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

DATE: June 2001

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602605F DIRECTED ENERGY TECHNOLOGY

	COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
	Total Program Element (PE) Cost	0	32,041	36,678	37,827	36,773	37,266	38,186	39,126	Continuing	TBD
4866	Lasers & Imaging Technology	0	15,871	20,118	21,823	21,614	21,610	22,150	22,699	Continuing	TBD
4867	Advanced Weapons & Survivability Technology	0	16,170	16,560	16,004	15,159	15,656	16,036	16,427	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0	0	0

Note: Starting in FY 2001, the two projects in this PE were moved from PE 0602601F. FY 2003 - FY 2007 budget numbers do not reflect the DoD strategy review results.

(U) A. Mission Description

This PE 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), associated optical components and techniques, and long-range optical imaging concepts. In advanced weapons, this PE examines technologies such as narrow and wideband high power microwave devices and antennas. Both areas also provide vulnerability/lethality assessments of representative systems.

(U) B. Budget Activity Justification

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) C. Program Change Summary ($ in Thousands)

		FY 2000	FY 2001	FY 2002	Total Cost
(U)	Previous President's Budget (FY 2001 PBR)	0	32,337	32,017	
(U)	Appropriated Value	0	32,337		
(U)	Adjustments to Appropriated Value				
	a. Congressional/General Reductions				
	b. Small Business Innovative Research				
	c. Omnibus or Other Above Threshold Reprogram				
	d. Below Threshold Reprogram				
	e. Rescissions		-296		

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE June 2001
BUDGET ACTIVITY 02 - Applied Research	PE NUMBER AND TITLE 0602605F DIRECTED ENERGY TECHNOLOGY

(U) C. Program Change Summary ($ in Thousands) Continued

		FY 2000	FY 2001	FY 2002	Total Cost
(U)	Adjustments to Budget Years Since FY 2001 PBR			4,661	
(U)	Current Budget Submit/FY 2002 PBR	0	32,041	36,678	TBD

(U) Significant Program Changes:
Not Applicable.

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

DATE: June 2001

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602605F DIRECTED ENERGY TECHNOLOGY

PROJECT: 4866

COST ($ in Thousands)		FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
4866	Lasers & Imaging Technology	0	15,871	20,118	21,823	21,614	21,610	22,150	22,699	Continuing	TBD

(U) A. Mission Description

This project examines the technical feasibility of moderate to high power lasers, associated optical components, and long-range optical imaging concepts required for Air Force missions. High power solid state and chemical laser devices, optical components, advanced beam control and atmospheric compensation technologies, laser target vulnerability assessment techniques, and nonlinear optical processes and techniques are developed. Advanced, short-wavelength laser devices for applications such as illuminators and imaging sources for target identification and assessment are developed. Laser technologies are studied for their utility in aimpoint selection, target maintenance, and damage assessment.

(U) FY 2000 ($ in Thousands)

(U) $0 This work was performed in PE 0602601F/Project 3326. The funding was $17.279 million.

(U) $0 Total

(U) FY 2001 ($ in Thousands)

(U) $2,091 Develop long-range optical technologies for increased resolution, characterization, and data fusion applications. Explore lightweight membrane mirror issues for scaling to very large size (~ 10-meter mirrors). Address issues associated with producing the mirror close to final curvature and demonstrate on 0.5 meter class mirror with holographic correction.

(U) $724 Develop and field test nonlinear optics technologies to support beam projection and imaging applications associated with large aperture lightweight optics. The nonlinear optics components that provide optical compensation for beam projection and imaging technology will be scaled up in size and integrated into laboratory/field tests and demonstrations. Additional improvements and techniques to extend the wavelength regime and reduce the number of such components will be pursued.

(U) $4,855 Develop high power chemical and all gas iodine laser technologies for applications such as directed energy weapons, illuminators, and wavelength specific applications. Perform engineering validation of advanced chemical oxygen iodine laser nozzle concepts which include iodine atom production techniques and integrated ejector nozzle concepts. Demonstrate a one-kilowatt all gas phase supersonic iodine laser. Perform validation testing of advanced nozzle concepts for potential application to airborne lasers.

