

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 1997
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BUDGET ACTIVITY 2 - Applied Research	PE NUMBER AND TITLE 0602601F Phillips Laboratory Exploratory Development
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COST (\$ In Thousands)	FY 1996 Actual	FY 1997 Estimate	FY 1998 Estimate	FY 1999 Estimate	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	Cost to Complete	Total Cost
Total Program Element (PE) Cost	130,112	147,712	111,136	123,514	132,746	140,551	144,546	146,825	Continuing	Continuing
1010 Geophysics and Weather Technology	26,911	25,744	16,507	19,076	19,558	20,325	20,682	21,144	Continuing	Continuing
1011 Rocket Propulsion Technology	36,613	33,863	29,505	36,509	38,030	39,555	39,920	39,279	Continuing	Continuing
3326 Lasers and Imaging Technology	19,316	18,553	21,252	20,716	20,436	20,111	21,396	22,070	Continuing	Continuing
5797 Advanced Weapons and Survivability Technology	16,705	16,039	15,403	15,950	17,059	17,632	17,959	18,510	Continuing	Continuing
8809 Space and Missile Technology	30,567	53,513	28,469	31,263	37,663	42,928	44,589	45,822	Continuing	Continuing
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0	0	0

(U) A. Mission Description and Budget Item Justification This is the Applied Research program for the Phillips Laboratory. In geophysics, this PE develops technologies to understand, mitigate, and exploit effects of weather and geophysics environments on the design and operation of Air Force systems. This includes defining, modeling, and developing techniques to predict the phenomena of solar and space environments. In rocket propulsion, this PE develops technologies for boost and orbit transfer, satellite maneuvering, and tactical/ballistic missile rocket propulsion. In lasers, this PE examines the technical feasibility of moderate to high power lasers, associated optical components, and long-range optical imaging concepts required for Air Force missions. Technologies researched include high power laser devices, mid-infrared semiconductor laser devices, semiconductor diode laser arrays, optical components, advanced beam control and atmospheric compensation technologies, techniques for laser target vulnerability assessments, and nonlinear optics processes and techniques. Advanced weapons examines high power microwave and other unconventional weapon concepts using innovative technologies such as compact toroids. This also provides for vulnerability assessments of representative U.S. strategic and tactical systems to directed energy weapons, directed energy weapon technology assessment for specific Air Force missions, and directed energy weapon lethality assessments against foreign targets. In space and missiles, this PE develops the following technologies: spacecraft platform (e.g., structures, controls, power, and thermal management); space-based payload (e.g., sensors, satellite communications, and survivable electronics); satellite control (e.g., spacecraft software); ballistic missile/launch vehicle-specific (e.g., astrodynamics and guidance, navigation, and control avionics); and integrated experiments of advanced technologies for transition to planned systems (e.g., payload/platform/launch vehicle merging). Note: Congress added \$12.3 million in FY 1996 (Project 1010, \$5 million for the High-Frequency Active Auroral Research Program (HAARP), Project 1011, \$6 million for Integrated High Payoff Rocket Propulsion Technology (IHRPT), and Project 3326, \$1.3 million for the Advanced Electro-Optical Spectrograph) plus \$27.4 million in FY 1997 (Project 1010, \$7.5 million for HAARP, and Project 8809, \$10.1 million for MightySat and \$9.8 million for the Rocket System Launch Program) which explains the perceived decrease in FYs 1998 and 1999. Also, the emphasis on Geophysics and Weather Technology has been decreased, while additional emphasis has been placed on space and associated technologies.

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BUDGET ACTIVITY 2 - Applied Research			PE NUMBER AND TITLE 0602601F Phillips Laboratory Exploratory Development		
(U) B. <u>Program Change Summary (\$ in Thousands)</u>					
	<u>FY 1996</u>	<u>FY 1997</u>	<u>FY 1998</u>	<u>FY 1999</u>	<u>Total</u>
(U) Previous President's Budget	131,733	121,107	125,521	134,584	Cost
(U) Appropriated Value	136,746	153,507			Cont
(U) Adjustments to Appropriated Value		-3,736			
a. Congressional/General Reductions	-2,736	-1,916			
b. SBIR	-1,724	-143			
c. Omnibus/Other Above Threshold Reprogrammings	-2,174				
(U) Current Budget Submit/FY 1998 PB	130,112	147,712	111,136	123,514	Cont
 (U) Change Summary Explanation:					
Funding: Changes to this PE since the previous President's Budget are due to budget constraints and priorities within the Science and Technology (S&T) Program.					
Schedule: Not Applicable.					
Technical: Not Applicable.					
 (U) C. <u>Other Program Funding Summary</u> Not Applicable.					
 (U) D. <u>Schedule Profile</u> Not Applicable.					

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RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)								DATE February 1997		
BUDGET ACTIVITY 2 - Applied Research				PE NUMBER AND TITLE 0602601F Phillips Laboratory Exploratory Development				PROJECT 1010		
COST (\$ In Thousands)	FY 1996 Actual	FY 1997 Estimate	FY 1998 Estimate	FY 1999 Estimate	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	Cost to Complete	Total Cost
1010 Geophysics and Weather Technology	26,911	25,744	16,507	19,076	19,558	20,325	20,682	21,144	Continuing	Continuing
<p>(U) A. <u>Mission Description and Budget Item Justification</u> This project develops the technologies to understand, mitigate, and exploit the effects of the weather and geophysics environments on the design and operation of Air Force systems. This includes defining, modeling, and developing techniques to predict the phenomena of solar and space environments. Models are developed to specify and predict optical and infrared backgrounds and signatures of spacecraft and missiles, as well as techniques to predict when and where ionospheric disturbances will occur. Atmospheric drag effects on satellites are studied. Space debris is measured and modeled for its impact on spaceborne systems. New techniques for measuring, modeling, simulating, and predicting meteorological effects that impact the Air Force mission are researched. Additionally, seismic technology for nuclear test monitoring and test ban treaty verification is matured.</p> <p>(U) <u>FY 1996 (\$ in Thousands)</u></p> <ul style="list-style-type: none"> - (U) \$4,712 Develop space radiation specification and solar hazard prediction techniques for space system design and operations. <ul style="list-style-type: none"> - (U) Formulated and updated radiation belt models that are essential for Air Force and DOD space system designs and operations. - (U) Developed adaptive optical techniques for improved imaging of disruptive solar events. - (U) \$4,107 Develop atmospheric optical background simulations, models, and integrated codes for space system design and operation. <ul style="list-style-type: none"> - (U) Collected data from the mid-course space experiment for use in developing stellar, on-board calibration sources for advanced space-based surveillance and tracking systems. - (U) \$2,518 Develop active and passive remote sensing techniques for target signature identification and atmospheric wind profile measurements. <ul style="list-style-type: none"> - (U) Used the Flying Infrared Signatures Technology Aircraft (FISTA) to collect infrared signatures of the B-2, other aircraft, and missiles to validate existing operational target and scenes codes. - (U) Tested an airborne laser imaging, detection, and ranging demonstrator on the FISTA to increase the accuracy of target measurements by characterizing the optical path between the aircraft and the target. - (U) \$4,476 Develop global ionosphere models to improve communications and space system applications. <ul style="list-style-type: none"> - (U) Extended the Parameterized Real-Time Ionospheric Specification Model to 22,000 kilometers and transitioned it to operational use. - (U) \$1,926 Measure and model the effects of local plasmas on Air Force space systems. <ul style="list-style-type: none"> - (U) Measured degradation of radio frequency transmissions passing through plasmas generated around aerospace vehicles. - (U) \$410 Develop seismic event identification techniques for nuclear test ban treaty verification. <ul style="list-style-type: none"> - (U) Delivered a physical model for guided crustal waves for applications in the Eurasian and Middle East region. - (U) \$4,768 Evaluate the interaction between high power, high-frequency, ground transmitted radio waves and the ionosphere. 										
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BUDGET ACTIVITY 2 - Applied Research	PE NUMBER AND TITLE 0602601F Phillips Laboratory Exploratory Development	PROJECT 1010
	<ul style="list-style-type: none"> - (U) Conducted research to characterize the background ionosphere. 	
<ul style="list-style-type: none"> - (U) \$3,994 	<ul style="list-style-type: none"> Develop weather analysis, simulation, and prediction techniques for use in global and theater combat weather systems. - (U) Delivered an advanced-parameter, global cloud analysis model to Air Force Global Weather Central. - (U) Completed data fusion project to integrate disparate weather data from battlefields to enhance theater weather forecasting. 	
<ul style="list-style-type: none"> - (U) \$26,911 	<ul style="list-style-type: none"> Total 	
(U) FY 1997 (\$ in Thousands)		
<ul style="list-style-type: none"> - (U) \$4,305 	<ul style="list-style-type: none"> Develop space radiation specification and solar hazard prediction techniques for space system design and operations. - (U) Design the follow-on Compact Radiation Effects Satellite payload that will analyze potentially dangerous high energy particles in space. 	
<ul style="list-style-type: none"> - (U) \$3,251 	<ul style="list-style-type: none"> Develop atmospheric optical background simulations, models, and integrated codes for space system design and operation. - (U) Extend the wavelength coverage of the operational atmospheric backgrounds code into the ultraviolet and millimeter wavelength regions. 	
<ul style="list-style-type: none"> - (U) \$1,913 	<ul style="list-style-type: none"> Develop active and passive remote sensing techniques for target signature identification and atmospheric wind profile measurements. - (U) Use Flying Infrared Signatures Technology Aircraft measurements to expand and validate the spectral in-band radiance images of target and scene codes improving the warfighter's target discrimination capabilities. 	
<ul style="list-style-type: none"> - (U) \$4,459 	<ul style="list-style-type: none"> Develop global ionosphere models to improve communications and space system applications. - (U) Incorporate scintillation data into the operational wideband model to improve accuracy of communications disruption warnings. 	
<ul style="list-style-type: none"> - (U) \$7,500 	<ul style="list-style-type: none"> Evaluate the interaction between high power, high-frequency, ground transmitted radio waves and the ionosphere. - (U) Expand high frequency transmitter power from 360 kilowatts (kw) to 960kw to enhance experimental research capabilities. - (U) Conduct experimental research on the generation of Extremely Low Frequency/Very Low Frequency (ELF/VLF) waves in the ionosphere for potential communications and underground structure imaging applications. 	
<ul style="list-style-type: none"> - (U) \$4,316 	<ul style="list-style-type: none"> Develop global and theater weather analysis, simulation, and prediction techniques for combat weather system applications. - (U) Complete theater-scale analysis procedures for combat weather displays and theater weather forecast model initialization. 	
<ul style="list-style-type: none"> - (U) \$25,744 	<ul style="list-style-type: none"> Total 	

