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RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)						DATE February 2006	
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development			R-1 ITEM NOMENCLATURE Advanced Aerospace Systems PE 0603286E				
COST (In Millions)	FY 2005	FY2006	FY2007	FY 2008	FY 2009	FY 2010	FY 2011
Total Program Element (PE) Cost	66.919	54.594	115.829	202.587	250.823	250.923	253.923
Advanced Aerospace Systems AIR-01	66.919	54.594	115.829	202.587	250.823	250.923	253.923

(U) Mission Description:

(U) The Advanced Aerospace Systems program element is budgeted in the Advanced Technology Budget Activity because it addresses high payoff opportunities to dramatically reduce costs associated with advanced aeronautical systems and provide revolutionary new system capabilities for satisfying current and projected military mission requirements. Research and development of integrated system concepts, as well as enabling vehicle subsystems will be conducted. Studies conducted under this project include examination and evaluation of emerging aerospace threats, technologies, concepts, and applications for missiles, munitions, and vehicle systems.

(U) Program Accomplishments/Planned Programs:

	FY 2005	FY 2006	FY 2007
A160	9.000	7.000	10.500

(U) The A160 program will exploit a hingeless, rigid rotor concept operating at the optimum rotational speed to produce a vertical take-off and landing (VTOL) unmanned air vehicle (UAV) with low disk loading and rotor tip speeds resulting in an efficient low power loiter and high endurance system. This unique concept offers the potential for significant increases in VTOL UAV range (2,500 nm) and/or endurance (24-32 hours). Detailed design, fabrication and testing of this vehicle is being conducted to establish its performance, reliability, and maintainability. The A160 concept is being evaluated for surveillance and targeting, communications and data relay, crew recovery, resupply of forces in the field, and special operations missions in support of Army, Navy, Marine Corps, and other agency needs. The program will also conduct development tests of heavy fuel engine technology in support of, and in coordination with, other DARPA programs that are developing highly efficient heavy fuel engine technologies to further advance current range and endurance projections as well as improve operational reliability and logistics

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compatibility. DARPA established an MOA with the Army for this program in April 2003. The A160 program will transition to the Army after completion of this Phase.

(U) Program Plans:

- Continue ground and flight test of A160 vehicles.
- Perform conceptual design and trade studies of A160 variants for a variety of mission roles, including study of technology risk reduction, architecture, survivability, and command and control.
- Develop new main rotor gearboxes for diesel and turboshaft engines.
- Integrate new advanced lightweight diesel engine on prototype A005.
- Integrate Pratt & Whitney 207 engines on A006 and A008.

	FY 2005	FY 2006	FY 2007
Advanced Aeronautics Demonstration	13.833	14.100	19.800

(U) The Advanced Aeronautics Demonstration program will develop novel aircraft concepts to enable the Services to perform wide-ranging and mixed missions outside the current flight envelope using advanced propulsion and aerodynamic technologies. The program consists of two primary projects, the Canard Rotor/Wing (CRW) and Heliplane.

(U) The Army, Navy, Air Force, Marine Corps and Special Operations Command Forces have a need for affordable, survivable, vertical take-off and landing (VTOL) air vehicles to support dispersed units. CRW aircraft offer the potential for a high-speed, rapid response capability from a VTOL air vehicle with significant range and stealth improvements as compared to other VTOL concepts. Design, fabrication, ground and flight test of a scaled vehicle demonstrator will validate the stability and control system and aerodynamic performance required for vertical take-off, landing and hover via a rotating center wing that stops and locks in place for efficient high speed cruise. Following demonstration of the small scale vehicle, the program will proceed with design, development and demonstration of more operationally representative vehicles including manned aircraft.

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(U) The Heliplane program will design, develop and flight test an air vehicle that combines the VTOL and low disk loading characteristics of a helicopter with the speed and efficiency characteristics of a fixed wing aircraft. The Heliplane demonstrator aircraft will be tailored to a Combat Search and Resuce (CSAR) mission with a 400 mph cruise speed, a 1000 lb payload, and an unrefueled range of 1000 miles. The Heliplane program will conduct a combination of analysis and experiments to develop and demonstrate key enabling technologies. Once key enabling technologies have been demonstrated, a preliminary and detailed design of the Heliplane system will be completed, a full scale test of the rotor system will be conducted, and a Heliplane demonstrator will be fabricated and flight tested.

