PE NUMBER: 0602605F
PE TITLE: DIRECTED ENERGY TECHNOLOGY

Exhibit R-2, RDT&E Budget Item Justification

DATE: February 2007

BUDGET ACTIVITY: 02 Applied Research

PE NUMBER AND TITLE: 0602605F DIRECTED ENERGY TECHNOLOGY

	Cost ($ in Millions)	FY 2006 Actual	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
	Total Program Element (PE) Cost	43.287	50.019	54.883	53.362	69.249	58.419	69.307	75.617	Continuing	TBD
4866	Lasers & Imaging Technology	28.795	25.124	33.584	31.954	42.985	35.715	42.897	47.041	Continuing	TBD
4867	Advanced Weapons & Survivability Technology	14.492	15.424	16.396	16.261	20.520	17.227	20.980	23.031	Continuing	TBD
55SP	Laser and Imaging Space Tech	0.000	9.471	4.903	5.147	5.744	5.477	5.430	5.545	0.000	0.000

Note: In FY 2008, relay mirror technology efforts in Project 55SP, Laser and Imaging Space Technology, will transfer to Project 4866, Lasers and Imaging Technology, within this PE in order to more effectively manage the efforts.

(U) A. Mission Description and Budget Item Justification

This program covers research in directed energy technologies, primarily lasers and high power microwaves. In lasers, this includes moderate to high power lasers (solid state and chemical) and associated optical components and techniques. In advanced weapons, this program examines technologies such as narrowband and wideband high power microwave devices and antennas. Both areas also provide vulnerability/lethality assessments of representative systems. Note: In FY 2007, Congress added $1.8 million for Ceramics for Next Generation Tactical Laser Systems. This program is in Budget Activity 2, Applied Research, since it develops and determines the technical feasibility and military utility of evolutionary and revolutionary technologies.

(U) B. Program Change Summary ($ in Millions)

		FY 2006	FY 2007	FY 2008	FY 2009
(U)	Previous President's Budget	44.169	48.422	53.340	54.252
(U)	Current PBR/President's Budget	43.287	50.019	54.883	53.362
(U)	Total Adjustments	-0.882			
(U)	Congressional Program Reductions		-0.014		
	Congressional Rescissions		-0.189		
	Congressional Increases		4.300		
	Reprogrammings	-0.088	-2.500		
	SBIR/STTR Transfer	-0.794			
(U)	Significant Program Changes:				

Not Applicable.

C. Performance Metrics

Under Development.

Exhibit R-2a, RDT&E Project Justification			DATE February 2007
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602605F DIRECTED ENERGY TECHNOLOGY	PROJECT NUMBER AND TITLE 4866 Lasers & Imaging Technology	

Cost ($ in Millions)	FY 2006 Actual	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
4866 Lasers & Imaging Technology	28.795	25.124	33.584	31.954	42.985	35.715	42.897	47.041	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

Note: In FY 2008, relay mirror technology efforts previously performed in Project 55SP, Lasers and Imaging Space Technology, within this PE will transfer to this project to more effectively manage the efforts.

(U) A. Mission Description and Budget Item Justification

This project explores the technical feasibility of moderate to high power lasers and supporting laser technologies for aircraft protection, force protection, precision engagement, and Global War On Terrorism missions. Develop new technologies, perform physics based modeling, and evaluate new materials that will enable development of: (1) compact, reliable, and affordable laser systems with good beam quality, scalability to high power, and high potential military utility; (2) optical and beam control systems to enhance laser beam propagation and pointing and tracking over long distances in the atmosphere. Emphasis will be on using computer modeling and simulation and laboratory experiments to demonstrate traceability to key concept performance parameters, reliability, affordability, and packaging requirements unique to potential applications. Develop and implement system concept assessment tools supporting the definition of laser system concept performance, military utility and cost trade decisions.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2006	FY 2007	FY 2008	FY 2009
(U) MAJOR THRUST: Develop solid state laser technologies for airborne tactical and strategic applications. Technologies include fiber lasers and bulk solid state lasers.	11.462	13.320	15.547	15.500

