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

DATE: February 1999

BUDGET ACTIVITY: 3 - Advanced Technology Development

PE NUMBER AND TITLE: 0603605F Advanced Weapons Technology

	COST *($ In Thousands)*	FY 1998 Actual	FY 1999 Estimate	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
	Total Program Element (PE) Cost	51,753	53,317	38,995	34,225	38,911	41,763	47,703	50,995	Continuing	Continuing
3150	Advanced Optics Technology	16,976	14,769	925	1,175	1,296	1,352	4,895	5,776	Continuing	Continuing
3151	High Power Semiconductor Laser Technology	5,556	9,783	10,975	4,907	9,597	10,418	12,855	13,540	Continuing	Continuing
3152	High Power Microwave Technology	6,601	7,327	7,581	8,916	9,561	10,020	8,770	8,953	Continuing	Continuing
3647	High Energy Laser Technology	22,620	21,438	19,514	19,227	18,457	19,973	21,183	22,726	Continuing	Continuing
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0	0	0

(U) A. Mission Description: This Advanced Technology Development program demonstrates advanced directed energy and optical imaging concepts. Speed-of-light weapons and long-range, high resolution optical imaging through the turbulent atmosphere offer significant payoffs for many Air Force missions, such as theater missile defense, suppression of enemy air defenses, and control of space. This program has already demonstrated many major technological breakthroughs such as removing significant atmospheric distortions from optical transmissions (e.g., laser beams) and producing small, relatively high power laser diode phased arrays. Major emphasis areas include: high power microwave and high energy laser technologies; long-range optical imaging; and high power laser diodes and diode arrays. Because of the unique effects associated with high power microwaves there are many potential applications ranging from low power disruptions to high power destruction of electronic devices. Thus, a wide range of high power microwave technologies are being developed. Within high energy lasers the emphasis is on developing methods to increase the power on target. This is done by continuing to remove more of the atmospheric degradations and to develop more efficient laser devices. Long-range optical imaging offers high resolution images of space objects from the ground for applications such as satellite status assessments. High power diodes offer great potential for very small optical sources at many wavelengths for applications such as infrared illuminators and infrared countermeasure sources as well as high data rate secure communications. This PE will continue to develop a wide range of directed energy technologies for many DoD applications. Note: Congress added $10 million for space laser imaging and $6 million for Field Laser Demonstrator upgrades in FY 1998 and $6 million for Field Laser Radar upgrades plus $7.5 million for Geo Space Object Imaging in FY 1999 which explains the perceived decrease in FYs 2000 and out.

(U) B. Budget Activity Justification: This program is in Budget Activity 3, Advanced Technology Development, since it develops and demonstrates technologies for existing system upgrades and/or new system developments that have military utility and address warfighter needs.

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

	FY 1998	FY 1999	FY 2000	FY 2001	Total Cost
(U) Previous President's Budget/FY 1999 PB	50,832	40,153	40,138	39,975	Cont
(U) Appropriated Value	55,238	53,653			
(U) Adjustments to Appropriated Value					
a. Congressional/General Reductions	-3,629	-336			
b. SBIR	-454				
c. Omnibus/Other Above Threshold Reprogrammings	-343				
d. Below Threshold Reprogrammings	941				
(U) Adjustments to Budget Year Since FY 1999 PB			-1,143	-5,750	
(U) Current Budget Submit/FY 2000 PB	51,753	53,317	38,995	34,225	Cont

(U) Significant Program Changes: Changes to this program since the previous President's Budget are due to higher priorities within the Science and Technology (S&T) Program.

FY 1999: $1,654 identified as a source for SBIR.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 1999
BUDGET ACTIVITY 3 - Advanced Technology Development	PE NUMBER AND TITLE 0603605F Advanced Weapons Technology PROJECT 3150

COST *($ In Thousands)*	FY 1998 Actual	FY 1999 Estimate	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
3150 Advanced Optics Technology	16,976	14,769	925	1,175	1,296	1,352	4,895	5,776	Continuing	Continuing

(U) A. Mission Description: This project develops advanced optical technologies for locating, identifying, and analyzing distant and/or dim objects. This work supports high energy laser technologies because an imaging subsystem is required for target verification, accurate and sustainable laser beam placement on target, and near-real-time damage assessment. Several advanced technologies including nonlinear optics, adaptive optics, and specialized signal processing are being developed. The goal is high quality optical image reconstruction, concentrating on removing turbulent atmosphere-induced distortions. Many of the technologies developed/being developed have significant application to astronomy research.