(U) $2,684 Develop laser source, beam control, and target coupling technologies to counter current and next generation air-to-air and surface-to-air missile threats to aircraft platforms. Develop an electrically pumped mid-infrared solid state laser operating at room temperature, eliminating the optical pump source and cryogenic cooler for mid-infrared lasers. Investigate novel materials effects associated with plasma/spark and ultra-fast lasers for countering focal plane array seekers. Obtain a high fidelity surrogate seeker for laboratory testing of effects. Develop a moderate power

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE June 2001
BUDGET ACTIVITY 02 - Applied Research	PE NUMBER AND TITLE 0602605F DIRECTED ENERGY TECHNOLOGY
PROJECT 4866	

(U) A. Mission Description Continued

(U) FY 2001 ($ in Thousands) Continued

ultra-fast laser source for investigations of novel atmospheric propagation characteristics.

(U) $5,517 Develop low-cost, scalable, high power solid state laser architectures by integrating doped fiber lasers with diode-laser pump sources for directed energy applications such as unmanned aerial vehicle designators/imagers and next generation weapons applications such as space-based lasers and airborne lasers. Develop promising fiber laser technologies exhibiting attributes that will enable applications that require laser mobility such as low-cost, high efficiency (approaching 30%), compactness (30 milliwatts per cubic centimeter), and scalability. Develop integration technologies necessary for demonstration of power at one kilowatt.

(U) $15,871 Total

(U) FY 2002 ($ in Thousands)

(U) $2,036 Develop and field test advanced optics technologies to support beam projection and imaging applications associated with large aperture lightweight optics. Develop new integrated component nonlinear optics /liquid crystal devices for faster corrections, increased resolution, and larger apertures. Test and characterize these devices in a laboratory environment. Emphasize extending the wavelength coverage and decreasing number of system components. Decreasing the number of system components and extending the wavelength coverage have major applications to space-based optical systems. Produce one-meter class membrane mirror with near final curvature and demonstrate holographic correction of the mirror surface.

(U) $5,667 Develop high power chemical laser technologies for applications such as directed energy weapons, illuminators, and wavelength specific applications. Optimize high pressure ejector nozzle performance and iodine atom generation for potential long-range technology insertion into applications such as airborne lasers. Demonstrate a 500-watt microwave-driven supersonic all gas-phase iodine laser. Begin construction of a combustor-driven one kilowatt supersonic all gas-phase iodine laser. Optimize efficiency of the radio frequency-pumped overtone carbon monoxide laser in various spectral bands of interest for infrared countermeasures and remote sensing applications.

(U) $3,811 Develop laser source, beam control, and target coupling technologies to counter current and next generation air-to-air and surface-to-air missile threats to aircraft platforms. Demonstrate multifunctional laser countermeasure components capable of detecting, tracking, and defeating advanced anti-aircraft missiles. Test a full-up integrated countermeasures concept utilizing static pointer/tracker optics and the new surrogate missile seeker obtained in FY 2001. Demonstrate a pulsed/ultrafast laser source capable of countering focal plane array missile seekers.

(U) $6,090 Develop low-cost, scalable, high power solid state laser architectures for directed energy applications such as unmanned aerial vehicle designators/imagers and next generation weapons applications such as space-based lasers and airborne lasers. Develop promising fiber laser technologies exhibiting attributes that will enable applications that require laser mobility such as low-cost, high efficiency (approaching 35%), compactness (goal greater than one kilowatt per cubic foot), and scalability. Develop integration technologies necessary for combining multiple

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE June 2001
BUDGET ACTIVITY 02 - Applied Research	PE NUMBER AND TITLE 0602605F DIRECTED ENERGY TECHNOLOGY
PROJECT 4866	

(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands) Continued

fiber laser modules including nonlinear optical phasing technologies.

(U) $528 Develop advanced laser remote optical sensing technology to support standoff detection requirements for chemical/biological agent aerosols for measurement and signature intelligence, bomb damage assessment, target characterization, and theater intelligence, surveillance, and reconnaissance. Complete Phase II experiments for frequency agile heterodyne receiver development.