(U) In FY 2006: Developed laser component technologies for detecting, identifying, tracking, and defeating electro-optic targets from airborne tactical platforms. Enhanced new laser structures for near-infrared, mid-infrared, and long-wavelength operation. Developed single- and multi-wavelength packaging and delivery methods. Began development of solutions to aero-optical issues on airborne platforms. Assessed laser requirements for destroying detectors in the threat sensors. Performed lethality assessment studies of the various laser concepts in relevant scenarios. Validated vulnerability assessment models by experiments. Investigated and demonstrated alternative laser architectures and gain media. Demonstrated greater than five watts in a wavelength versatile laser. Refined laser technologies to obtain architectures that are favorable in terms of size, weight, efficiency, affordability, and fieldability for tactical laser weapon applications.

(U) In FY 2007: Design and develop laser sources for jamming/damaging optical threats, focusing on increased efficiency and reliability. Perform testing of ultra-short pulse laser sources to evaluate potential applications. Continue development of solutions to aero-optical issues on airborne platforms. Investigate technologies for tactical platform disturbance mitigation and proceed to subsystem implementation of advanced techniques. Continue applying latest technologies to tactical laser handheld

Exhibit R-2a, RDT&E Project Justification		DATE February 2007
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602605F DIRECTED ENERGY TECHNOLOGY**	PROJECT NUMBER AND TITLE **4866 Lasers & Imaging Technology**

(U) **B. Accomplishments/Planned Program ($ in Millions)**	FY 2006	FY 2007	FY 2008	FY 2009
systems. Perform additional lethality assessment studies of the various laser concepts in relevant scenarios. Continue to validate vulnerability assessment models. Refine technologies to obtain architectures that are favorable in terms of size, weight, efficiency, affordability, and fieldability for tactical laser weapon applications. Develop the most promising solid state laser technologies for scaling to the weapons class power level. Demonstrate "eye-safe" wavelength solid state laser technology for designator and illuminator applications.				
(U) In FY 2008: Refine laser sources to obtain higher efficiencies and improve ruggedness of designs. Continue development of system-level solutions to aero-optical issues involving airborne tactical laser weapon applications. Perform further lethality assessment studies to assess the effectiveness of the various laser concepts in relevant scenarios. Continue coupon-level and mid-scale demonstration experiments to validate vulnerability assessment models. Continue to scale electric lasers up to the weapons class power level. Refine technologies in effort to obtain suitable parameters in terms of size, weight, efficiency, affordability, reliability, maintainability, supportability, environmental acceptability (air, land, and maritime), and ruggedness for the next-generation applications.				
(U) In FY 2009: Improve design of laser sources for jamming/damaging optical threats. Perform damage tests against real or simulated advanced threat systems and use test results to verify models and laser effectiveness. Increase efficiencies and improve ruggedness of designs. Conclude development of system-level solutions to aero-optical issues of tactical laser weapons applications on airborne platforms, with goal of procurement of representative beam delivery sub-system. Continue lethality assessment studies to assess the effectiveness of the various laser concepts in relevant scenarios. Perform coupon-level and mid-scale demonstration experiments to validate vulnerability assessment models. Continue to scale electric lasers up to the weapons class power level.				
(U)				
(U) MAJOR THRUST: Develop chemical, gas, and hybrid laser technologies (i.e. new fuel chemistry, fuel regeneration techniques, and nozzle designs) for scalable, high energy laser devices with improved efficiency for insertion into airborne platforms and ground based lasers.	4.673	4.885	6.074	5.470
(U) In FY 2006: Continued to investigate the scalability of high performance zero-gravity singlet delta oxygen generator concepts for airborne laser applications. Demonstrated advanced chemical and electrical singlet oxygen generator technology to help improve current levels of performance. Investigated fiber pumped molecular gas lasers. Developed advanced diagnostics for chemical oxygen iodine laser performance measurements to identify potential enhancements. Began work on				