(U) Program Plans:

- Complete CRW demonstrator flight tests.
- Continue design studies of follow-on CRW manned and unmanned vehicles.
- Perform Heliplane system trade studies and develop conceptual design.
- Develop and conduct risk-reduction demonstrations of key Heliplane technologies and components.
- Complete preliminary and detailed design of Heliplane demonstrator.
- Fabricate Heliplane demonstrator aircraft.
- Conduct flight tests to validate Heliplane performance.

	FY 2005	FY 2006	FY 2007
Oblique Flying Wing (OFW)	0.000	7.028	13.500

(U) The Oblique Wing aircraft is a flying wing, which flies with variable sweep to improve high speed characteristics. A supersonic, variable sweep oblique flying wing would be efficient in both high speed cruise and low speed loiter, would be compatible with survivability requirements, and would have a structurally efficient airframe. Possible missions that would take advantage of the combination of high and low speed performance could include: penetrating intelligence, surveillance, and reconnaissance; long range strike, hunter/killer and multimission aircraft. A supersonic aircraft capable of extremely long loiter times would have a revolutionary impact on the battlefield, necessitating fewer combat aircraft and fewer tankers to accomplish mission objectives. The goal of the Oblique Flying Wing (OFW) program is to expand the design space for future aircraft concepts, particularly for those missions that demand both supersonic speed and long endurance. The potential for a unique

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combination of excellent high speed and low speed performance would enable rapid deployment and long loiter time, for example, in surveillance or combat air patrol (CAP) roles. The OFW program will integrate technologies such as advanced controls to develop and fly one or more scaled demonstrator vehicles. The program will also identify key design requirements for the objective system, allowing the services to evaluate the technology for implementation in future operational systems. This effort was previously budgeted in this project under the Advanced Aeronautics Demonstration program.

(U) Program Plans:

- Develop oblique wing concept design.
- Define, develop and demonstrate key oblique wing component technologies.
- Begin system design for an objective oblique wing system and a flight demonstrator.

	FY 2005	FY 2006	FY 2007
Cormorant Unmanned Air Vehicle (UAV)	6.984	9.600	14.600

(U) The Cormorant Unmanned Air Vehicle (UAV) program will examine the feasibility of a UAV that may be deployed from the sea without carrier support. The program will explore concepts that launch from both the sea surface and submarines. Technical challenges include aircraft structural integrity and water tightness at submarine launch depths and on the surface, aircraft dynamics at the air/sea interface, engine technology to survive periodic immersion in salt water, and advanced composite materials development to withstand sea-surface operations. The Cormorant UAV is envisioned to provide close air support for vessels such as the Littoral Combat ship (LCS) and SSGN. Pending the outcome of demonstration results, transition of the Cormorant UAV to the Navy is planned after the completion of Phase III in FY 2010.

(U) Program Plans:

- Initiate feasibility studies; conduct modeling and simulation vehicle behaviors in the air/sea interface.
- Explore novel composite materials.
- Perform concept design studies.
- Perform engine quick start demonstration and engine concept development.

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- Perform risk reduction experiments for materials and subsystems including full scale end-to-end splashdown to docking demonstration.

	FY 2005	FY 2006	FY 2007
Heavy Fuel Engine for A160	6.687	6.612	10.729

(U) The Heavy Fuel Engine for the A160 program will develop and demonstrate a heavy-fuel, lightweight, and efficient engine for the A160 air vehicle. In the future, heavy fuel (diesel or JP-8) will be the only logistic fuel for the battlefield. Conventional heavy-fuel engines are too heavy for air vehicles and, at the desired size, not efficient enough. Innovative and advanced diesel engine designs are being developed to achieve both efficiency and a significant reduction in weight. The engines will enable the A160 to achieve maximum range and endurance while operating on diesel fuel. Detailed design, fabrication, and testing is being conducted to assess engine performance and reliability. The A160 Engine Development technology is planned for transition to the Army at the conclusion of Phase III, which is anticipated to be completed in 2007.