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BUDGET ACTIVITY 2 - Applied Research	PE NUMBER AND TITLE 0602601F Phillips Laboratory Exploratory Development	PROJECT 1010
<u>(U) FY 1998 (\$ in Thousands)</u>		
– (U) \$4,352	Develop space radiation specification and solar hazard prediction techniques for space system design and operations.	
	– (U) Transition quasi-dynamic radiation belt models to product center and industry for satellite design and orbit selection.	
	– (U) Complete initial report on the threat of space particles for counterspace activities.	
	– (U) Deliver solar proton prediction scheme to 50th Weather Squadron to warn of radio-blackouts over the polar caps.	
– (U) \$3,193	Develop background clutter mitigation techniques for space system design and operation.	
	– (U) Transition Mid-course Space Experiment and Miniature Seeker Technology Integration (MSTI-3) satellite data to atmospheric spatial structure background codes to develop enhanced target-background discrimination algorithms.	
– (U) \$1,385	Develop active and passive remote sensing techniques for atmospheric parameter measurements.	
	– (U) Use advanced modeling and simulation technologies to provide real-time target and background scene generation capability for training and hardware-in-the-loop simulations	
	– (U) Develop compact solid state wind sensing lidar for ballistic wind applications (e.g., cargo drops and B-52 bomb drops).	
	– (U) Evaluate lidar designs for remote sensing of atmospheric optical and wind turbulence for aircraft safety and surveillance systems.	
– (U) \$3,958	Develop global ionosphere models to improve communications and space system applications.	
	– (U) Deliver Coupled Ionospheric Scintillation Model to Air Weather Service for support to Air Force communications systems.	
	– (U) Transition Global Ionospheric Forecast Model to user in support of Command, Control, Communication, and Intelligence (C3I), Spacetrack, and surveillance systems.	
– (U) \$3,619	Develop global and theater weather analysis, simulation, and prediction techniques for combat weather system applications.	
	– (U) Complete validation of satellite data unified retrieval method to support theater weather forecast models.	
	– (U) Incorporate satellite-based cloud module into simulation procedures for system design and testing.	
	– (U) Develop method to incorporate radar and lidar weather data into combat weather support forecast modules	
– (U) \$16,507	Total	

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BUDGET ACTIVITY 2 - Applied Research	PE NUMBER AND TITLE 0602601F Phillips Laboratory Exploratory Development	
PROJECT 1010		
(U) <u>FY 1999 (\$ in Thousands)</u>		
– (U) \$4,460	Continue the development of space radiation specification and solar hazard prediction techniques for space system design and operations.	
	– (U) Develop coronal mass ejection model needed by 50th Weather Squadron (50WS) to provide three to seven day warning of geomagnetic disturbances that cause false launch indicators, satellite tracking errors, and communications disruptions.	
	– (U) Upgrade Phillips Lab’s Integrated Space Environment Model and deliver to 50WS for use in space weather hazard alerts.	
	– (U) Deliver magnetospheric substorm model to 50WS for use in predicting satellite surface charging and Command, Control, Communication, and Intelligence (C3I) disruptions.	
– (U) \$3,217	Continue the development of background clutter mitigation techniques for space system design and operation.	
	– (U) Develop improved optical and infrared background models that support advanced sensor imaging techniques for detection and tracking of dim targets, such as cruise missiles.	
– (U) \$1,625	Continue the development of active and passive remote sensing techniques for atmospheric parameter measurements and simulation of battlefield environments.	
	– (U) Demonstrate and validate design concepts for real-time target and background scene generation capability.	
	– (U) Test and evaluate solid state wind sensing lidars for B-52 applications.	
	– (U) Develop compact, solid state ultraviolet differential absorption lidar for trace gas and chemical detection for use on aircraft.	
– (U) \$5,899	Continue the development of global ionosphere models to improve communications and space system applications.	
	– (U) Develop scintillation warning techniques/displays for command, control, and communication system outage alerts.	
	– (U) Deliver Theoretical Ionosphere-Atmosphere Real-time Algorithm to Air Weather Service for navigation, communications, and space track applications.	
– (U) \$3,875	Continue the development of global and theater weather analysis, simulation, and prediction techniques for combat weather system applications.	
	– (U) Tailor numerical weather prediction models to forecast contrails for stealth aircraft operations.	
	– (U) Develop radiative cloud module for weather scene simulation techniques for training and wargaming applications.	
– (U) \$19,076	Total	

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BUDGET ACTIVITY 2 - Applied Research				PE NUMBER AND TITLE 0602601F Phillips Laboratory Exploratory Development					PROJECT 1011	
<i>COST (\$ In Thousands)</i>	FY 1996 Actual	FY 1997 Estimate	FY 1998 Estimate	FY 1999 Estimate	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	Cost to Complete	Total Cost
1011 Rocket Propulsion Technology	36,613	33,863	29,505	36,509	38,030	39,555	39,920	39,279	Continuing	Continuing
<p>(U) A. <u>Mission Description and Budget Item Justification</u> The technologies developed in this project are boost and orbit transfer, satellite maneuvering, and tactical and ballistic missile rocket propulsion. This project develops technologies and provides technology options for rocket propulsion advanced demonstrations, components, or subsystems. Technologies of interest are those which will improve reliability, operability, survivability, affordability, environmental compatibility, and performance of future space and missile launch sub-systems while reducing material, manufacturing, and support costs. Technology will be developed to reduce the weight and cost of components using new materials, improved designs, and improved manufacturing techniques. All efforts in this project are part of the Integrated High Payoff Rocket Propulsion Technology (IHRPT) initiative; a joint DOD, NASA, and industry effort to focus rocket propulsion technology on national needs.</p> <p>(U) <u>FY 1996 (\$ in Thousands)</u></p> <ul style="list-style-type: none"> - (U) \$3,848 Develop propellants with a high-energy density. <ul style="list-style-type: none"> - (U) Determined feasibility of solid hydrogen and metallic clusters, metal atom doped cryogenic-solids, and solids with impurities as high-energy-density materials - (U) Continued development of cryogenic solids, high-pressure solids, extended solids, and high-energy density material additives in cryogenic solids for future use in a solid or hybrid rocket with revolutionary performance increases. - (U) Test fired combustion chamber using solid oxygen as a fuel. - (U) Test fired the first liquid high-energy density additive (quadricyclane) in a 4,000 lb. engine. Began increased-scale demonstrations. - (U) Continued search for new, higher-energy compounds for solid and liquid propellants. - (U) Conducted synthesis of solid, non-ozone depleting oxidizers. - (U) Developed scale-up capability for liquid high-energy-density materials - (U) \$6,266 Develop propulsion technologies for tactical missiles. <ul style="list-style-type: none"> - (U) Fabricated and began demonstrating components such as no-erosion, altitude-compensating nozzles used in solid rocket missiles. - (U) Developed lightweight insulating liners for reduced-weight solid rocket motors. - (U) Designed a nozzle (supersonic splitline flexseal nozzle) that reduces missile weight and increases missile agility. - (U) Tested environmentally safe, minimum-smoke propellant for use in tactical missiles to eliminate missile vulnerability caused by exhaust plume signature tracking - (U) Initiated development of hybrid propulsion systems for potential use as a tactical missile. 										
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BUDGET ACTIVITY 2 - Applied Research	PE NUMBER AND TITLE 0602601F Phillips Laboratory Exploratory Development	PROJECT 1011
<ul style="list-style-type: none"> - (U) \$14,166 Develop propulsion technology for reliable, safe, and low-cost boost and orbit transfers. <ul style="list-style-type: none"> - (U) Manufactured low-cost, coated carbon-carbon/ceramic components and hybrid polymers for future demonstration of high temperature, non-erosive, lightweight components for solid rocket motors. - (U) Used advanced manufacturing and fabrication methods to produce fluid film bearings. Integrated the bearings into a breadboard turbopump to validate cost and weight savings. Began testing hydrostatic bearings in turbopump assemblies under "real" conditions. - (U) Fabricated a combustion chamber to produce increased performance bearings using powder metallurgy technology. - (U) Designed and fabricated an altitude compensating nozzle to be integrated into a liquid propellant engine. - (U) Developed and evaluated new injectors that are less expensive and increase engine reliability and performance over existing injectors. - (U) Designed and developed the fabrication processes to produce a high performance, low-cost cryogenic upper stage combustion chamber for an expander cycle. - (U) Designed and fabricated an advanced preburner engine component that uses liquid cryogenic propellants, meets high throttle requirements and does not vaporize the propellants. - (U) Characterized new, lightweight components and developed the processes required to use the materials in liquid fuel rockets. - (U) Compiled data on hybrid propulsion concepts to develop state-of-the-art hybrid rocket motor technologies - (U) \$7,376 Develop advanced boost and orbit transfer propellants which are environmentally safe during manufacture, storage, use and disposal <ul style="list-style-type: none"> - (U) Characterized and evaluated the synthesized non-toxic, non-cryogenic, high-performance storable liquid fuels and oxidizers. - (U) Designed non-toxic, non-cryogenic, high-performance storable liquid fuels and oxidizers. - (U) Developed lab procedures to minimize propellant, explosive, and pyrotechnic waste products. Optimize disposal procedures. - (U) Synthesized alternative, environmentally acceptable propellants that increase the stability and mechanical integrity of missiles. - (U) Tested ways to improve and make more efficient the manufacturing of new environmentally safe solid rocket fuels. - (U) Manufactured and evaluated laboratory quantities of new high-energy chemicals to be used in environmentally-safe propellants. - (U) \$4,957 Develop propulsion technology for satellite control and on-orbit transfer. <ul style="list-style-type: none"> - (U) Developed concepts and components for solar thermal propulsion. - (U) Investigated the beam divergence of a 1000-watt node thruster (an arcjet) and evaluated methods that could reduce divergence. - (U) \$36,613 Total 		
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BUDGET ACTIVITY 2 - Applied Research	PE NUMBER AND TITLE 0602601F Phillips Laboratory Exploratory Development	PROJECT 1011
<p>(U) <u>FY 1997 (\$ in Thousands)</u></p> <ul style="list-style-type: none"> - (U) \$2,253 Develop high-energy-density materials. <ul style="list-style-type: none"> - (U) Complete analysis of solid hydrogen and metallic clusters, metal atom doped cryogenic solids, and solids with impurities. Transition the best high-energy-density materials into the cryogenic solid properties and combustion programs. Begin testing and evaluation of downselected propellants to transition into future high-performance boost and orbit transfer propulsion systems. - (U) Finish exploring cryogenic solid, high-pressure solid, and extended solid properties. Determine candidates for cryogenic solid combustion programs that will show revolutionary performance increases by replacing current liquid or solid propulsion systems with cryogenic solid or hybrid-fuel rockets in future space launch missions. - (U) Develop techniques to accurately measure high-energy-density additive concentrations in cryogenic solids to maximize future propulsion system performance. - (U) Test fire cryogenic hybrid-fuel rocket using oxygen and a cryogenic hydrocarbon to demonstrate performance increases over current liquid propulsion systems. - (U) Perform large-scale engine tests/demonstrations with new additives (quadricyclane). Prepare for launch-size demonstrations and begin transitioning additives into system-ready applications. - (U) Complete strained-ring hydrocarbon high-energy compound development. Identify the best candidates for a scale-up program to replace current liquid fuels. - (U) Select solid, non-ozone depleting oxidizers and other synthesized, new high-energy-density materials for development. Begin small scale demonstrations of environmentally-safe solid rocket motor fuel processing using these new ingredients. - (U) \$3,134 Develop propulsion technologies for tactical missile system applications. <ul style="list-style-type: none"> - (U) Test fabrication techniques to manufacture lightweight solid rocket engine liners. - (U) Complete testing and demonstration of environmentally safe, minimum-smoke propellants to eliminate vulnerability caused by exhaust plume signature tracking - (U) Develop the fabrication processes for novel nozzle concepts (supersonic splitline flexseal nozzle) that reduce missile weight while increasing missile agility. - (U) Evaluate commercial technologies and practices for their possible incorporation into low-cost, high-performance, environmentally safe tactical missiles. - (U) Analyze new propellants and components to develop a lightweight, highly-maneuverable propulsion system that will assure high kill ratios against the next generation of highly maneuverable aircraft. - (U) Continue development of hybrid propulsion systems for potential use as a tactical missile 		
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BUDGET ACTIVITY
2 - Applied Research