Exhibit R-2a, RDT&E Project Justification		DATE February 2007
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602605F DIRECTED ENERGY TECHNOLOGY**	PROJECT NUMBER AND TITLE **4866 Lasers & Imaging Technology**

(U) **B. Accomplishments/Planned Program ($ in Millions)**	FY 2006	FY 2007	FY 2008	FY 2009
technologies that would increase the range of future high power airborne lasers. Investigated chemical-electrical hybrid laser technologies that offer potential for power scaling and component size and weight reduction.				
(U) In FY 2007: Continue to investigate scaling of high-performance oxygen generator concepts for airborne laser applications. Evaluate iodine injection schemes for oxygen generators. Evaluate and refine advanced chemical laser technologies demonstrated in FY 2006. Pursue scaling chemical-electric hybrid laser technologies that offer potential for power scaling and component size and weight reduction.				
(U) In FY 2008: Demonstrate enhanced-performance singlet delta oxygen generator coupled with advanced ejector nozzle concepts for airborne laser applications, including advanced fuel chemistries. Continue scaling path demonstrations for electric discharge oxygen-iodine lasers and diode-pumped atomic lasers.				
(U) In FY 2009: Refine high-performance singlet delta oxygen generator and advanced ejector nozzle concepts for airborne laser applications based on results of previous demonstration. Begin real-world condition demonstrations for electric discharge oxygen-iodine lasers and diode-pumped atomic lasers.				
(U)				
(U) MAJOR THRUST: Develop optical and imaging technologies for advanced beam control, atmospheric compensation, and pointing and tracking for future optical imaging/laser systems. Note: In FY 2008, relay mirror technology efforts previously performed in Project 55SP, Laser and Imaging Space Technology, within this PE were placed here to more effectively manage the efforts.	5.787	5.126	11.963	10.984
(U) In FY 2006: Began development of component-level and system-level solutions to aero-optical issues involving tactical laser applications on airborne platforms; analyzed most promising concepts for field testing. Continued aero-optical wavefront sensor development. Evaluated advanced inertial reference unit improvements. Continued testing of tactical beam control propagation codes. Continued working towards demonstration of high-bandwidth active tracking of uncooperative targets. Simulated and investigated advanced adaptive optics for relay mirror uplink beam control. Developed and evaluated two beam propagation techniques for tracking and illumination of a cruise missile through an airborne relay mirror. Continued design of low-altitude relay mirror field experiments. Began testing of advanced sodium-beacon adaptive optics system on 3.5 meter telescope.				
(U) In FY 2007: Continue development of system-level solutions to aero-optical issues involving tactical laser applications on airborne platforms and acquire adaptive optics system for wind tunnel aero-optics disturbance mitigation testing. Investigate technologies for tracking in clutter and tactical platform				

Exhibit R-2a, RDT&E Project Justification		DATE: February 2007
BUDGET ACTIVITY: 02 Applied Research	PE NUMBER AND TITLE: 0602605F DIRECTED ENERGY TECHNOLOGY	PROJECT NUMBER AND TITLE: 4866 Lasers & Imaging Technology

