of U.S. Army weapon systems such as Crusader, FSCS, FCS, MLRS, HIMARS, M74 & M85 bomblets, and BAT P3I. <ul style="list-style-type: none"> - Provide engineering-based predictions of the subsystem capabilities of air and ground combat platforms after multiple impact combinations of direct and/or indirect fire threats. • 117 - Small Business Innovation Research/Small Business Technology Transfer (SBIR/STTR) Programs <p>Total 21958</p> <p>FY 2000 Planned Program:</p> <ul style="list-style-type: none"> • 16460 - Evaluate candidate propellants produced by ARDEC and industry partners; establish comprehensive database for use by ammunition designers to enhance gun lethality at reduced vulnerability. <ul style="list-style-type: none"> - Perform complex numerical simulations of launch disturbances and critical damping of initial free flight motions for future smart munitions to extend range and improve accuracy for both direct and indirect fire weaponry. - Evaluate, in conjunction with Army users, operational concepts employing technologies such as advanced lightweight artillery weapons and systems to enhance positional awareness; employ distributed interactive simulations incorporating these systems to improve training. - Investigate an advanced armor system capable of defeating future medium caliber KE and shaped charge threats that is compatible with the goals of AAN. - Evaluate performance of candidate sensor suite and kill mechanism technologies that will enable the development of CKE AP and begin the down-select to those with the best growth potential toward the Full Spectrum Active Protection (FSAP) STO goals. Begin integration of tracker, kill mechanism and residual armor components into a CKE brassboard demonstration. 		
Project AH80	Page 7 of 10 Pages	Exhibit R-2A (PE 0602618A)

UNCLASSIFIED

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R-2A Exhibit)		DATE February 1999
BUDGET ACTIVITY 2 - Applied Research	PE NUMBER AND TITLE 0602618A Ballistics Technology	PROJECT AH80
FY 2000 Planned Program: (Continued)		
	- Exploit emerging technologies in the area of lethal mechanisms for direct fire applications, especially sheathed penetrators, amorphous metals, fragmenting warhead designs for medium caliber ammunition, and extending rods.	
• 6970	- Verify and validate select component-level ballistic algorithms to support development and Live Fire Test & Evaluation of over ten U.S. Army weapon systems, including ground, munition, aviation, and lightly armored systems.	
	- Develop physically based models to predict the probability of ignition of sustained diesel and JP-8 fuel fires in U.S. group combat systems with and without fire suppression systems.	
• 2000	- Identify, test and evaluate vehicle integratable sensor technologies and compact, command-fused Kinetic Energy penetrator counter-munition concepts	
• 400	- Demonstrate the feasibility of future large caliber ETC guns. Evaluate and select ETC technologies, design and fabrication two ETC-gun modules, test, and evaluate modules for feasibility of an ETC-gun weapon system integration into FMVS. (NATO funds: Partner Germany)	
• 5000	- Develop critical machine perception and intelligent control technologies for an unmanned ground vehicle/weapon carrier to autonomously follow a manned lead vehicle in cooperation with the Tank-Automotive Research, Development and Engineering Center.	
Total	30830	
FY 2001 Planned Program:		
• 19577	- Implement selected gun propellant formulations (sample sizes) in scaled ballistic studies to demonstrate improved performance and propellant integrity with reduced vulnerability.	
	- Conduct experimental demonstrations of multi-disciplinary designs for guidance, navigation, and control technologies applied to smart munitions.	
	- Transition technologies which will provide new operational capabilities to light forces operating in low intensity conflicts and rapid deployment scenarios to Army Research, Development, Engineering Centers and the user community.	
	- Design and characterize innovative armors, structures, protection mechanisms, and survivability concepts for future lightweight combat vehicle protection.	
	- Down select CKE technology options, complete the integration to a brassboard CKE AP system and commence testing to optimize performance of the selected system.	
	- Develop novel lethal penetrator concepts to include explosively-assisted penetrators, hypervelocity penetrator concepts (e.g., segmented rods), and novel shaped charge liner configurations to defeat increasing levels of armor protection.	
• 7232	- Implement advanced armor penetration algorithms in survivability/lethality analysis codes for sophisticated multi-layering schemes and functionally-graded material technologies under development for multi-hit protection of U.S. Army ground systems (such as C2V, FSCS, and FIV).	
	- Improve compartment and component-level analysis codes to predict the survivability, vulnerability, and lethality of next generation vehicle armament and propulsion systems.	
• 2000	- Conduct experimental tests to demonstrate improved compactness and hardening of CKE technologies with specific focus on the sensor suite/counter-munition integration and optimization	
Project AH80	Page 8 of 10 Pages	Exhibit R-2A (PE 0602618A)

UNCLASSIFIED

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R-2A Exhibit)								DATE February 1999		
BUDGET ACTIVITY 2 - Applied Research				PE NUMBER AND TITLE 0602618A Ballistics Technology				PROJECT AH81		
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
AH81 Armor/Anti-Armor Technology	3529	1299	0	0	0	0	0	0	0	4828
<p>Mission Description and Justification: The objective of this project has been to provide significantly increased levels of protection and survivability to existing and future combat systems, and to provide significantly increased lethality and effectiveness to existing and future anti-armor munitions by seeking novel and innovative solutions from industry. All of the funds in this project are used to fund contractual work to tap innovative ideas of industry. Anti-armor efforts develop technology to supports (1) a high priority Army program to enhance U.S. 120mm kinetic energy (KE) tank ammunition, especially against explosive reactive armor (ERA), which is available in the world arms market and is quite effective; (2) novel penetrators to improve munition effectiveness, and (3) an initiative to substantially extend the battlespace of the tank by developing technology needed for an extended range tank munition. Funding for these anti-armor efforts end in FY99. In FY 2000 and beyond, funds have been restructured to PE 0602601A, Project DC05, to consolidate armor technology development in a single project. Major contractors include: Dow Chemical Co., Midland, Miland Science Applications International Corp., Albuquerque, NM.</p> <p>FY 1998 Accomplishments:</p> <ul style="list-style-type: none"> • 2479 - Completed KE precursor final design and transitioned to PE 0603004A, Proj D232, for cartridge integration. • 525 - Conducted exploration of novel penetrator designs to defeat advanced armor systems. • 525 - Demonstrated top attack armor concepts employing electromagnetic defeat mechanisms and lightweight materials. • 525 - Demonstrated light armor protection panels for scout-class vehicles. <p>Total 3529</p> <p>FY 1999 Planned Program:</p> <ul style="list-style-type: none"> • 1274 - Demonstrate multi-liner explosively formed penetrator ability to form ultra-long penetrator and provide enhanced armor penetration from a smaller warhead configuration. • 25 - Small Business Innovation Research/Small Business Technology Transfer (SBIR/STTR) Programs <p>Total 1299</p> <p>FY 2000 Planned Program: Project not funded in FY 2000.</p> <p>FY 2001 Planned Program: Project not funded in FY 2001.</p>										
Project AH81			Page 10 of 10 Pages				Exhibit R-2A (PE 0602618A)			