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**0602601F Phillips Laboratory Exploratory
Development**

- (U) \$15,390 Develop propulsion technology to meet the needs of reliable, safe, and low-cost boost and orbit transfers.
 - (U) Demonstrate low-cost, high temperature, non-erosive, lightweight coated carbon-carbon ceramic and hybrid polymer components for use in solid rocket space launch and missile motors.
 - (U) Demonstrate the fluid film bearing designs and verify their performance and integrity when used in liquid turbopumps on future boost and orbit transfer systems.
 - (U) Design and test injectors that enable reduced cost, increased reliability, and increased engine performance in liquid boost and orbit transfer engines.
 - (U) Fabricate and test a high-performance, low-cost cryogenic upper stage combustion chamber for an expander cycle application.
 - (U) Fabricate and test an advanced preburner engine component that uses using liquid cryogenic propellants that meets the high throttling requirements and does not vaporize propellants.
 - (U) Continue to characterize new materials and develop processes required to apply the materials to liquid-propellant rocket production with dramatic weight reductions.
 - (U) Develop design and processing techniques for high-strength, low-weight engine and motor components (metals and non-metals).
- (U) \$7,499 Develop advanced boost and orbit transfer propellants which are environmentally safe during manufacture, storage, and use.
 - (U) Evaluate ignition characteristics, determine combustion efficiencies, and report the results of the synthesized non-toxic, non-cryogenic, high-performance, storable liquid fuels and oxidizers to begin developing a high-performance, environmentally safe, liquid replacement for current space launch systems.
 - (U) Fabricate and test non-toxic, non-cryogenic, high-performance, storable liquid additives for use with these new propellants (capable of withstanding the firing conditions created by the new propellants).
 - (U) Determine alternative disposal procedures/technologies to thermolyze or breakdown propellant, explosive, and pyrotechnic wastes into their non-hazardous constituent parts.
 - (U) Integrate all of the current solid propellant work being done under the high-energy-density materials program and incorporate the most promising chemicals into state-of-the-art propellants (liquid, solid, and hybrid)
 - (U) Evaluate and analyze radically new methods of solid rocket motor and propellant manufacturing to develop low-cost environmentally friendly solid rocket motors that exceed the performance of current liquid propellant rockets.
 - (U) Scale-up and demonstrate the most innovative high-energy chemicals that are currently being synthesized within government and contractor laboratories. The most promising chemicals (solid or liquid) will be fed into an innovative propellants project to be used in next generation propellants for space launch systems