	B. Accomplishments/Planned Program ($ in Millions)	FY 2006	FY 2007	FY 2008	FY 2009
	disturbance mitigation. Develop selected technologies for transition from laboratory to field testing. Continue investigation of advanced adaptive optics techniques. Demonstrate detection and discrimination of small, nonresolved space objects using sodium-beacon adaptive optics system.				
(U)	In FY 2008: Integrate adaptive optics hardware in wind tunnel tests to measure and characterize aero-optical disturbances. Develop and analyze advanced tactical beam control architectures and critical beam control components, such as inertial references and trackers. Begin development of lightweight optics and advanced tracking techniques and technologies. Complete sub-system fabrication in order to conduct a low-power demonstration. Begin development of a 25 kilowatt laser for integration into the relay mirror system. Begin integration of sodium beacon with high efficiency adaptive optics system.				
(U)	In FY 2009: Complete demonstration of system-level solutions to aero-optical distortions associated with airborne tactical laser weapons systems in wind-tunnel environment. Implement advanced platform disturbance initiative-readied technologies as component of end-to-end field demonstration of precision laser control. Continue further concept lethality assessments. Provide system concept engineering support for an integrated ground tactical demonstration. Demonstrate closed loop tracking in conjunction with sensor systems as part of continued development and integration of the relay mirror breadboard system. Demonstrate compensated imaging and detection of very dim space objects at visible wavelengths. Integrate and demonstrate advanced tactical beam control systems and critical beam control components, such as inertial references and trackers. Continue development of lightweight optics and advanced tracking techniques and technologies. Conduct a low-power demonstration. Integrate a 25 kilowatt laser with the relay mirror to demonstrate the laser-mirror system. Integrate sodium beacon with high efficiency adaptive optics system.				
(U)					
(U)	CONGRESSIONAL ADD: Adaptive Optics Lasercom	2.421	0.000	0.000	0.000
(U)	In FY 2006: Conducted Congressionally-directed effort for Adaptive Optics Lasercom.				
(U)	In FY 2007: Not Applicable.				
(U)	In FY 2008: Not Applicable.				
(U)	In FY 2009: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: Advanced Laser Materials Development	2.710	0.000	0.000	0.000
(U)	In FY 2006: Conducted Congressionally-directed effort for Advanced Laser Materials Development.				
(U)	In FY 2007: Not Applicable.				

Exhibit R-2a, RDT&E Project Justification		DATE February 2007
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602605F DIRECTED ENERGY TECHNOLOGY	PROJECT NUMBER AND TITLE 4866 Lasers & Imaging Technology

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2006	FY 2007	FY 2008	FY 2009
(U) In FY 2008: Not Applicable.				
(U) In FY 2009: Not Applicable.				
(U)				
(U) CONGRESSIONAL ADD: Ceramics for Next Generation Tactical Laser Systems	1.742	1.793	0.000	0.000
(U) In FY 2006: Conducted Congressionally-directed effort for Ceramics for Next Generation Tactical Laser Systems.				
(U) In FY 2007: Conduct Congressionally-directed effort for Ceramics for Next Generation Tactical Laser Systems.				
(U) In FY 2008: Not Applicable.				
(U) In FY 2009: Not Applicable.				
(U) Total Cost	28.795	25.124	33.584	31.954

(U) C. Other Program Funding Summary ($ in Millions)

	FY 2006 Actual	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total Cost
(U) Related Activities:										
(U) PE 0601108F, High Energy Laser Research Initiatives.										
(U) PE 0602500F, Multi-Disciplinary Space Technology.										
(U) PE 0602890F, High Energy Laser Research.										
(U) PE 0603444F, Maui Space Surveillance System.										
(U) PE 0603500F, Multi-Disciplinary Advanced Development Space Technology.										
(U) PE 0603605F, Advanced Weapons Technology.										
(U) PE 0603924F, High Energy										

Exhibit R-2a, RDT&E Project Justification		DATE February 2007
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602605F DIRECTED ENERGY TECHNOLOGY**	PROJECT NUMBER AND TITLE **4866 Lasers & Imaging Technology**

(U) C. Other Program Funding Summary ($ in Millions)

Laser Advanced Technology Program.

(U) PE 0603883C, Ballistic Missile Defense Boost Phase Segment.

(U) This project has been coordinated through the Reliance 21 process to harmonize efforts and eliminate duplication.