(U) Program Plans:

- Complete prototype engine performance and endurance testing.
- Perform engine design optimization based on lessons learned from build and test.
- Demonstrate performance and reliability of optimized engines at 38% efficiency, a power to weight ratio of 0.9hp/lb, and producing 450 hp at 15,000 ft.

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	FY 2005	FY 2006	FY 2007
Critical Munition Capability	6.500	7.000	8.000

(U) The Critical Munition Capability program consists of four efforts: HyperJAM (Hypersonic Joint Attack Munition), MAULLM (Multi-target Autonomous Loitering Littoral Munition), BEDLAM (Battlefield Electronically Disruptive Loitering Attack Missile), and DIME (Deep Interdiction with Multiple Engagements). The goal of each of these efforts is to provide the warfighter with a range of weapons that enable effective, precise, responsive, and decisive disruption to enemy forces.

(U) HyperJAM provides the capability to deliver GPS precision guided weapons to high value, well defended, and relocatable targets with range capability in excess of 400 nm. HyperJAM uses conventional rocket technology (black brandt rocket) integrated with a modified aerodynamically enhanced Joint Direct Attack Munition (JDAM) high speed nosecone to deliver MK84 munitions to precise locations. Utilization of a zoom maneuver from a high performance aircraft (F-16, F/A-18) allows delivery of an air-to-surface weapon on a ballistic trajectory that greatly enhances its range capability with the same lethality/accuracy.

(U) MAULLM will develop concepts and technologies for a containerized, platform-independent multi-mission weapon concept that will provide rapid response and lethality in packages with significantly lower missile unit cost, decreased logistical support and lower life-cycle costs, while increasing flexibility compared to current Naval gun and missile systems. MAULLM will address current Naval threats such as massed, swarming suicide attack boats, and will significantly enhance operations ashore by providing a long-loiter, on-call weapon capable of engaging multiple (~10) individual targets.

(U) BEDLAM will develop concepts and technologies for detection, exploitation, and disruption of a wide variety of enemy electronic emissions and will integrate them into a mission module suitable for use on small loitering missiles to establish patterns or meetings with other emitters to aid in intelligence and targeting.

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(U) DIME will develop weapons capable of a wide variety of interdiction and persistent control missions in the most difficult environments with minimal supervision after initial tasking. The program will re-examine the trade-space between missiles and aircraft, with the objective of the operational utility of aircraft and UAVs with the support requirements, acquisition characteristics, and attritability of munitions. All aspects of the weapon system will be considered, and technology development will be considered in those found to be mission drivers, including sensors, autonomous operation, command and control, warheads, submunitions, airframe, propulsion, and concept of operations.

(U) Program Plans:

- HyperJam
 - Completed simulation studies to determine range capability and control requirements for potential Army, Navy and Air Force customers.
 - Develop system level requirements for air and gun delivered munitions.
 - Develop integrated missile/munition concepts with greater range and lethality.
 - Initiate preliminary system design.
- MAULLM
 - Develop and demonstrate critical technologies. Conduct preliminary design studies.
 - Evaluate communication and command and control technologies and select best option(s).
- BEDLAM
 - Conduct initial experiments and modeling to determine system requirements.
 - Complete preliminary design study.
- DIME
 - Develop mission concepts and technical requirements studies.
 - Define trades between alternative system concepts with modeling and experiments.
 - Complete preliminary designs.
 - Complete technology risk reduction development.
 - Develop and demonstrate completed system.