(U) $1,986 Assess the vulnerability of six satellites (U.S., NATO, and foreign) to the effects of directed energy weapons, primarily high energy lasers. Update previously completed assessments on catalogued satellites. Fuse finite state models with other satellite data and observables to produce a more complete space situational awareness posture.

(U) $20,118 Total

(U) B. Project Change Summary

Not Applicable.

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

(U) Related Activities:

(U) PE 0603319F, Airborne Laser Demonstrator.

(U) PE 0603444F, Maui Space Surveillance System.

(U) PE 0603605F, Advanced Weapons Technology.

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

(U) D. Acquisition Strategy

Not Applicable.

(U) E. Schedule Profile

(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE: June 2001
BUDGET ACTIVITY: 02 - Applied Research	PE NUMBER AND TITLE: 0602605F DIRECTED ENERGY TECHNOLOGY — PROJECT: 4867

COST ($ in Thousands)		FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
4867	Advanced Weapons & Survivability Technology	0	16,170	16,560	16,004	15,159	15,656	16,036	16,427	Continuing	TBD

(U) A. Mission Description

High power microwave (HPM) and other unconventional weapon concepts using innovative technologies are explored in this project. Technologies that support a wide range of Air Force missions such as suppression of enemy air defenses, command and control warfare, and aircraft self-protection are developed. This project 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) FY 2000 ($ in Thousands)

(U) $0 This work was performed in PE 0602601F/Project 625797. The funding was $18.110 million.

(U) $0 Total

(U) FY 2001 ($ in Thousands)

(U) $3,046 Investigate and develop technologies for multi-pulsed narrowband and wideband HPM components to support multiple Air Force applications as recommended by the Phase II Directed Energy Applications in Tactical Airborne Combat (DE ATAC) study. Continue investigation of better source modeling techniques in order to incorporate HPM technologies into warfighting/war gaming activities. Investigate high efficiency repetitively-pulsed HPM source. Develop frequency agile HPM source. Develop compact repetitively operated sources. Start pulsed atmospheric breakdown experiments. Start explosive generator development experiments to support compact single-shot HPM sources.

(U) $1,846 Assess effects/lethality of HPM weapon technologies against representative air and ground military systems. Continue to conduct susceptibility tests of representative command and control warfare targets. Investigate effects on targets of HPM sources pulsed at high repetition rates.

(U) $1,982 Investigate and develop wideband HPM technologies that support command and control warfare and other wideband applications. Research advanced antenna designs driven by mission concepts. Continue applied research to improve wideband HPM sources in order to achieve greater range or smaller packaging. Continue advancement of computer codes' ability to predict the electromagnetic coupling to target equipment and probability of effect inside increasingly complex structures. Expand HPM effects prediction models for implementation into engagement scenario models. Research methods to enhance HPM source technology such as power throughput for solid state switches and high repetition rates for high pressure gas switches.

(U) $2,873 Develop narrowband HPM technologies that support suppression of enemy air defenses through the use of reusable airborne platforms and munitions. Continue to expand range of predictability of HPM narrowband effects models for military electronic targets of interest. Continue validation of predictability of models. Continue investigation of pulsed power and HPM source capability to support an integrated experiment to

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE June 2001
BUDGET ACTIVITY 02 - Applied Research	PE NUMBER AND TITLE 0602605F DIRECTED ENERGY TECHNOLOGY
PROJECT 4867	

(U) A. Mission Description Continued

(U) FY 2001 ($ in Thousands) Continued

show proof-of-principle capability for single shot technologies. Complete design of subscale (laboratory) breadboard high power microwave (HPM) system to validate approach and capability for repetitively pulsed technologies for HPM munitions and airborne electronic attack. Continue development of component technologies – pulsed power, sources, and antennas – for repetitively pulsed airborne and munitions systems.

(U) $3,691 Investigate HPM technologies that support offensive and defensive advanced airborne tactical applications, to include airborne and munitions platforms, made possible based on increased power available on future aircraft. Design and fabricate optimal sources for the most promising concepts identified by the FY 2000 trade off study. Perform effects experiments upon targets of interest to determine effectual lethality of each concept. Develop HPM aircraft self-protect effects database of commercial-off-the-shelf sources, missile targets, and aircraft platforms.