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<ul style="list-style-type: none"> - (U) \$1,403 Develop techniques for use in sustainment of strategic systems while at the same time being potentially advantageous to the development of the next generation booster <ul style="list-style-type: none"> - (U) Continue the development of service life assessment techniques of current solid rocket propellant missile systems - (U) \$4,184 Develop satellite propulsion technology for control and on-orbit transfer. <ul style="list-style-type: none"> - (U) Develop and evaluate improved designs to fabricate a pulsed plasma thruster with increased power efficiency. - (U) Design solar thrusters and concentrators for satellite propulsion systems with longer life. - (U) Develop and improve technologies for implementation of the high power Hall thruster - (U) \$33,863 Total <p>(U) <u>FY 1998 (\$ in Thousands)</u></p> <ul style="list-style-type: none"> - (U) \$3,111 Develop propellants with a high-energy density. <ul style="list-style-type: none"> - (U) Continue testing and evaluation of downselected propellants to transition into future high-performance boost and orbit transfer propulsion systems. These potential propellants were culled from the analysis of solid hydrogen and metallic clusters, metal atom doped cryogenic solids, and solids with impurities conducted previously. - (U) Begin subscale testing of potential candidates for cryogenic solid combustion programs that will show revolutionary performance increases by replacing current liquid or solid propulsion systems with cryogenic solid or hybrid-fuel rockets in future space launch missions. - (U) Continue testing and comparison of techniques to accurately measure high energy density additive concentrations in cryogenic solids to maximize future propulsion system performance. - (U) Complete performance of large-scale engine tests/demonstrations with new additives (quadricyclane). Continue preparation for launch-size demonstrations and transitioning additives into system-ready applications. - (U) Continue selection of solid, non-ozone depleting oxidizers and other synthesized, new, high energy density materials for development. Continue small-scale demonstrations of environmentally-safe solid rocket motor fuel processing using these new ingredients. 		
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BUDGET ACTIVITY 2 - Applied Research		February 1997
PE NUMBER AND TITLE 0602601F Phillips Laboratory Exploratory Development		PROJECT 1011
<ul style="list-style-type: none"> - (U) \$6,261 - (U) \$7,867 - (U) \$4,942 -- (U) \$5,820 - (U) \$1,504 - (U) \$29,505 	<ul style="list-style-type: none"> Develop propulsion technologies for tactical missiles. <ul style="list-style-type: none"> - (U) Continue to test fabrication techniques to manufacture lightweight solid rocket motorliners. - (U) Evaluate and test advanced propellants for future air-to-air and air-to-surface missile systems. - (U) Complete development of the fabrication processes for novel nozzle concepts (supersonic splitline flexseal nozzle) that reduce missile weight while increasing missile agility. Conduct testing. - (U) Continue to evaluate and test commercial technologies and practices for their possible incorporation into low-cost, high-performance, environmentally safe tactical missiles. - (U) Continue analysis and testing of new propellants and components to develop a lightweight, highly-maneuverable propulsion system that will assure high kill ratios against the next generation of highly maneuverable aircraft. Develop propulsion technology for reliable, safe, and low-cost boost and orbit transfers. <ul style="list-style-type: none"> - (U) Continue to demonstrate low-cost, high temperature, non-erosive, lightweight coated carbon-carbon ceramic and hybrid polymer components for use in solid rocket space launch and missile motors. - (U) Complete fabrication and testing of an advanced preburner engine component that uses using liquid cryogenic propellants that meets the high throttling requirements and does not vaporize propellants. - (U) Begin development of compatible case/liner and insulator system for higher combustion temperature propellants to be used in strategic systems. Develop advanced boost and orbit transfer propellants which are environmentally safe during manufacture, storage, use and disposal <ul style="list-style-type: none"> - (U) Continue the fabrication and testing of non-toxic, non-cryogenic, high-performance, storable liquid additives for use with the above new propellants (capable of withstanding the firing conditions created by the new propellants). Develop techniques for use in sustainment of strategic systems while at the same time being potentially advantageous to the development of the next generation booster Develop propulsion technology for satellite control and on-orbit transfer. <ul style="list-style-type: none"> - (U) Continue the Hall thruster development for possible inclusion into the next generation satellites. - (U) Continues work in the development and evaluation of improved designs to fabricate pulsed plasma thrusters with increased power efficiency, the next level of improvements. - (U) Continue the design and test of solar thrusters and concentrators for satellite propulsion systems with longer life. Total 	
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RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)		DATE February 1997
BUDGET ACTIVITY 2 - Applied Research	PE NUMBER AND TITLE 0602601F Phillips Laboratory Exploratory Development	PROJECT 1011
<p>(U) <u>FY 1999 (\$ in Thousands)</u></p> <ul style="list-style-type: none"> - (U) \$4,048 Develop propellants with a high-energy density. <ul style="list-style-type: none"> - (U) Continue testing and evaluation of downselected propellants to transition into future high-performance boost and orbit transfer propulsion systems. These potential propellants were culled from the analysis of solid hydrogen and metallic clusters, metal atom doped cryogenic solids, and solids with impurities previously conducted. - (U) Continue subscale testing of potential candidates for cryogenic solid combustion programs that will show revolutionary performance increases by replacing current liquid or solid propulsion systems with cryogenic solid or hybrid-fuel rockets in future space launch missions. - (U) Continue testing and comparison of techniques to accurately measure high energy density additive concentrations in cryogenic solids to maximize future propulsion system performance. - (U) Begin evaluation of next generation of hydrocarbon fuel additives to improve the performance of current and future space launch systems. - (U) Continue selection of solid, non-ozone depleting oxidizers and other synthesized, new, high energy density materials for development. Continue small-scale demonstrations of environmentally-safe solid rocket motor fuel processing using these new ingredients. - (U) \$4,475 Develop propulsion technologies for tactical missiles. <ul style="list-style-type: none"> - (U) Continue to test fabrication techniques to manufacture lightweight solid rocket motorliners. - (U) Continue to evaluate and test advanced propellants for future air-to-surface missile systems. - (U) Continue to evaluate and test commercial technologies and practices for their possible incorporation into low-cost, high-performance, environmentally safe tactical missiles. - (U) Continue analysis and testing of new propellants and components to develop a lightweight, highly-maneuverable propulsion system that will assure high kill ratios against the next generation of highly maneuverable aircraft. - (U) \$14,863 Develop propulsion technology for reliable, safe, and low-cost boost and orbit transfers. <ul style="list-style-type: none"> - (U) Continue to demonstrate low-cost, high temperature, non-erosive, lightweight coated carbon-carbon ceramic and hybrid polymer components for use in solid rocket space launch and missile motors. - (U) Complete demonstration of the fluid film bearing designs and verify their performance and integrity when used in liquid turbopumps on future boost and orbit transfer systems. 		
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		DATE February 1997
BUDGET ACTIVITY 2 - Applied Research	PE NUMBER AND TITLE 0602601F Phillips Laboratory Exploratory Development	
	<ul style="list-style-type: none"> - (U) Complete fabrication and test of a high-performance, low-cost cryogenic upper stage combustion chamber for an expander cycle application. - (U) Continue to characterize new materials and develop processes required to apply the materials to liquid-propellant rocket production with dramatic weight reductions. - (U) Continue to develop design and processing techniques for high-strength, low-weight engine and motor components (metals and non-metals). - (U) Continue development of altitude compensating thrust chamber assembly technology improvements which will provide significant gains in performance for reusable launch vehicles. - (U) Verify performance and weight improvements of rapid densification nozzle technology using improved strategic propellants for future ballistic missiles. - (U) \$4,917 Develop advanced boost and orbit transfer propellants which are environmentally safe during manufacture, storage, use and disposal <ul style="list-style-type: none"> - (U) Continue the evaluation of ignition characteristics, determine combustion efficiencies, and report the results of the synthesized non-toxic, non-cryogenic, high-performance, storable liquid fuels and oxidizers to begin developing a high-performance, environmentally safe, liquid replacement for current space launch systems. - (U) Continue the fabrication and testing of non-toxic, non-cryogenic, high-performance, storable liquid additives for use with the above new propellants (capable of withstanding the firing conditions created by the new propellants). - (U) Continue the determination of alternative disposal procedures/technologies to thermolyze or breakdown propellant, explosive, and pyrotechnic wastes into their non-hazardous constituent parts. Continuing effort as new oxidizers and fuels are developed. - (U) Continue the integration of the current solid propellant work being done under the high energy-density materials program and incorporate the most promising chemicals into state-of-the-art propellants (liquid, solid, and hybrid) - (U) Continue to scale-up and demonstrate the most innovative high-energy chemicals that are currently being synthesized within government and contractor laboratories. The most promising chemicals (solid or liquid) are fed into an innovative propellants project to be used in next generation propellant for space launch systems - (U) Continue developing higher combustion temperature propellants for use in future strategic systems. - (U) \$4,541 Develop techniques for use in sustainment of strategic systems while at the same time being potentially advantageous to the development of the next generation booster - (U) \$3,665 Develop propulsion technology for satellite control and on-orbit transfer. 	

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BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
2 - Applied Research	0602601F Phillips Laboratory Exploratory Development	1011
<p>– (U) Continue work in the development and evaluation of improved designs to fabricate pulsed plasma thrusters with increased power efficiency.</p> <p>– (U) Continue the design and test of solar thrusters and concentrators for satellite propulsion systems with longer life.</p> <p>– (U) \$36,509 Total</p>		
Project 1011	Page 15 of 38 Pages	Exhibit R-2 (PE 0602601F)

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RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)					DATE February 1997
BUDGET ACTIVITY 2 - Applied Research		PE NUMBER AND TITLE 0602601F Phillips Laboratory Exploratory Development			PROJECT 1011
(U) B. <u>Program Change Summary (\$ in Thousands)</u>					
	<u>FY 1996</u>	<u>FY 1997</u>	<u>FY 1998</u>	<u>FY 1999</u>	Total
(U) Previous President's Budget	36,923	30,293	30,447	31,169	Cost
(U) Current Budget Submit/FY 1998 PB	36,613	33,863	29,505	36,509	Cont
(U) Change Summary Explanation:					
Funding: Changes to this project since the previous President's Budget are due to budget constraints and priorities within the Science and Technology (S&T) Program.					
Schedule: Not Applicable.					
Technical: Not Applicable.					
(U) C. <u>Other Program Funding Summary</u>					
(U) <u>Related Activities</u>					
- (U) PE 0602111N, Anti-Air/Anti-Surface Warfare Technology.					
- (U) PE 0602303A, Missile Technology.					
- (U) PE 0603302F, Space and Missile Launch Technology.					
- (U) PE 0603311F, Ballistic Missile Technology.					
- (U) PE 0603401F, Advanced Spacecraft Technology.					
- (U) This project has been coordinated through the Project Reliance process to harmonize efforts and eliminate duplication.					
(U) D. <u>Schedule Profile</u> Not Applicable.					
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RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)								DATE February 1997		
BUDGET ACTIVITY 2 - Applied Research				PE NUMBER AND TITLE 0602601F Phillips Laboratory Exploratory Development					PROJECT 3326	
COST (\$ In Thousands)	FY 1996 Actual	FY 1997 Estimate	FY 1998 Estimate	FY 1999 Estimate	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	Cost to Complete	Total Cost
3326 Lasers and Imaging Technology	19,316	18,553	21,252	20,716	20,436	20,111	21,396	22,070	Continuing	Continuing
<p>(U) A. <u>Mission Description and Budget Item Justification</u> 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. Technologies researched include advanced, short-wavelength laser devices for application as illuminators and imaging sources as well as advanced optical imagers for target identification and assessment. Laser technologies will be studied for their utility in aimpoint selection, target maintenance, and damage assessment. Additionally, high power laser devices and mid-infrared semiconductor laser devices, semiconductor diode laser arrays, optical components, advanced beam control and atmospheric compensation technologies, techniques for laser target vulnerability assessments, and nonlinear optics processes and techniques are developed.</p> <p>(U) <u>FY 1996 (\$ in Thousands)</u></p> <ul style="list-style-type: none"> - (U) \$2,897 Develop generic high energy laser technologies for applications such as illuminators for use in wavelength-specific military missions. <ul style="list-style-type: none"> - (U) Demonstrated atomic-iodine laser pumped by chemically produced nitrogen-chloride. This laser is potentially significantly lighter weight than a comparable chemical oxygen-iodine laser. - (U) Completed semiconductor laser amplifier optimization studies of beam quality, output power, and coherence for applications such as laser communications. - (U) \$4,493 Develop basic laser source and target coupling technology for high-payoff applications such as laser-induced microwave emissions. <ul style="list-style-type: none"> - (U) Performed initial investigation of laser-induced microwave emissions to provide novel effect for upsetting electronic systems. - (U) Evaluated laser-induced microwave effects on military system materials. - (U) \$5,517 Develop long-range optical imaging technologies for increased resolution and data fusion to support missions such as space object identification and ground target identification from space. <ul style="list-style-type: none"> - (U) Conducted fundamental risk reduction experiments and demonstrations for technology critical to deep space imaging concepts selected in FY 1995. The concepts provide long-range signature/imaging capabilities currently not available. - (U) Identified a focused development of key concepts and technologies for transition to high-payoff applications for optical sensing, imaging, and stand-off detection. This will decrease cost and weight of space-based optics. - (U) Developed effort to incorporate real-time image processing algorithms into generic, on-platform processing schemes to reduce data transmission requirements. 										
Project 3326			Page 17 of 38 Pages				Exhibit R-2 (PE 0602601F)			