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	FY 2005	FY 2006	FY 2007
Advanced Aerospace System Concepts	3.310	3.254	4.900

(U) Studies conducted under this project examine and evaluate emerging aerospace technologies and system concepts for applicability to military use. This includes the degree and scope of potential impact/improvements to military operations, mission utility, and warfighter capability. Studies are also conducted to analyze emerging aerospace threats along with possible methods and technologies to counter them. The feasibility of achieving potential improvements, in terms of resources, schedule, and technological risk, is also evaluated. The results from these studies are used, in part, to formulate future programs or refocus ongoing work. Topics of consideration include: methods of defeating enemy anti-aircraft attacks; methods to intercept and defeat enemy unmanned air vehicles (UAVs); munition technologies to increase precision, range, endurance and lethality of weapons for a variety of mission sets; novel launch systems; and air vehicle control, power, propulsion, materials, and architectures.

- (U) Program Plans:
- Perform studies of candidate technologies and develop system concepts.
 - Conduct modeling and simulation of system architectures and scenarios.
 - Conduct enabling technology and sub-system feasibility experiments.

	FY 2005	FY 2006	FY 2007
Long Gun	6.185	0.000	0.000

(U) The Long Gun program evaluated and developed a re-useable, long endurance, low cost, joint, unmanned/armed air vehicle combined with a tri-mode long wave infrared/near infrared/visible (LWIR/NIR/VIS) sensor with laser spot targeting. The program utilized a ducted fan propulsion system. This program was last funded in FY 2005, and will be completed in FY 2006 at the conclusion of Phase I.

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- (U) Program Plans:
- Modified existing Affordable Weapon System airframe as basis for missile design.
 - Replaced engine with ducted fan, rotary engine operated with heavy fuel.
 - Developed and integrated tri-mode sensor/seeker with laser spot recognition for targeting.
 - Developed avionics package to support long-endurance flight.
 - Conducted inert flight tests and demonstrated long endurance operation.

	FY 2005	FY 2006	FY 2007
Global Range Transatmospheric Vehicle	0.000	0.000	5.300

(U) The Global Range Transatmospheric Vehicle program will develop a turbine-based combined cycle propulsion system consistent with the flight envelope of the Falcon (PE 0603287E/SPC-01) Hypersonic Cruise Vehicle concept, but subscale and of limited operational durability. To accomplish this objective, the program will further mature, integrate and flight-demonstrate propulsion technologies developed by the High Speed / Hypersonic Reusable Demonstration program (budgeted under PE 0602702E, Project TT-07) and the Falcon program (PE 0603287E). A scramjet engine flow path design, consistent with the Falcon Hypersonic Cruise Vehicle concept, will be matured to flight readiness. This flow path will then be integrated with a Mach 4, expendable turbine engine developed under the first of these previously mentioned programs to conduct a combined cycle engine ground demonstration. Successful accomplishment of the ground demonstration will lead to a flight demonstration of these systems in both low speed (turbojet) and high speed (scramjet) flight regimes. The program will also conduct studies and analysis of reusable materials technologies and thermal management strategies for these propulsion systems to determine the utility and potential applicability of those technologies to the end system. Accomplishment of these objectives will enable a future large scale hypersonic cruise X-vehicle development and demonstration program.

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- (U) Program Plans:
- Mature scramjet flow path.
 - Integrate turbine and scramjet engines.
 - Conduct ground testing of combined cycle engine.
 - Conduct a flight-test demonstration.

	FY 2005	FY 2006	FY 2007
Dual Mode Small Gunship	0.000	0.000	6.000

(U) The objective of the Dual Mode Small Gunship project is to build, test and fly a low-cost small aircraft, configured with sensors, weapons and special equipment, that is controlled either remotely or by a crew onboard. The vehicle will demonstrate persistent, sustained gunship and strike mission capabilities with troops on the ground directly commanding the aircraft's weapons and sensors. The gunship will give the ground warfighter particular advantage in urban environments where it will operate with high availability, fast response, precision strike and low collateral damage. The ability to have a pilot on-board will allow for easy deployment to theater and safe operation over populated areas by allowing the pilot to interface with the air traffic control infrastructure rather than the current, cumbersome method of deploying large UAVs. The plan to "unman" an existing aircraft also minimizes development costs. The Dual Mode Small Gunship is expected to have low development and procurement costs, high endurance and range, a large payload, and high dash speeds with a day/night adverse weather capability. Potential customers include the Army, SOCOM, Marines, and AFSOC.