(U) FY 1998 ($ in Thousands):

- (U) $829 Developed and demonstrated advanced, very long-range optical imaging technologies which increase resolution and data fusion to support missions such as space object identification and ground target identification from space.
- (U) $637 Developed nonlinear optics technologies for non-mechanical corrections in optical imaging.
- (U) $356 Developed and demonstrated signature technology for identifying and assessing health and status of satellites out to geosynchronous orbit.
- (U) $9,441 Developed technologies for active imaging of geosynchronous space objects.
- (U) $5,713 Upgraded the Field Laser Demonstrator for increased sensitivity to obtain very accurate data on space object and techniques for remote sensing of the atmosphere.
- (U) $16,976 Total

(U) FY 1999 ($ in Thousands):

- (U) $721 Develop and demonstrate advanced technologies which increase resolution and data fusion for very long-range optical imaging to support missions such as space object identification and ground target identification from space.
- (U) $548 Develop nonlinear optics technologies for non-mechanical corrections in optical imaging.
- (U) $101 Develop and demonstrate signature technology for identifying and assessing health and status of satellites out to geosynchronous orbit.
- (U) $7,196 Develop technologies for active imaging of geosynchronous space objects.
- (U) $5,756 Upgrade the Field Laser Demonstrator for increased sensitivity to obtain very accurate data on space object and techniques for remote sensing of the atmosphere.
- (U) $447 Identified as a source for SBIR.
- (U) $14,769 Total

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	PROJECT 3150

(U) FY 2000 ($ in Thousands):

– (U)	$330	Develop nonlinear optics technologies for non-mechanical corrections to optical imaging and beam projections.
– (U)	$50	Investigate advanced concepts to deploy and use very large optical mirrors in orbit for applications that support missions such as imaging and laser projection.
– (U)	$545	Investigate novel signature techniques for assessing the operational status of satellites out to geosynchronous orbit.
– (U)	$925	Total

(U) FY 2001 ($ in Thousands):

– (U)	$1,005	Develop nonlinear optics technologies for non-mechanical correction to beam projection and optical imaging.
– (U)	$85	Investigate concepts/technologies to allow projection through orbiting optical telescopes for applications such as imaging and laser beam projection.
– (U)	$85	Investigate novel signature techniques for assessing the operational status of satellites out to geosynchronous orbit.
– (U)	$1,175	Total

(U) B. Project Change Summary - Description of Significant Changes: Not Applicable

(U) C. Other Program Funding Summary:

(U) Related Activities:

- (U) PE 0305910F Spacetrack.
- (U) PE 0305160F, Defense Meteorological Satellite Program.
- (U) PE 0602102F, Materials.
- (U) PE 0602601F, Phillips Laboratory.
- (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: Not Applicable.

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

DATE: February 1999

BUDGET ACTIVITY: 3 - Advanced Technology Development

PE NUMBER AND TITLE: 0603605F Advanced Weapons Technology

PROJECT: 3151

COST *($ In Thousands)*	FY 1998 Actual	FY 1999 Estimate	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
3151 High Power Semiconductor Laser Technology	5,556	9,783	10,975	4,907	9,597	10,418	12,855	13,540	Continuing	Continuing

(U) A. Mission Description: This project continues to yield revolutionary breakthroughs in compact, robust, and affordable laser system technology for a wide range of military applications requiring small compact laser sources with low to moderate optical power. This is a long-term technology development project with both near-term and long-term goals. Near-term goals include developing compact, reliable infrared sources for a range of applications including night vision systems, landing zone markers, remote sensing, and covert communication systems. Longer-term goals focus on producing compact, significantly higher power sources for military applications including aircraft protection. This project leads the development of, and builds upon, a wide range of commercial advancements. Commercially available semiconductor lasers are widely used due to their low-cost, small size and weight, high reliability, and high efficiency in converting electricity to laser energy. This project preserves these attractive features while continually scaling output to higher powers/efficiencies and/or to military application-specific wavelengths. The project is divided into three technology areas. The first area investigates methods to increase output power from individual laser diodes while increasing power density onto a small spot. Secondly, semiconductor laser array integration methods, which produce a single, high quality laser beam at significantly higher power levels, are developed. Thirdly, wavelength-specific laser diodes for military applications are developed. Project scientists/managers also work directly with field users to develop proof-of-capability demonstrations and field tests for these revolutionary laser sources. This technology has many commercial applications, especially for eye-safe lasers.