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RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)		DATE February 1997
BUDGET ACTIVITY 2 - Applied Research	PE NUMBER AND TITLE 0602601F Phillips Laboratory Exploratory Development	PROJECT 3326
<ul style="list-style-type: none"> - (U) \$2,118 	<p>Investigate and develop nonlinear optics (NLO) technologies to support imaging and other applications.</p> <ul style="list-style-type: none"> - (U) Demonstrated feasibility of using specially prepared NLO crystals to simultaneously convert a commercially available near-infrared laser to tunable, multiple near-infrared and mid-infrared wavelengths. NLO components provide a compact, lightweight, efficient, less complex system for countermeasures, imaging, sensing, and communication applications. - (U) Demonstrated all-optical technique to stabilize and extend the modulation bandwidth of semiconductor lasers with the potential to increase optical communication data rates and reduce system size, weight and complexity. - (U) Demonstrated an automatic technique for the correction of figure errors in lightweight membrane mirrors and initiated an effort to characterize the performance and limitations of this technique. Nonlinear optics are an improvement over currently used technologies by providing a more compact, lighter-weight, faster, and less complex system for correcting figure errors. 	
<ul style="list-style-type: none"> - (U) \$3,035 	<p>Investigate and develop advanced high energy laser optical components.</p> <ul style="list-style-type: none"> - (U) Initiated program to identify and develop techniques to perform in situ status and health evaluation of optical components installed in a high energy laser system. Such techniques are useful for predicting performance degradation and/or catastrophic failure of optical components in operational high energy laser systems. - (U) Identified potentially non-toxic coolants and bonding processes for use in cooled transmissive optical components such as aperture sharing elements and cooled windows for high energy laser systems. Active cooling of transmissive optics may be necessary to reduce optical distortion due to laser heating. - (U) Continued developing very low absorption, low-scatter optical thin film coatings by investigating new coating materials and coating process modifications. This work will result in reduced cooling requirements, less optical distortion, decreased size and weight, and increased efficiency of optical systems used in airborne and space platforms. 	
<ul style="list-style-type: none"> - (U) \$1,256 	<p>Design, fabricate, and test a coude imaging spectrograph that will be used in conjunction with the adaptive optics system to obtain high spectral resolution. This is the only large format, high sensitivity camera for the Advanced Electro-Optical System on Maui, HI.</p>	
<ul style="list-style-type: none"> - (U) \$19,316 	<p>Total</p>	

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RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)		DATE February 1997
BUDGET ACTIVITY 2 - Applied Research	PE NUMBER AND TITLE 0602601F Phillips Laboratory Exploratory Development	PROJECT 3326
<p>(U) <u>FY 1997 (\$ in Thousands)</u></p> <ul style="list-style-type: none"> – (U) \$2,864 Develop generic, high energy laser technologies for applications such as illuminators for use in wavelength-specific military missions. <ul style="list-style-type: none"> – (U) Investigate performance parameters and scaling potential of atomic-iodine laser pumped by chemically produced, nitrogen chloride. – (U) Demonstrate lasing of 100 milliwatts at a wavelength of five micrometers from a diode laser. – (U) \$1,105 Develop basic laser source and target coupling technology for use in high-payoff applications such infrared countermeasures and creating laser-induced microwave effects. <ul style="list-style-type: none"> – (U) Complete experiment and analysis to assess the effectiveness of laser-induced microwave emissions in military applications. Results will provide a database on a novel effect used for upsetting electronic systems. – (U) \$2,782 Develop long-range optical imaging technologies for increased resolution and data fusion support missions such as space object identification and ground target identification from space. <ul style="list-style-type: none"> – (U) Conduct initial development of experiments on active and passive spectral technologies which increase performance and reduce cost of space-based optical sensors used for ground target identification. – (U) Develop advanced concepts for smart integrated sensor-processors to reduce data bandwidth requirements on space-based sensors. – (U) Develop advanced concepts for lightweight deployable large optics to permit long dwell optical surveillance from higher orbits. – (U) \$2,112 Investigate and develop nonlinear optics (NLO) technologies to support imaging and other applications. <ul style="list-style-type: none"> – (U) Continue to characterize automatic, all-optical techniques for producing pristine images from large, lightweight mirrors. Nonlinear optics are an improvement over currently used technologies by providing a more compact, lighter-weight, faster, and less complex system for correcting figure errors. – (U) Initiate an effort to produce a very efficient, mid-infrared source that uses a standard, near-infrared solid state laser and multiple nonlinear optical processes. NLO components provide a compact, light-weight, efficient, less complex system for countermeasures, imaging, sensing and communication systems. – (U) Begin studying NLO techniques for high bandwidth laser communications with automatic aimpoint maintenance and lightweight optics for space applications. These techniques have the potential to increase optical communication data rates, reduce system size, weight and complexity, and improve system efficiency. 		
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DATE
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BUDGET ACTIVITY
2 - Applied Research

PE NUMBER AND TITLE
**0602601F Phillips Laboratory Exploratory
Development**

- (U) \$2,161 Investigate and develop advanced, high energy laser optical components.
 - (U) Complete development of techniques to evaluate optical components installed in an operational high energy laser system for transition to advanced technology development.
 - (U) Complete testing and accept delivery of a cooled, transmissive optical element which is environmentally safe, and relieves thermal overload in optical systems.
 - (U) Complete development of very low absorption, low-scatter optical, thin-film coatings. Transition technology to industry for scaling. This work will result in reduced cooling requirements, less optical distortion, decreased size and weight, and increased efficiency of optical systems used in airborne and space platforms.
 - (U) \$3,877 Develop laser radar for space surveillance and remote sensing applications.
 - (U) Demonstrate capabilities to collect range, range rate, and doppler images against unaugmented low-earth orbit satellite. The technology provides improved range resolution and system operation without illumination from the sun.
 - (U) \$3,652 Develop high power semiconductor lasers/arrays at alternate wavelengths for applications and uses such as forward looking infrared (FLIR) systems and IR missile warning sensor jamming, chemical agent detection, illuminators, efficient semiconductor laser array pumping modules and infrared countermeasures (IRCM).
 - (U) Demonstrate ten watts peak output power at quasi-continuous wave operation from a two micron semiconductor diode laser array module at room temperature. This demonstration will provide a baseline for high efficiency pump laser arrays used as a subcomponent in Band 4 optically-pumped semiconductor lasers.
 - (U) Demonstrate 200 milliwatts continuous laser output power at four microns wavelength from a single semiconductor diode. The collected data will be used to scale output power to levels required for next generation, high efficiency, compact Band 4 IRCM sources for small tactical aircraft self-protection not provided by bulkier optically-pumped semiconductor lasers.
 - (U) \$18,553 Total
- (U) FY 1998 (\$ in Thousands)
- (U) \$932 Develop generic, high energy laser technologies for applications such as illuminators and use in wavelength-specific military missions.
 - (U) Apply FY 1997 experimental results to technology demonstration of a high energy, chemical nitrogen chloride iodine transfer laser. This laser has the potential to be significantly lighter weight than a comparable chemical oxygen-iodine laser.