- (U) Program Plans:
- Modify an existing low cost aircraft for use as an "optionally piloted" aircraft, with weapons systems and sensors.
 - Demonstrate ability to control the aircraft, its weapons and sensors from the ground.

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	FY 2005	FY 2006	FY 2007
Seaplane Unmanned Air Vehicle (UAV)	0.000	0.000	5.500

(U) This program will develop an unmanned amphibious seaplane concept that could provide the Navy and Marine Corps with the capability to take-off and land in the water at very high sea states (up to sea state 5). It will be able to “rest” in a sea loiter mode for long periods of time and wait for further commands, extending quiescent endurance time to days until an action is required. It will also be able to fly back to any friendly ship and refuel. Potential missions include intelligence, surveillance, reconnaissance and targeting (ISRT), communications relay, electronic warfare, unmanned undersea vehicle (UUV) delivery and recovery, and anti-submarine warfare (ASW). Other potential customers could include the Coast Guard and SOCOM. The seaplane UAV will also be able to take-off and land on rivers and lakes, facilitating surveillance and other missions over land operations.

- (U) Program Plans:
- Conduct initial feasibility studies.
 - Conduct subsystem risk analysis and laboratory tests.
 - Initiate preliminary design.

	FY 2005	FY 2006	FY 2007
Heavy Lift	0.000	0.000	6.000

(U) Heavy Lift Short Take Off and Landing/Verticle Take Off and Landing (STOL/VTOL) aircraft are an essential part of the future ground force. The objective of this program is to develop and demonstrate technologies that would lead to novel STOL/VTOL air vehicle concepts and designs. An objective VTOL aircraft would be able to lift a 20-ton payload and carry it forward at speeds of 200+ knots with a tactical radius of 400 or more miles. Such a vehicle would be optionally-manned. Technology advances may include advanced rotors, propellers, hybrid-mode engines, and advanced composite airframes. Transition partners for the Heavy Lift program will be sought in Army, Marine Corps, Special Operations Command, and Navy.

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- (U) Program Plans:
- Perform trade studies and modeling and simulation.
 - Develop and test enabling technologies/subsystems.
 - Conduct preliminary design.

	FY 2005	FY 2006	FY 2007
Close Air Support Technology for Loitering Engagement (CASTLE)	0.000	0.000	5.000

(U) The Close Air Support Technology for Loitering Engagement (CASTLE) program will develop alternatives to current, manned systems and explore approaches to provide persistent on-demand overhead fire support with gun-ship like precision, tailored lethal effectiveness and unit directed responsive command and control. Key technologies to be analyzed, developed and integrated under CASTLE include 1) affordable, survivable, and persistent unmanned aircraft, 2) weapons consistent with man-on-the loop close air support application, such as auto-loading EM guns, directed energy weapons, vertical launch missiles, or deep magazine traditional guns and precision bombs, 3) sensors for targeting and designation and 4) an adaptive command and control system to permit small unit request, coordination, and direction of supporting fires.

- (U) Program Plans:
- Evaluate candidate technologies for CASTLE.
 - Conduct initial concept tradeoff for preliminary CASTLE system designs.
 - Perform modeling and simulation of alternative candidate air system architectures to assess effectiveness of alternative CASTLE approaches.
 - Complete preliminary design of air vehicle design concept and development.
 - Perform CASTLE technology risk reduction experiments and demonstrations.

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	FY 2005	FY 2006	FY 2007
Aircraft Self Protection (ASP)	0.000	0.000	6.000

(U) The Aircraft Self Protection (ASP) program will explore the active protection of slow moving, high altitude aircraft systems with guided missiles or high energy laser weapons as an alternative/complement to passive defense by signature control. Today such aircraft rely on stealth technology to avoid detection and engagement by long range surface to air missile threats. In the future, the unique advantage enjoyed by the United States may be eroded by technological advances, and stealthy aircraft often give up their advantage in detectability when they utilize active radar and laser sensors in the conduct of their mission. An active aircraft self-defense system could relax the design constraints imposed by signature control, allowing a greater range of platform capabilities. Because lasers provide “speed-of-light” response and a deep magazine, we will examine their suitability relative to the more conventional missile based solutions. The ASP program will evaluate both pod-mounted and fully integrated system concepts and will develop and demonstrate missile detection, threat tracking, engagement, and defeat at a safe range.