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification			DATE: February 2007
BUDGET ACTIVITY: 02 Applied Research	PE NUMBER AND TITLE: 0602605F DIRECTED ENERGY TECHNOLOGY	PROJECT NUMBER AND TITLE: 4867 Advanced Weapons & Survivability Technology	

Cost ($ in Millions)		FY 2006 Actual	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
4867	Advanced Weapons & Survivability Technology	14.492	15.424	16.396	16.261	20.520	17.227	20.980	23.031	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project explores high power microwave (HPM) and other unconventional weapon concepts using innovative technologies. Technologies are developed that support a wide range of Air Force missions such as the potential disruption and degradation of an adversary's electronic infrastructure and military capability. This effect can often be applied covertly with no collateral structural or human damage. Targeted capabilities include local computer and communication systems, as well as large and small air defense and command and control systems. This project also provides for vulnerability assessments of representative U.S. strategic and tactical systems to HPM weapons, HPM weapon technology assessment for specific Air Force missions, and HPM weapon lethality assessments against foreign targets.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2006	FY 2007	FY 2008	FY 2009
(U) MAJOR THRUST: Investigate and develop technologies for narrowband and wideband HPM components to support multiple Air Force applications such as the disruption of electronic systems and subsystems.	6.417	4.015	4.821	4.445

(U) In FY 2006: Developed a compact repetitively pulsed gigawatt-class HPM source. Developed a conformal high power phased array antenna for the compact pulsed HPM source. Developed compact permanent magnets for the compact pulsed gigawatt HPM source. Developed a compact pulse power system to drive the HPM source. Conducted laboratory measurements of the compact pulsed gigawatt HPM demonstration unit. Developed vacuum systems that are compact and can be installed in an airborne platform. Developed compact solid-state wideband source and antenna for target identification. Developed target identification algorithms. Conducted target identification field experiments to determine optimal design.

(U) In FY 2007: Conduct measurements using the compact repetitively pulsed gigawatt-class HPM demonstration unit. Improve the compact HPM source and conformal antenna that they can be integrated into an airborne platform. Develop a command and control system for the airborne platform HPM unit. Implement nanotechnology to reduce the HPM source weight and size. Conduct field tests of a mesoband unit that will characterize the system and demonstrate the effectiveness of the system. Develop an engineering model of a compact wideband target identification system that can be used to conduct laboratory experiments for applications such as target under trees.

(U) In FY 2008: Continue testing of the compact repetitively pulsed gigawatt-class HPM demonstration unit. Continue to improve the compact HPM source and conformal antenna such that they can be

Exhibit R-2a, RDT&E Project Justification		DATE February 2007
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602605F DIRECTED ENERGY TECHNOLOGY	PROJECT NUMBER AND TITLE 4867 Advanced Weapons & Survivability Technology

	B. Accomplishments/Planned Program ($ in Millions)	FY 2006	FY 2007	FY 2008	FY 2009
	integrated into an airborne platform. Develop a compact wideband target identification unit that can be used to conduct laboratory experiments in support of the target under trees program. Further develop flux trapping technology for compact flux compression generators and perform functional testing. Perform design studies for disk generators to further reduce the size of single shot devices. Perform functional testing of a multi-stage ceramic loaded polymer Blumlein line.				
(U)	In FY 2009: Enhance the compact repetitively pulsed gigawatt-class HPM testbed. Integrate and demonstrate the conformal antenna and command and control system for the compact HPM testbed. Improve the wideband antenna and high voltage switch and demonstrate the effectiveness during field tests.				
(U)					
(U)	MAJOR THRUST: Develop and use the ability to assess the effects/lethality of HPM directed energy weapon technologies against representative air and ground systems. Develop and apply sophisticated models to enhance the development of HPM and related technology.	3.925	4.478	5.315	5.607
(U)	In FY 2006: Continued to advance elemental modeling methodology to predict target susceptibility. Developed advanced descriptions of target functional behavior for insertion into modeling and simulation codes. Continued susceptibility testing of electronic targets. Validated plasma model on dielectric pulse power interfaces and antenna breakdown. Improved the fidelity of the solution to electromagnetic models by statically refining the numerical grid and by having a boundary conformal solution. Continued integration of electromagnetic codes with thermal and electron transport codes.				
(U)	In FY 2007: Predict susceptibilities of relevant electronic systems based on model and manufacturer. Conduct further experiments on the systems to verify model accuracy and compare predictions with experiments. Adjust models as required. Identify and mitigate platform susceptibility to onboard HPM and associated electromagnetic interference/compatibility considerations for fratricide issues. Refine preliminary battle damage assessment system for HPM sources. Continue susceptibility testing of electronic targets. Apply hardening techniques to identified platforms. Identify and mitigate HPM susceptibility for military systems against both domestic and foreign sources. Validate integration of electromagnetic codes with thermal and electron transport codes for HPM sources and components. Begin integration of boundary conformal solutions. Apply plasma model for high field regions. Investigate improved material physics models. Initiate development of automatic optimization for HPM system design.				
(U)	In FY 2008: Incorporate elemental modeling into predictive code for use in targeting and war gaming.				