(U) FY 1998 ($ in Thousands):

- (U) $1,157 Developed laser diodes for improved performance/higher power as sources in near-term applications such as infrared countermeasures, illumination, designation, and communication and for incorporation into laser diode array architectures.
- (U) $969 Developed coherent laser diode arrays for improved performance/higher power as sources in applications requiring power levels beyond those available from single diodes.
- (U) $1,674 Developed semiconductor diode lasers and optically-pumped semiconductor lasers to support current advanced infrared countermeasures system upgrades for tactical fixed and rotary-wing aircraft. Development focused on concepts with the potential for high efficiency, compact infrared laser sources covering Bands 2 and 4.
- (U) $1,756 Developed the basic laser source and target coupling technology needed to damage/destroy missile seeker components of next generation advanced imaging infrared-guided air-to-air and surface-to-air missiles.
- (U) $5,556 Total

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BUDGET ACTIVITY 3 - Advanced Technology Development	PE NUMBER AND TITLE 0603605F Advanced Weapons Technology
PROJECT 3151	

(U) FY 1999 ($ in Thousands):

- (U) $1,869 Develop laser diodes for improved performance/higher power as sources in near-term applications such as illumination, designation, and communication and for incorporation into laser diode array architectures.
- (U) $1,127 Develop scaleable laser arrays (fiber/diode) for improved performance in applications requiring high power levels and beam quality such as designating/tracking sources for the airborne laser and ground-based laser applications and as weapon sources for degrade and damage in aircraft self-protection applications.
- (U) $3,908 Develop semiconductor diode lasers and optically-pumped semiconductor lasers to support current advanced infrared countermeasures system upgrades to tactical fixed and rotary-winged aircraft. Development will focus on concepts with the potential for high efficiency, compact infrared laser sources covering Bands 2 and 4.
- (U) $2,576 Develop the basic laser source and target coupling technology needed to damage/destroy missile seeker components of next generation advanced imaging infrared-guided air-to-air and surface-to-air missiles.
- (U) $303 Identified as a source for SBIR.
- (U) $9,783 Total

(U) FY 2000 ($ in Thousands):

- (U) $895 Develop and demonstrate high brightness solid state/semiconductor lasers requiring unique properties such as wavelength agility or long coherence length for applications such as remote sensing/identification of chemicals or structures.
- (U) $1,533 Develop and demonstrate, scaleable, solid state laser arrays (fiber/diode) for improved performance in applications requiring high brightness (high power levels and improved beam quality), such as designation/tracking sources for airborne laser and ground-based laser applications and as weapon sources for tactical applications such as damage/destroy aircraft protection programs.
- (U) $4,174 Develop and demonstrate semiconductor diode lasers and optically-pumped semiconductor lasers to support advanced infrared countermeasures system upgrades to tactical fixed and rotary-winged aircraft. Development will focus on concepts with the potential for high efficiency, compact infrared laser sources covering Bands 2 and 4.
- (U) $4,373 Develop and demonstrate the laser source, beam control, and target coupling technology needed to damage/destroy next generation imaging advanced infrared-guided air-to-air and surface-to-air missiles.
- (U) $10,975 Total

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	PROJECT 3151

(U) FY 2001 ($ in Thousands):

- (U) $1,448 Develop and demonstrate high brightness solid state/semiconductor lasers requiring unique properties such as wavelength agility or long coherence length for applications such as remote sensing/identification of chemicals or structures.
- (U) $1,224 Develop and demonstrate, scaleable, solid state laser arrays (fiber/diode) for improved performance in applications requiring high brightness (high power levels and improved beam quality), such as designation/tracking sources for airborne laser and ground-based laser applications and as weapon sources for tactical applications such as damage/destroy aircraft protection programs.
- (U) $2,235 Develop and demonstrate semiconductor diode lasers and optically-pumped semiconductor lasers to support advanced infrared countermeasures (IRCM) system upgrades to tactical fixed and rotary-winged aircraft. Development will focus on concepts with the potential for high efficiency, compact infrared laser sources covering Bands 2 and 4.
- (U) $4,907 Total

(U) B. Project Change Summary - Description of Significant Changes: Not Applicable.