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RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)		DATE February 1997
BUDGET ACTIVITY 2 - Applied Research	PE NUMBER AND TITLE 0602601F Phillips Laboratory Exploratory Development	PROJECT 3326
<ul style="list-style-type: none"> - (U) \$4,421 Develop long-range optical imaging technologies for increased resolution and data fusion support missions such as space object identification. <ul style="list-style-type: none"> - (U) Conduct initial development of experiments on active and passive spectral technologies which increase performance and reduce cost of space-based optical sensors used for ground target identification. - (U) Evaluate on-board image processing concepts to decrease communication bandwidth requirements. - (U) Establish lab test facility for large deployable optics technology and smart sensors. - (U) \$4,978 Develop basic laser source and target coupling technology for high-payoff applications such as infrared countermeasures (IRCM). <ul style="list-style-type: none"> - (U) Begin investigating effects of laser illumination on materials relevant to degrade and damage IRCM applications. - (U) \$1,765 Investigate and develop nonlinear optics (NLO) technologies to support imaging and other applications. <ul style="list-style-type: none"> - (U) Transition technology for automatic, all-optical compensation techniques for large lightweight mirrors with poor optical quality to imaging satellite systems development projects. Nonlinear optics are an improvement over currently used technologies by providing a more compact, lighter-weight, faster, and less complex system for correcting figure errors. - (U) Demonstrate a tunable mid-infrared laser converter with better than 50% conversion efficiency from the near-infrared. This converter could potentially improve IRCM and sensing system efficiencies by a factor of two. - (U) Begin investigating NLO techniques to decrease system complexity and increase speed of aimpoint imaging and tracking for countermeasure applications. - (U) Continue to investigate NLO techniques to increase current laser communication bandwidths with automatic crosslink acquisition and tracking and lightweight optics. The use of NLO will provide a more lightweight, efficient communications system capable of handling more information. - (U) \$4,356 Develop high power semiconductor lasers/arrays at alternate wavelengths for applications and uses such as forward looking infrared (FLIR) systems and IR missile warning sensor jamming, chemical agent detection, illuminators, efficient semiconductor laser array pumping modules and infrared countermeasures (IRCM). <ul style="list-style-type: none"> - (U) Demonstrate an incoherent 20 watt peak output power, continuous wave operation, two micron semiconductor diode laser array module at room temperature. This device will provide a compact, high power, efficient pump laser array used as a subcomponent in band 4 optically-pumped semiconductor lasers to increase their performance. - (U) Demonstrate 750 milliwatts continuous laser output power at four microns wavelength from a single semiconductor diode. This demonstration will establish the feasibility of direct electrical-to-optical generation of mid-infrared wavelengths, enabling improved packing efficiency and reliability by a factor of two for small tactical aircraft self-protection. 		
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BUDGET ACTIVITY 2 - Applied Research	PE NUMBER AND TITLE 0602601F Phillips Laboratory Exploratory Development	PROJECT 3326
	<ul style="list-style-type: none"> - (U) Demonstrate two watts coherent peak output power at quasi-continuous wave operation from a single, band 1 semiconductor diode at room temperature. The collected data will demonstrate the necessary powers needed to jam band 1 infrared surface-to-air missiles. 	
	<ul style="list-style-type: none"> - (U) \$4,800 Develop coherent laser diode arrays for improved performance/higher power in applications requiring high power levels. - (U) Demonstrate 100 watts continuous wave power from an array of phased diode lasers to establish the baseline technology for advanced laser defenses such as large aircraft self-protection. - (U) Demonstrate and evaluate a 200 watt high power system with a one cubic foot laser head. This one cubic foot design will provide that basis for high performance aircraft and space asset self-protection system designs. 	
	- (U) \$21,252 Total	
	(U) <u>FY 1999 (\$ in Thousands)</u>	
	<ul style="list-style-type: none"> - (U) \$1,218 Develop generic, high energy laser technologies for applications such as illuminators and use in wavelength-specific military missions. - (U) Investigate alternate lightweight, high energy density donor sources to power the atomic-iodine laser. Using sources which are lighter and provide more energy than hydrogen will decrease the weight of the chemical oxygen iodine laser. 	
	<ul style="list-style-type: none"> - (U) \$5,857 Develop long-range optical imaging technologies for increased resolution and data fusion support missions such as space object identification and ground target identification from space. - (U) Conduct initial development of experiments on active and passive spectral technologies which increase performance and reduce cost of space-based optical sensors used for ground target identification. - (U) Evaluate on-board image processing concepts to decrease communication bandwidth requirements. - (U) Establish lab test facility for large deployable optics technology and smart sensors. 	
	<ul style="list-style-type: none"> - (U) \$3,195 Develop basic laser source and target coupling technology for high-payoff applications such as infrared countermeasures (IRCM). - (U) Continue investigating effects of laser illumination on materials relevant to degrade and damage IRCM applications. 	
	<ul style="list-style-type: none"> - (U) \$809 Investigate and develop nonlinear optics (NLO) technologies to support imaging and other applications. - (U) Continue investigating NLO techniques to decrease system complexity and increase speed of aimpoint imaging and tracking for countermeasure applications. - (U) Demonstrate high laser communication bandwidths with automatic crosslink acquisition and tracking and lightweight optics. The use of NLO will provide a more lightweight, efficient communications system capable of handling more information. - (U) Evaluate performance of and study scaling issues associated with tunable-mid-infrared laser converters to maintain improved efficiency at higher powers. 	

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RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)		DATE February 1997
BUDGET ACTIVITY 2 - Applied Research	PE NUMBER AND TITLE 0602601F Phillips Laboratory Exploratory Development	PROJECT 3326
<ul style="list-style-type: none"> - (U) \$5,159 Develop high power semiconductor lasers/arrays at alternate wavelengths for applications and uses such as forward looking infrared (FLIR) systems and IR missile warning sensor jamming, chemical agent detection, illuminators, efficient semiconductor laser array pumping modules and infrared countermeasures (IRCM). <ul style="list-style-type: none"> - (U) Demonstrate 40 watts incoherent peak output power at quasi-continuous wave operation from a two micron semiconductor diode laser array module at room temperature. This demonstration will provide a baseline for high efficiency pump sources used as a subcomponent in portable, high brightness band 4 optically-pumped semiconductor lasers for FY 2000 field experiments. - Demonstrate two watts peak/one watt average output power at greater than four microns wavelength from a single semiconductor diode laser to establish the baseline for all semiconductor direct diode laser-based small tactical aircraft self-protection not provided by lower efficiency optically-pumped semiconductor lasers. - Demonstrate a less than three times diffraction limited beam at one watt peak output power from a single, band 1 semiconductor diode laser at room temperature. The collected data will demonstrate the necessary beam quality needed to directionally focus the power downrange and jam band 1 infrared surface-to-air missiles. - (U) \$4,478 Develop coherent laser diode arrays for improved performance/higher power in applications requiring high power levels. <ul style="list-style-type: none"> - (U) Demonstrate a factor of two increase (200 watts) in continuous wave power from an array of phased diode lasers to establish the baseline for using such devices in directed energy weapons systems. - (U) Continue to evaluate a 200 watt high power system with a one cubic foot laser head for high performance aircraft and space asset self-protection applications. - (U) \$20,716 Total 		

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RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)								DATE February 1997		
BUDGET ACTIVITY 2 - Applied Research				PE NUMBER AND TITLE 0602601F Phillips Laboratory Exploratory Development					PROJECT 5797	
COST (\$ In Thousands)	FY 1996 Actual	FY 1997 Estimate	FY 1998 Estimate	FY 1999 Estimate	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	Cost to Complete	Total Cost
5797 Advanced Weapons and Survivability Technology	16,705	16,039	15,403	15,950	17,059	17,632	17,959	18,510	Continuing	Continuing
<p>(U) A. <u>Mission Description and Budget Item Justification</u> High power microwave (HPM) and other unconventional weapon concepts using innovative technologies such as compact toroids are explored in this project. Technologies that support a wide range of Air Force missions such as space control, command and control warfare, and counter-air warfare are developed. This project provides for vulnerability assessments of representative U.S. strategic and tactical systems to directed energy weapons, directed energy weapon technology assessment for specific Air Force missions, and directed energy weapon lethality assessments against foreign targets. In addition to directed energy weapon threats, this project conducts assessments of specific space environmental (natural and man-made) effects on space systems and develops hardening technologies and methodologies.</p> <p>(U) <u>FY 1996 (\$ in Thousands)</u></p> <ul style="list-style-type: none"> - (U) \$6,619 Develop generic advanced weapon technologies that support many Air Force applications. <ul style="list-style-type: none"> - (U) Developed advanced, pulse-power technologies that will power new, HPM source designs. - (U) Continued development of narrowband and ultra-wideband HPM sources and antennas for command and control warfare efforts. - (U) Developed high-performance computer codes to support plasma and pulsed power research. - (U) Investigated ability of HPM to neutralize biological weapons. - (U) Transitioned ultra-wideband antenna to PE 0603605F. - (U) \$2,895 Assess effects/lethality of directed energy weapon technologies against representative air and ground military systems. <ul style="list-style-type: none"> - (U) Developed computer modeling codes that predict HPM coupling into aircraft. Completed B-2 shielding survey. - (U) Developed technologies to harden military assets against HPM damage and effects. - (U) Continued characterization of HPM upset of various system's hardware, including command and control network equipment. - (U) Developed specifications, standards, and hardness maintenance technologies for systems such as the F-16, Hawk missile, and A-10. - (U) Completed counter-air effectiveness analyses of HPM weapons. 										
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RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)		DATE February 1997
BUDGET ACTIVITY 2 - Applied Research	PE NUMBER AND TITLE 0602601F Phillips Laboratory Exploratory Development	
PROJECT 5797		
<ul style="list-style-type: none"> - (U) \$3,399 - (U) \$1,769 - (U) \$2,023 - (U) \$16,705 	<ul style="list-style-type: none"> Develop high power microwave (HPM) technologies that will support applications such as suppression of enemy air defenses, counter-air, command and control warfare, and aircraft self-protection. <ul style="list-style-type: none"> - (U) Completed HPM weapons concept exploration for command and control warfare. - (U) Continued theoretical analysis of predicted HPM weapons' effectiveness for suppression of enemy air defense and command and control warfare. - (U) Downselected wideband, HPM source which provides aircraft self-protection. - (U) Developed downselected narrowband source technology for application in suppression of enemy air defenses. - (U) Completed HPM weapons application analysis for use in counter-air applications. Develop HPM technologies, including susceptibility and effects experiments and modeling and data base development, to support space control applications. <ul style="list-style-type: none"> - (U) Completed effects experiments on two imaging components and two low noise amplifiers. - (U) Performed assessments of HPM technology with space control threat application. - (U) Initiated evaluation of basing modes for HPM threat technologies. Assess the vulnerability of various space assets to threats such as solar radiation, space debris, and directed energy weapons. <ul style="list-style-type: none"> - (U) Developed satellite lethality and assessment models for four assets. - (U) Provided advanced sensor design and assessments for a multi-spectral, multi-sensor data analysis workstation. - (U) Completed space payload assessment and environmental interaction experiments. Total 	
<p>(U) <u>FY 1997 (\$ in Thousands)</u></p> <ul style="list-style-type: none"> - (U) \$5,102 	<ul style="list-style-type: none"> Develop generic advanced weapon technologies that support many Air Force applications. <ul style="list-style-type: none"> - (U) Continue to develop advanced pulse-power, microwave, and radio-frequency technologies for offensive and defensive weapon systems. - (U) Develop high-performance computer codes to support narrowband HPM source and pulsed power research. - (U) Develop first-generation, compact, high-voltage pulsed electrical power generator for microwave and radio frequency sources. - (U) Assess ability of pulsed power and HPM technology to neutralize biological weapons. - (U) Continue to develop narrowband and wideband sources and antennas. 	