Exhibit R-2a, RDT&E Project Justification		DATE February 2007
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602605F DIRECTED ENERGY TECHNOLOGY	PROJECT NUMBER AND TITLE 4867 Advanced Weapons & Survivability Technology

	B. Accomplishments/Planned Program ($ in Millions)	FY 2006	FY 2007	FY 2008	FY 2009
	Continue susceptibility testing of electronic targets. Apply hardening techniques and technology to identified platforms. Identify and mitigate HPM susceptibility for military systems of interest to HPM sources. Continue to refine preliminary battle damage assessment technologies for use with HPM. Apply virtual modeling for HPM system enhancement. Validate and document the efficacy of automatic adaptive grid generation for HPM system design. Extend the air breakdown model already in development to simulate plasma channel formation. Apply boundary conformal methods to HPM system enhancement. Continue to investigate and integrate improved material models into HPM tube simulations. Continue development of automatic design enhancement.				
(U)	in FY 2009: Continue susceptibility testing of electronic targets to refine modeling techniques. Update and enhance modeling and simulation software to account for new developments. Continue platform susceptibility work and apply hardening technology to platforms. Continue application of virtual modeling for HPM system enhancement. Begin integration of adaptive grid generation methods into HPM system simulations. Using boundary conformal methods to perform HPM system enhancement. Apply improved material physics models to HPM system enhancement. Apply automatic enhancement to HPM tube design.				
(U)					
(U)	MAJOR THRUST: Investigate HPM technologies that support offensive and force protection airborne tactical applications, including non-lethal counterpersonnel applications, made possible by the increased power available on future aircraft.	4.150	6.931	6.260	6.209
(U)	In FY 2006: Refined HPM system source code to reflect payload to platform integration issues such as thermal, x-ray, and electrical issues. Examined the status of power conditioning subsystems to determine their applicability to an airborne experiment. Ensured understanding of air breakdown potentials given specific antenna interfaces. Continued refinement of solid state subsystem designs. Continued refinement of solid state pulsed power subsystem designs.				
(U)	In FY 2007: Further develop HPM source materials and assess applicability of solid state subsystem designs supporting ruggedized high power airborne and counter-improvised explosive device systems. Extend HPM system source code to reflect multiple options for high power subsystem components. Refine antenna concepts to meet airborne requirements for counter electronics including addressing issue related to propagation, air breakdown, and radomes. Mature relativistic magnetron technologies. Refine existing beam control/antenna concepts to meet airborne requirements including addressing issue related to propagation, breakdown, and radomes. Research, study and identify technology or data				

Exhibit R-2a, RDT&E Project Justification		DATE February 2007
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602605F DIRECTED ENERGY TECHNOLOGY	PROJECT NUMBER AND TITLE 4867 Advanced Weapons & Survivability Technology

(U) B. Accomplishments/Planned Program ($ in Millions)