(U) C. Other Program Funding Summary:

(U) Related Activities:

- (U) PE 0602102F, Materials.
- (U) PE 0602204F, Aerospace Avionics.
- (U) PE 0603270F, Electronic Combat Technology.
- (U) PE 0602601F, Phillips Laboratory.
- (U) PE 0602234N, Systems Support Technology.
- (U) Representatives from Army, Navy, Ballistic Missile Defense Organization, National Laboratories, and Air Force using commands are members of the government review team for this technology.
- (U) Joint field demonstrations of this technology are ongoing with: the Air Force Pararescue School; the Air Force Special Operations Command; the U.S. Coast Guard; and the U.S. Customs Service.
- (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: Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE February 1999
BUDGET ACTIVITY 3 - Advanced Technology Development	PE NUMBER AND TITLE 0603605F Advanced Weapons Technology	PROJECT 3152

COST *($ In Thousands)*	FY 1998 Actual	FY 1999 Estimate	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
3152 High Power Microwave Technology	6,601	7,327	7,581	8,916	9,561	10,020	8,770	8,953	Continuing	Continuing

(U) A. Mission Description: This project develops high power microwave (HPM) generation technologies. It also develops a susceptibility/vulnerability/lethality data base to identify potential vulnerabilities of U.S. systems to HPM threats and to provide a basis for future offensive and defensive weapons system decisions. Representative U.S. and foreign assets will be tested to understand real system susceptibilities. Both wideband (wide frequency range) and narrowband (very small frequency range) technologies are being developed. The technologies developed in this project will demonstrate the applicability of high power microwaves that can damage/degrade/deny/ destroy electronic systems and subsystems for missions such as suppression of enemy air defense, command and control warfare, and aircraft self-protection.

(U) FY 1998 ($ in Thousands):
- (U) $2,811 Developed and demonstrated HPM suppression of enemy air defense technologies to render inoperative electronic components of an adversary's Integrated Air Defense System.
- (U) $2,216 Developed HPM technologies to support advanced tactical applications to defend large aircraft from attack by precision guided missiles of all types.
- (U) $1,143 Developed and demonstrated HPM technologies to render inoperative command and control warfare technologies.
- (U) $431 Developed and demonstrated nonlethal active denial technology.
- (U) $6,601 Total

(U) FY 1999 ($ in Thousands):
- (U) $3,081 Develop and demonstrate HPM suppression of enemy air defense technologies to render inoperative electronic components of an adversary's Integrated Air Defense System.
- (U) $2,357 Develop HPM technologies to support advanced tactical applications.
- (U) $1,172 Develop and demonstrate HPM technologies to render inoperative command and control warfare technologies.
- (U) $490 Develop and demonstrate nonlethal active denial technology.
- (U) $227 Identified as a source for SBIR.
- (U) $7,327 Total

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PROJECT 3152	

(U) FY 2000 ($ in Thousands):
- (U) $4,061 Develop and demonstrate high power microwave (HPM) technologies to render inoperative sample electronic components of an adversary's Integrated Air Defense System.
- (U) $2,932 Develop and demonstrate HPM technologies to render inoperative sample command and control components of an adversary.
- (U) $588 Develop and demonstrate nonlethal directed energy weapons and data for multiple mission applications including future peacekeeping assignments.
- (U) $7,581 Total

(U) FY 2001 ($ in Thousands):
- (U) $4,720 Develop and demonstrate HPM technologies to render inoperative electronic components of an adversary's Integrated Air Defense System.
- (U) $3,460 Develop and demonstrate HPM technologies to render inoperative command and control components of an adversary.
- (U) $736 Develop and demonstrate nonlethal directed energy weapons and data for multiple mission applications including future peacekeeping assignments.
- (U) $8,916 Total

(U) B. Project Change Summary - Description of Significant Changes: Not Applicable.

(U) C. Other Program Funding Summary:

(U) Related Activities:
- (U) PE 0602202F, Human Systems Technology.
- (U) PE 0602601F, Phillips Laboratory.
- (U) PE 0602120A, Electronic Survivability and Fuzing Technology.
- (U) PE 0602111N, Anti-Air Warfare, Anti-Surface Warfare 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: Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 1999
BUDGET ACTIVITY 3 - Advanced Technology Development	PE NUMBER AND TITLE 0603605F Advanced Weapons Technology PROJECT 3647

COST *($ In Thousands)*	FY 1998 Actual	FY 1999 Estimate	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
3647 High Energy Laser Technology	22,620	21,438	19,514	19,227	18,457	19,973	21,183	22,726	Continuing	Continuing

(U) A. Mission Description: This project provides for the development, demonstration, and detailed assessment of technology needed for high energy laser weapons. Near-term focus is on ground-based and airborne high energy laser missions, although the technology developed for this project is directly applicable to most high energy laser applications. Critical technologies demonstrated include: scaleable laser devices, with near-term emphasis on the Chemical Oxygen-Iodine Laser (COIL); optical components; and laser beam control to efficiently compensate and propagate laser radiation through the atmosphere to a target. Detailed computational models to establish high energy laser weapon effectiveness and satellite and missile vulnerability will be developed. Correcting the laser beam for distortions induced by propagation through the turbulent atmosphere is the key technology in most high energy laser applications. The beam control technology developed in this project has a significant benefit to the astronomy community.