(U) Program Plans:

- Perform ASP system tradeoff analysis, resulting in system size, weight, power and effectiveness criteria.
- Evaluate alternative high energy laser designs and missile or projectile technology for ASP applications.
- Demonstrate integration of missile warning and tracking capabilities with lightweight beam director technology against incoming missile threats.
- Select initial ASP design concept and perform development to preliminary design review.

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	FY 2005	FY 2006	FY 2007
Unmanned Combat Armed Rotorcraft (UCAR)	10.000	0.000	0.000

(U) The goal of the Unmanned Combat Armed Rotorcraft (UCAR) program was to design, develop, integrate and demonstrate the enabling technologies and system capabilities required to perform armed reconnaissance and attack missions within the Army's Future Force system-of-systems environment. The enabling technologies were survivability, autonomous operations, command and control, and targeting/weapons delivery. A highly survivable UCAR system would be able to prosecute enemy high value targets with relative impunity without placing a pilot in harm's way. UCAR's autonomous capabilities could have enabled effective teaming with manned systems and could have eliminated the requirement for a dedicated ground control station. The UCAR capabilities could have provided the Future Force with the mobility, responsiveness, lethality, survivability, and sustainability required to ensure mission success. Specific objectives of the UCAR program included: development and demonstration of an effective, low total ownership cost design for the system; an air and ground-based command and control architecture for UCAR operations that did not require a dedicated ground control station; autonomous multi-ship cooperation and collaboration; autonomous low altitude flight; and system survivability. In recognition of the Army's decision to terminate their support of the program, DARPA's efforts were completed at the end of Phase II.

- (U) Program Plans:
- Completed system trades, effectiveness, and affordability analyses through modeling and simulation.

	FY 2005	FY 2006	FY 2007
Modular Blended Wing Body Multi-Role Aircraft (MBWB MRA)	4.420	0.000	0.000

(U) The goal of the MBWB MRA effort was to develop and demonstrate a system that could efficiently and affordably meet the Joint Service needs for a bomber, tanker, and transport. The MBWB MRA would have been reconfigurable on the flight line to a bomber, tanker, or transport in less than 24 hours. Commercial derivatives of the MBWB MRA would have carried freight at a cost per air ton mile that is 20-40% below that of existing aircraft.

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- (U) Program Plans:
- Performed system and conceptual design studies.
 - Explored various mission capabilities and completed military needs and utility analyses.

(U) <u>Program Change Summary:</u> <i>(In Millions)</i>	<u>FY 2005</u>	<u>FY 2006</u>	<u>FY 2007</u>
Previous President's Budget	71.420	75.866	111.029
Current Budget	66.919	54.594	115.829
Total Adjustments	-4.501	-21.272	4.800
 Congressional program reductions	 -0.063	 -21.272	
Congressional increases	0.000		
Reprogrammings	-2.354		
SBIR/STTR transfer	-2.084		

(U) **Change Summary Explanation:**

FY 2005	Decrease reflects DOE transfer directed by P.L. 108-447 and the SBIR/STTR transfer.
FY 2006	Decrease reflects the congressional reductions to HABIT, Long Gun, undistributed reductions for Section 8125 and the 1% reduction for Section 3801: Government-wide rescission.
FY 2007	Increase reflects introductions of several new aircraft concepts and the Global Range Transatmospheric Vehicle, offset by elimination of funding for HABIT and Walrus, in keeping with congressional intent.

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(U) Other Program Funding Summary Cost:

A160	FY 2005	FY 2006	FY 2007
Army S&T, Phase I	15.000	10.000	15.000
Army S&T, Phase II	0.000	9.190	18.740

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