		FY 2006	FY 2007	FY 2008	FY 2009
	(effects, safety, stabilization, engagement) requirements impacting overall airborne conceptual approach, including non-lethal. Refine millimeter wave diagnostic techniques.				
(U)	In FY 2008: Continue development of HPM source materials and assess applicability of solid state subsystem designs supporting ruggedized high power airborne and counter-improvised explosive device systems. Analyze the results from the HPM system source code that reflects multiple options for high power subsystem components. Continue to refine antenna concepts to meet airborne requirements for counter electronics and counter-improvised explosive device systems including addressing issues related to propagation, breakdown, and radomes. Continue development of full power non-lethal test source and technology studies for conceptual approach. Complete millimeter wave diagnostic techniques.				
(U)	In FY 2009: Implement maturing HPM source materials and assess the applicability of solid state subsystem designs supporting ruggedized high power airborne and counter-improvised explosive device systems. Implement the enhanced options for high power subsystem components based on the results of the HPM system source code. Implement the antenna design that best meets airborne requirements for counter electronics and counter-improvised explosive device systems including addressing issues related to propagation, breakdown, and radomes. Complete development of full power non-lethal test source. Continue non-lethal beam control/antenna work and technology studies for conceptual approach.				
(U)	Total Cost	14.492	15.424	16.396	16.261

(U) C. Other Program Funding Summary ($ in Millions)

	FY 2006 Actual	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total Cost
(U) Related Activities:										
(U) PE 0602202F, Human Systems Technology.										
(U) PE 0603605F, Advanced Weapons Technology.										
(U) This project has been coordinated through the Reliance 21 process to harmonize efforts and eliminate duplication.										

Exhibit R-2a, RDT&E Project Justification		DATE February 2007
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602605F DIRECTED ENERGY TECHNOLOGY	PROJECT NUMBER AND TITLE 4867 Advanced Weapons & Survivability Technology

(U) **D. Acquisition Strategy**

Not Applicable.

Exhibit R-2a, RDT&E Project Justification			DATE: February 2007
BUDGET ACTIVITY: 02 Applied Research	PE NUMBER AND TITLE: 0602605F DIRECTED ENERGY TECHNOLOGY	PROJECT NUMBER AND TITLE: 55SP Laser and Imaging Space Tech	

Cost ($ in Millions)	FY 2006 Actual	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
55SP Laser and Imaging Space Tech	0.000	9.471	4.903	5.147	5.744	5.477	5.430	5.545	0.000	0.000
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

Note: In FY 2007, efforts will transfer from PE 0602500F, Multidisciplinary Advanced Development Space Technology, Project 5023, Laser and Imaging Space Tech, to this project in order to more effectively manage and provide oversight of the efforts. Also in FY 2008, relay mirror technology efforts previously will transfer from this project to Project 4866, Lasers and Imaging Technology, to this project to more effectively manage the efforts.

(U) A. Mission Description and Budget Item Justification

Develop advanced, long-range, optical technologies such as advanced beam control; beam acquisition, tracking, and pointing; adaptive optics; dual line-of-sight pointing; large, lightweight optics; and optical coatings that support future space-object imaging systems. Assess the vulnerability of satellites to the effects of high-energy laser weapons and update catalogued satellites.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2006	FY 2007	FY 2008	FY 2009
	0.000	7.613	2.692	2.824

(U) MAJOR THRUST: Develop advanced, long-range, optical technologies such as advanced beam control; beam acquisition, tracking, and pointing; adaptive optics; dual line-of-sight pointing; large, lightweight optics; and optical coatings that support future space-object imaging systems. Note: In FY 2008, relay mirror technology efforts previously performed in this major thrust will be moved to Project 4866, Lasers and Imaging Technology, within this PE to more effectively manage the efforts.

(U) In FY 2006: Not Applicable.

(U) In FY 2007: Begin investigations in support of a high-power demonstration to kill a missile through a relay mirror. Complete development of first generation advanced wavefront control device for imaging and beam projection. Continue investigation of advanced adaptive optics techniques for uplink beam control. Investigate designs for tactical relay mirrors for propagation of laser energy through turbulence. Begin procurement of long lead optical components to include transmitting and receiving beam director telescopes for integration into a breadboard relay mirror payload. Perform phased array imaging experiment in the presence of atmospheric disturbances without the aid of a retro-reflector. Perform orbit angular validation momentum experiment and establish a research approach to advance a concept for secure high bandwidth communications. Conclude the development of lightweight mirrors.