(U) $1,933 Assess the vulnerability of seven satellites (U.S., NATO, and foreign) to the effects of directed energy weapons, primarily high energy lasers. Update previously completed assessments on catalogued satellites. Support Space Situational Awareness by developing finite state models to predict satellite performance from observed behavior. Compile assessment data and models into easily accessible folders for satellite characterization.

(U) $799 Investigate the best means for active denial technologies to support agile combat support applications. Continue development of millimeter wave sources for active denial technology and conduct experiments including beam transport and power extraction. Investigate HPM source enhancement technologies using computer simulations.

(U) $16,170 Total

(U) FY 2002 ($ in Thousands)

(U) $3,262 Investigate and develop technologies for multi-pulsed narrowband and wideband HPM components to support multiple Air Force applications as recommended by the Phase II Directed Energy Applications in Tactical Airborne Combat (DE ATAC) study. Continue developing better HPM source modeling techniques to incorporate HPM technologies into warfighting/war gaming activities. Design high efficiency repetitively pulsed HPM source. Conduct laboratory test of frequency agile HPM source. Continue development of compact repetitively operated sources. Continue pulsed atmospheric breakdown experiments. Continue explosive generator development experiments to support compact single-shot HPM sources.

(U) $2,560 Assess effects/lethality of HPM weapon technologies against representative air and ground military systems. Continue to conduct susceptibility tests of representative command and control warfare targets. Conduct susceptibility tests of high, repetitively pulsed effects on targets. Implement effects data and results into narrowband and wideband HPM experiments and demonstrations.

(U) $1,029 Investigate and develop wideband HPM core technologies that support wideband applications. Continue to improve the electrical efficiency of

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE: June 2001
BUDGET ACTIVITY: 02 - Applied Research	PE NUMBER AND TITLE: 0602605F DIRECTED ENERGY TECHNOLOGY	PROJECT: 4867

(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands) Continued

high power microwave (HPM) sources in order to achieve greater range, longer lifetime, or smaller packaging. Continue validation of computer codes' ability to predict the wideband electromagnetic coupling to increasingly complex structures.

(U) $3,485 Develop narrowband HPM technologies that support suppression of enemy air defenses through the use of reusable airborne platforms and munitions. Continue to expand range of predictability of HPM narrowband effects models to damage or disrupt military electronic targets of interest. Continue validation of predictability of models. Integrate pulsed power and HPM source to show capability for single shot technologies. Select a repetitively pulsed multi-gigawatt technology for HPM breadboard munitions and airborne electronic attack proof-of-concept. Continue development of component technologies – pulsed power, sources, and antennas – for repetitively pulsed airborne and munitions systems.

(U) $4,417 Investigate HPM technologies that support offensive and defensive advanced airborne tactical applications, to include airborne and munitions platforms, made possible based on increased power available on future aircraft. Fabricate and test optimal sources for the most promising concepts identified by the tradeoff study to include an HPM repetitively pulsed source on an unmanned combat air vehicle platform. Continue to perform effects experiments upon targets of interest to determine effectual lethality of each concept. Continue development of HPM aircraft protect effects database and characterize commercial-off-the-shelf sources, missile targets, and aircraft platforms.

(U) $1,807 Investigate the best means for active denial technologies to support agile combat support applications. Continue development of millimeter wave sources for active denial technology, including airborne active denial technologies -- conduct experiments including power combining, depressed collector, and modulation schemes. Begin development of components other than the millimeter wave source such as the prime power, power conditioning, and antenna required to enable a man-portable system. Investigate HPM source enhancement technologies using computer simulations.

(U) $16,560 Total

(U) B. Project Change Summary

Not Applicable.

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

(U) Related Activities:

(U) PE 0602202F, Human Systems Technology.

(U) PE 0603605F, Advanced Weapons Technology.

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

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE June 2001
BUDGET ACTIVITY: 02 - Applied Research	PE NUMBER AND TITLE: 0602605F DIRECTED ENERGY TECHNOLOGY / PROJECT: 4867

(U) D. Acquisition Strategy

Not Applicable.

(U) E. Schedule Profile

(U) Not Applicable.