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BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
2 - Applied Research	0602601F Phillips Laboratory Exploratory Development	5797
<ul style="list-style-type: none"> - (U) \$2,713 Assess effects/lethality of directed energy weapon technologies against representative air and ground military systems. <ul style="list-style-type: none"> - (U) Continue to develop computer modeling codes that predict high power microwave (HPM) coupling into advanced technology aircraft. Complete coupling experiments on small-aircraft simulator that can be transferred to aircraft such as the F-22. - (U) Develop protection technology for external HPM threat to advanced technology fighter aircraft. - (U) Complete command and control warfare effectiveness analyses on command and control facilities using postulated HPM threats. - (U) Transition specifications and standards and HPM hardness technologies to F-16 and F-22 program offices. - (U) Continue program of establishing thresholds of differing effects caused by differing microwave threats as applied to a wide variety of electronics subsystems. - (U) Develop HPM protection criteria for large aircraft, such as cargo-transport, air-refueling, and bomber aircraft. - (U) \$3,671 Develop HPM technologies that will support applications such as suppression of enemy air defenses, command and control warfare, and aircraft self-protection. <ul style="list-style-type: none"> - (U) Continue in situ experimentation with installed systems for command and control warfare using HPM. - (U) Begin in situ demonstrations of selected HPM sources that provide aircraft self-protection. - (U) Refine computer models of weapon effectiveness for all weapon applications. - (U) Perform experiment using downselected narrowband source for suppression of enemy air defenses. - (U) \$2,453 Develop HPM technologies, including susceptibility and effects experiments and modeling and data base development, to support space control applications. <ul style="list-style-type: none"> - (U) Execute susceptibility experiments and analysis of effects on two subsystems and two devices. - (U) Select and evaluate technologies that lead to selection of best concepts for basing of HPM technology. - (U) Develop requirements for source technology development in support of threat demonstration. - (U) Begin to develop experimental methodologies to measure effects of HPM on satellite systems. - (U) \$2,100 Assess the vulnerability of various space assets to threats such as solar radiation, space debris, and directed energy weapons. <ul style="list-style-type: none"> - (U) Develop directed energy weapon lethality and assessment models for five satellites. - (U) Continue satellite survivability/vulnerability/lethality assessments for ground-based laser technology. - (U) Transition advanced data fusion techniques to the multi-spectral, multi-sensor data analysis workstation. - (U) \$16,039 Total 		
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RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)		DATE February 1997
BUDGET ACTIVITY 2 - Applied Research	PE NUMBER AND TITLE 0602601F Phillips Laboratory Exploratory Development	PROJECT 5797
<p>(U) <u>FY 1998 (\$ in Thousands)</u></p> <ul style="list-style-type: none"> - (U) \$6,055 Develop generic advanced weapon technologies that support many Air Force applications. <ul style="list-style-type: none"> - (U) Apply high performance, parallel, plasma physics computer codes to narrowband source and compact pulsed power design. - (U) Perform integrated experiments to assess coupling compact, high voltage electrical generators; gigawatt narrowband devices; and efficient antennas. - (U) Complete development of high power, first generation wideband source, including antenna. - (U) Complete the assessment of the ability of pulsed power and high power microwave (HPM) technology to neutralize biological weapons. - (U) \$1,985 Assess effects/lethality of directed energy weapon technologies against representative air and ground military systems. <ul style="list-style-type: none"> - (U) Continue to identify HPM protection requirements for large aircraft (cargo-transport and bombers) that would be carrying HPM devices. - (U) Continue to develop practical methods to protect existing and advanced technology aircraft from proposed/identified , external HPM threats. - (U) Continue to develop techniques and technology to evaluate HPM coupling and effects into hardened, command-post like structures with modern electronics. - (U) Continue to develop and validate techniques to evaluate HPM effects on families of electronics components found in difficult-to-obtain weapons/threats. - (U) Continue to develop and validate advanced computer models which provide predictions for HPM coupling and effects into a wide variety of structures (command posts) and weapons systems of moderate complexity. - (U) \$3,358 Develop HPM technologies that will support applications such as suppression of enemy air defenses, command and control warfare, and aircraft self-protection. <ul style="list-style-type: none"> - (U) Use new technology ultra-wideband (UWB) sources to perform effects experiments on structures with command and control electronics systems. - (U) Prepare and implement diagnostic procedures and instrumentation for a critical experiment to demonstrate UWB capability to defeat infrared seekers. - (U) Improve transition of computer modeling code and experimental data into operational (flyout) modeling codes to model HPM effects on postulated missile threats. - (U) Integrate previously down-selected narrow-band source with newly developed pulsed-power generator for suppression of enemy air defenses. 		
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BUDGET ACTIVITY 2 - Applied Research	PE NUMBER AND TITLE 0602601F Phillips Laboratory Exploratory Development	PROJECT 5797
<ul style="list-style-type: none"> - (U) \$2,012 Develop high power microwave (HPM) technologies, including susceptibility and effects experiments and modeling and data base development, to support space control applications. <ul style="list-style-type: none"> - (U) Transition effects analysis and experimentation from subsystem to systems, begin to demonstrate and quantify effects on systems. - (U) Thoroughly evaluate best basing mode for HPM technology demonstration. - (U) Begin source development to support threat demonstration. - (U) \$1,993 Assess the vulnerability of various space assets to threats such as solar radiation, space debris, and directed energy weapons. <ul style="list-style-type: none"> - (U) Continue to develop directed energy weapon lethality and assessment models for five satellites. - (U) Continue satellite survivability/vulnerability/lethality assessments for ground-based laser technology. - (U) Continue to transition advanced data fusion techniques to the multi-spectral, multi-sensor data analysis workstation. - (U) \$15,403 Total 		
(U) FY 1999 (\$ in Thousands)		
<ul style="list-style-type: none"> - (U) \$6,196 Develop generic advanced weapon technologies that support many Air Force applications. <ul style="list-style-type: none"> - (U) Develop and test components for next-generation, compact, high voltage, high impedance, pulsed electrical power sources for microwave and radio frequency sources. - (U) Complete the transition of high performance plasma physics computer simulation codes to designers of microwave and pulsed power devices. - (U) Develop technology to increase the energy efficiency of multigigawatt narrowband sources. - (U) Develop technologies for next-generation wideband sources and antennas. - (U) \$2,087 Assess effects/lethality of directed energy weapon technologies against representative air and ground military systems. <ul style="list-style-type: none"> - (U) Finalize development of computer modeling codes that predict HPM coupling into advanced technology aircraft. - (U) Finalize development of fratricide protection technology for advanced technology fighter aircraft. - (U) Begin integrating specifications and standards and HPM hardness technologies to F-16 and F-22 program offices. - (U) Continue directed energy weapon lethality/survivability enhancements and characterization of equipment upset of various foreign and U.S. systems. - (U) Transfer HPM protection technology for large aircraft, such as cargo-transport, air-refueling, and bomber aircraft. 		

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RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)		DATE February 1997
BUDGET ACTIVITY 2 - Applied Research	PE NUMBER AND TITLE 0602601F Phillips Laboratory Exploratory Development	PROJECT 5797
<ul style="list-style-type: none"> – (U) \$3,494 Develop high power microwave (HPM) technologies that will support applications such as suppression of enemy air defenses, command and control warfare, and aircraft self-protection. <ul style="list-style-type: none"> – (U) Finalize in situ experimentation with installed systems for command and control warfare using HPM. – (U) Continue in situ demonstrations of selected HPM sources that provide aircraft self-protection. – (U) Continue to hone computer models of weapon effectiveness for all weapon applications. – (U) Demonstrate technology with experiment using downselected narrowband source for suppression of enemy air defenses. – (U) \$2,096 Develop HPM technologies, including susceptibility and effects experiments and modeling and data base development, to support space control applications. <ul style="list-style-type: none"> – (U) Execute lab-level critical experiments to directly support future threat demonstration. – (U) Continue source technology development to support threat demonstration. – (U) Continue susceptibility experiments on subsystems to support threat demonstration. – (U) \$2,077 Assess the vulnerability of various space assets to threats such as solar radiation, space debris, and directed energy weapons. <ul style="list-style-type: none"> – (U) Select directed energy weapon lethality and assessment models for five satellites. – (U) Continue survivability/vulnerability/lethality assessments for ground-based laser technology. – (U) Continue to transition advanced data fusion techniques to the multi-spectral, multi-sensor data analysis workstation. – (U) \$15,950 Total 		