(U) In FY 2008: Understand the bandwidth, movement, and resolution limits of various adaptive optics concepts, correlate the attributes to user needs to include aero-optic compensation, and demonstrate a selected concept in a system level experiment. Complete a low power phased array transceiver experiment that includes simultaneous imaging and beam projection with wide field of regard beam steering elements. Select a particular approach to enable orbital angular momentum communication and

Exhibit R-2a, RDT&E Project Justification		DATE February 2007
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602605F DIRECTED ENERGY TECHNOLOGY	PROJECT NUMBER AND TITLE 55SP Laser and Imaging Space Tech

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2006	FY 2007	FY 2008	FY 2009
began experimental validation with continued modeling and theoretical investigation.				
(U) In FY 2009: Develop advanced adaptive optic components and evaluate system implementation of those components. Continue to work on the orbital angular momentum communication research.				
(U)				
(U) MAJOR THRUST: Assess the vulnerability of satellites to the effects of high-energy laser weapons and update catalogued satellites.	0.000	1.858	2.211	2.323
(U) In FY 2006: Not Applicable.				
(U) In FY 2007: Develop and apply new, improved algorithms and hardware for satellite characterization and vulnerability assessment. Continue to update assessment methodology by incorporating new data, including results of laser illumination, tracking, and compensated imaging, techniques. Assess the survivability and vulnerability of aerospace systems to the effects of directed energy weapons. Update response databases for continued improvement of predictive avoidance analyses and continue to provide data to U.S. Strategic Command for the performance of Laser Clearinghouse functions. Continue to expand knowledge of space material properties and aging effects. Continue to improve and mature capabilities to rapidly fuse sensor data to ascertain the health and status of aerospace systems.				
(U) In FY 2008: Explore new methods to develop and apply improved algorithms and hardware for satellite characterization and assessment. Continue to refine assessment methodology by incorporating new data into modeling tools, including results of laser illumination, tracking, and compensated imaging; and applying new techniques. Assess the survivability and vulnerability of evolving aerospace systems to the effects of directed energy weapons. Integrate developed space material properties and aging effects data and algorithms into assessments. Continue to improve and mature capabilities to rapidly fuse existing sensor data to assess the operational health and status of aerospace systems while working to begin transition of these capabilities to U.S. Strategic Command and other users.				
(U) In FY 2009: Expand analysis capabilities to provide assessments of effects on aerospace systems from new and emerging directed energy concepts. Continue to refine and broaden assessment methodologies by incorporating new experimental data from laser illumination, tracking, and compensated imaging; results of space materials properties and aging analysis; and enhanced numerical techniques. Continue to assess the survivability and vulnerability of evolving aerospace systems to the effects of directed energy weapons. Continue to advance the capabilities to rapidly fuse sensor data to assess the operational health and status of aerospace systems and continue to transition the matured capabilities to operational users.				

Exhibit R-2a, RDT&E Project Justification		DATE February 2007
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602605F DIRECTED ENERGY TECHNOLOGY	PROJECT NUMBER AND TITLE 55SP Laser and Imaging Space Tech

(U) B. Accomplishments/Planned Program ($ in Millions)

	FY 2006	FY 2007	FY 2008	FY 2009
(U) Total Cost	0.000	9.471	4.903	5.147

(U) C. Other Program Funding Summary ($ in Millions)

	FY 2006 Actual	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total Cost
(U) Related Activities:										
(U) PE 0602500F, Multi-Disciplinary Space Tech.										
(U) PE 0603444F, Maui Space Surveillance Systems.										
(U) PE 0603500F, Multi-Disciplinary Adv Dev Space Technology.										
(U) PE 0603605F, Advanced Weapons Technology.										

(U) This project has been coordinated through the Reliance 21 process to harmonize the efforts and eliminate duplication.

(U) D. Acquisition Strategy

Not Applicable.