(U) FY 1998 ($ in Thousands):

- (U) $2,516 Developed and demonstrated the technology for scaleable, high efficiency, high energy laser devices for potential weapon applications.
- (U) $1,645 Performed vulnerability assessments on potential high energy laser targets to provide critical data for designing laser systems which can defeat a range of targets and to provide critical data for designing systems protected against laser threats.
- (U) $881 Investigated and developed advanced, high energy laser optical components.
- (U) $9,632 Performed atmospheric compensation and laser beam control experiments from ground-based platforms to support applications ranging from weaponization to space object identification.
- (U) $7,946 Characterized atmospheric attenuation and distortion on laser beam propagation, conducted atmospheric compensation and beam control experiments, and developed an airborne ultra-precision inertial pointing brassboard to enhance boost phase theater ballistic missile tracking.
- (U) $22,620 Total

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PROJECT 3647	

(U) FY 1999 ($ in Thousands):

- (U) $2,185 Develop and demonstrate the technology for scaleable, high efficiency, high energy laser devices for potential weapon applications.
- (U) $1,693 Perform vulnerability assessments on potential high energy laser targets to provide critical data for designing laser systems which can defeat a range of targets and to provide critical data for designing systems protected against laser threats.
- (U) $746 Investigate and develop advanced, high energy laser optical components.
- (U) $10,388 Perform atmospheric compensation and laser beam control experiments from ground-based platforms to support applications ranging from weaponization to space object identification.
- (U) $5,749 Characterize atmospheric attenuation and distortion on laser beam propagation, conduct atmospheric compensation and beam control experiments, and develop an airborne ultra-precision inertial pointing brassboard to enhance boot phase theater ballistic missile tracking.
- (U) $677 Identified as a source for SBIR.
- (U) $21,438 Total

(U) FY 2000 ($ in Thousands):

- (U) $2,300 Develop and demonstrate the technology for scaleable, high efficiency, high energy laser devices for potential weapon applications.
- (U) $960 Perform vulnerability assessments on potential high energy laser targets to provide critical data for designing laser systems which can defeat a range of targets and to provide critical data for designing systems protected against laser threats.
- (U) $200 Investigate and develop advanced, high energy laser optical components for future weapon systems.
- (U) $9,014 Perform atmospheric compensation/beam control experiments from ground-based platforms to support applications ranging from weaponization to space object identification.
- (U) $7,040 Characterize atmospheric attenuation and distortion on laser beam propagation from airborne platforms, investigate and evaluate advanced concepts for atmospheric compensation and beam control in modeling and laboratory experiments, and conduct atmospheric compensation and beam control field tests to develop and demonstrate feasibility and performance in realistic environments for applications such as theater missile defense.
- (U) $19,514 Total

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PROJECT 3647	

(U) FY 2001 ($ in Thousands):

- (U) $2,101 Develop and demonstrate the technology for scaleable, high efficiency, high laser devices for potential weapon applications.
- (U) $702 Perform vulnerability assessments on potential high energy laser targets to provide critical data for designing laser systems which can defeat a range of targets and to provide critical data for designing systems protected against laser threats.
- (U) $202 Investigate and develop advanced, high energy laser optical components for future weapon systems.
- (U) $9,301 Perform atmospheric compensation/beam control experiments from ground-based platforms to support applications ranging from weaponization to space object identification.
- (U) $6,921 Characterize atmospheric attenuation and distortion on laser beam propagation from airborne platforms, investigate and evaluate advanced concepts for atmospheric compensation and beam control in modeling and laboratory experiments, and conduct atmospheric compensation and beam control field tests to develop and demonstrate feasibility and performance in realistic environments for applications such as theater missile defense.
- (U) $19,227 Total

B. Project Change Summary - Description of Significant Changes: Not Applicable.

(U) C. Other Program Funding Summary:

(U) Related Activities:

- (U) PE 0602601F, Phillips Laboratory.
- (U) PE 0603319F, Airborne Laser Demonstration.
- (U) PE 0305910F, Spacetrack.
- (U) PE 0603217C, Ballistic Missile Defense, Advanced Development (High Altitude Balloon Experiment).
- (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: Not Applicable.