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RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)								DATE February 1997		
BUDGET ACTIVITY 2 - Applied Research				PE NUMBER AND TITLE 0602601F Phillips Laboratory Exploratory Development				PROJECT 8809		
COST (\$ In Thousands)	FY 1996 Actual	FY 1997 Estimate	FY 1998 Estimate	FY 1999 Estimate	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	Cost to Complete	Total Cost
8809 Space and Missile Technology	30,567	53,513	28,469	31,263	37,663	42,928	44,589	45,822	Continuing	Continuing
<p>(U) A. <u>Mission Description and Budget Item Justification</u> This project focuses on five major space and missile technology areas: spacecraft platform technologies (e.g., structures, controls, power, and thermal management); space-based payload technologies (e.g., sensors, satellite communications, and avionics); satellite control technologies (e.g., spacecraft software); ballistic missile launch vehicle specific technologies (e.g., astrodynamics and guidance, navigation, and control avionics); and integrated experiments of advanced technologies for transition to planned systems (e.g., payload/platform/launch vehicle merging).</p> <p>(U) <u>FY 1996 (\$ in Thousands)</u></p> <ul style="list-style-type: none"> - (U) \$6,224 Develop technologies for space platform subsystems such as cryocoolers, space vehicle thermal management, compact solar power cells, lightweight batteries, and improved power generation concepts <ul style="list-style-type: none"> - (U) Fabricated and tested solar cell flex array deployment and solar to electric energy conversion efficiency - (U) Fabricated and evaluated solid state primary battery for space and missile launch vehicles - (U) Characterized and evaluated lightweight thermal bus components for future space vehicle thermal management subsystems - (U) \$5,745 Develop technologies for space platform structures such as spacecraft structural controls for vibration suppression and lightweight composite satellite and launch vehicle structures. <ul style="list-style-type: none"> - (U) Initiated advanced 'mechanisms' technology development program to replace current generation pin pullers, tie down bolts, etc. - (U) Completed non-pyrotechnic release device technology development. - (U) Completed preliminary design for the launch vibration isolation program. - (U) Completed multi-functional structures technology program. - (U) \$5,745 Develop technologies for space-based payload subsystems such as hardened sensors and satellite communications. <ul style="list-style-type: none"> - (U) Continued improvements to long-wavelength mercury cadmium telluride detectors under low background radiation conditions - (U) Developed optimized low-noise, high-performance quantum well infrared photodetectors in the mid-, long-, and very long-wavelength spectral regions. - (U) Designed radio frequency communication modems, modem controllers, and associated high-speed network components - (U) Continued development of integrated space-based surveillance models that address background clutter, target cross section, and propagation losses. Developed algorithms to improve the accuracy of space-based observation systems using existing resources. - (U) Evaluated component technologies for large aperture space-based surveillance antennas 										
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BUDGET ACTIVITY 2 - Applied Research	PE NUMBER AND TITLE 0602601F Phillips Laboratory Exploratory Development	PROJECT 8809
– (U) \$4,045	Develop technologies for space-based payload components such as hardened electronics and computer memories. – (U) Designed and evaluated advanced packaging technology whose goal is the reduction of size/volume/weight by a factor of ten. – (U) Fabricated standard space-based surveillance signal processing module	
– (U) \$2,995	Develop technologies for satellite control such as standardized, reusable software for astrodynamics, and command and control – (U) Designed and developed common satellite control software. – (U) Developed astrodynamics parallel processing code for propagation and differentiation correction program. – (U) Constructed algorithms for integrated space technology product development.	
– (U) \$4,999	Develop ground and small satellite integration technologies for space and near-space experiments – (U) Fabricated MightySat-I satellite, assembled four of five experiments, and assembled Ultra High Frequency (UHF) ground control stations. – (U) Completed initial design of the MightySat-II.1 satellite that will demonstrate hyperspectral imaging technologies, electric propulsion technologies, and several concepts for advanced structures.	
– (U) \$814	Develop technologies supporting launch vehicles and ballistic missiles such as guidance, navigation, and control avionics – (U) Designed solid state micro-mechanical guidance instruments for future Air Force ballistic missile environments – (U) Fabricated next generation thrust axis accelerometer which could provide low life cycle cost Minuteman III guidance upgrade.	
– (U) \$30,567	Total	
(U) <u>FY 1997 (\$ in Thousands)</u>		
– (U) \$5,710	Develop technologies for space platform subsystems such as cryocoolers, space vehicle thermal management, compact solar power cells, lightweight batteries, and innovative power generation concepts – (U) Complete solar cell flex array technology development effort – (U) Complete solid state primary battery for space and missile launch vehicle applications – (U) Develop ten degrees Kelvin cryocoolers for evaluation and characterization	
– (U) \$5,273	Develop technologies for space platform structures such as spacecraft structural controls for vibration suppression and lightweight composite satellite and launch vehicle structures. – (U) Continue the advanced adaptive structures technology development program. – (U) Conduct proof-of-concept experiments for the launch vehicle vibration isolation program. – (U) Initiate the advanced launch vehicle structures technology development program.	

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RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)		DATE February 1997
BUDGET ACTIVITY 2 - Applied Research	PE NUMBER AND TITLE 0602601F Phillips Laboratory Exploratory Development	PROJECT 8809
– (U) \$5,082	Develop technologies for space-based payload subsystems such as hardened sensors and satellite communications. <ul style="list-style-type: none"> – (U) Continue improvement of long-wavelength mercury cadmium telluride detectors and optimize for large focal plane arrays – (U) Develop larger format, quantum well, infrared photodetector focal plane arrays – (U) Evaluate and characterize radio frequency communications modem, modem controllers and network components. – (U) Integrate space-based surveillance models into wargaming simulations for immediate performance feedback – (U) Integrate and test space-based surveillance antenna component technologies to support system level design concepts. 	
– (U) \$3,737	Develop technologies for space-based payload components such as hardened electronics and memories. <ul style="list-style-type: none"> – (U) Evaluate and fabricate advanced packaging technology whose goal is ten times size/volume/weight reduction – (U) Evaluate a standard space-based surveillance signal processing module. 	
– (U) \$3,679	Develop technologies for satellite control such as standardized reusable software for astrodynamics. <ul style="list-style-type: none"> – (U) Develop satellite control software for applications such as multi-mission advanced ground intelligent control. – (U) Assemble next generation gravitational astrodynamics model, permitting on-maintainable orbits analysis. – (U) Write software routines for integrated space technology product development. 	
– (U) \$18,770	Develop ground and small satellite integration technologies for space and near-space experiments <ul style="list-style-type: none"> – (U) Complete MightySat-I spacecraft and experiments assembly. Integrate experiments with spacecraft. Technologies to be evaluated include: Increased power solar cells, lightweight composite structure, shape memory release device, microparticle impact detector, electronics miniaturization techniques. Perform environmental test and checkout. Integrate MightySat-I on Shuttle Hitchhiker Ejection System. – (U) Assemble and integrate exploratory ground, hardware-in-the-loop, and small satellite technologies, and techniques to validate overall concept. – (U) Design and fabricate the baseline MightySat Phase II vehicle. Tailor vehicle to meet requirements of first flight which is demonstrating nine distinct experiments. These include a hyperspectral imager, pulsed plasma thrusters, multi-functional structures, and miniaturized electronics. – (U) Develop near-space capabilities for experiments requiring high altitudes, long durations, and guided recovery systems. 	
– (U) \$1,831	Develop technologies such as guidance, navigation, and control avionics to support launch vehicles and ballistic missile flights. <ul style="list-style-type: none"> – (U) Fabricate solid state micro-mechanical guidance instruments for future ballistic missile environments – (U) Evaluate and test next generation thrust axis accelerometer. – (U) Develop improved techniques to determine accurate gravity field values--major source of error in space inertial navigation systems. 	
– (U) \$9,431	Develop Rocket System Launch Program launch capability using excess ballistic missile assets to test low-cost pop-up upperstage systems	
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		DATE February 1997
BUDGET ACTIVITY 2 - Applied Research	PE NUMBER AND TITLE 0602601F Phillips Laboratory Exploratory Development	
- (U) \$53,513 Total		

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BUDGET ACTIVITY 2 - Applied Research	PE NUMBER AND TITLE 0602601F Phillips Laboratory Exploratory Development	PROJECT 8809
<p>(U) <u>FY 1998 (\$ in Thousands)</u></p> <ul style="list-style-type: none"> – (U) \$5,594 Develop technologies for space platform subsystems such as cryocoolers, space vehicle thermal management, compact solar power cells, lightweight batteries and innovative power generation concepts <ul style="list-style-type: none"> – (U) Begin thin film solar cell development – (U) Complete development and integration testing of solid state primary battery for space and missile launch vehicle applications – (U) Evaluate and characterize ten to thirty degrees Kelvin cryocoolers – (U) \$4,158 Develop technologies for space platform structures such as spacecraft structural controls for vibration suppression and lightweight composite satellite and launch vehicle structures. <ul style="list-style-type: none"> – (U) Complete the advanced adaptive structures technology development program. – (U) Complete proof-of-concept experiments for the launch vehicle vibration isolation program and initiate avionics isolation program – (U) Continue the advanced launch vehicle structure technology development program. – (U) \$3,059 Develop technologies for space-based payload subsystems such as hardened sensors and satellite communications. <ul style="list-style-type: none"> – (U) Continue improvement of long-wavelength mercury cadmium telluride detectors and optimize for large focal plane arrays – (U) Complete development of large format, quantum well, infrared photodetector focal plane arrays and evaluate – (U) Integrate space-based surveillance models into wargaming simulations for immediate performance feedback – (U) \$3,955 Develop technologies for space-based payload components such as hardened electronics and memories. <ul style="list-style-type: none"> – (U) Continue evaluation and fabrication of advanced packaging technology whose goal is ten times size/volume/weight reduction – (U) Complete radiation hardened electronic materials investigation. – (U) Deliver interconnect and die advancement technologies. – (U) \$3,080 Develop technologies for satellite control such as standardized reusable software for astrodynamics and autonomous operations <ul style="list-style-type: none"> – (U) Continue development of satellite control software for applications such as multi-mission advanced ground intelligent control. – (U) Examine the use of wide area surveillance and distributed network for observation collection and processing. – (U) Continue writing software routines for integrated space technology product development. 		
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BUDGET ACTIVITY 2 - Applied Research	PE NUMBER AND TITLE 0602601F Phillips Laboratory Exploratory Development	PROJECT 8809
<ul style="list-style-type: none"> - (U) \$7,152 Develop ground and small satellite integration technologies for space and near-space experiments <ul style="list-style-type: none"> - (U) Launch MightySat-I from Space Shuttle mission STS-88. Conduct flight operations. One-year on-orbit will validate space applied research technologies minimizing the risk of inserting advanced technology into operational satellites. - (U) Begin development of technologies manifested for MightySat II.2 which tentatively include autonomous navigation and control, autonomous decision-making, threat-warning component technologies, and a fly wheel-storage device. - (U) Conclude fabrication of MightySat II.1 spacecraft bus and begin integration of experiments for FY 2000 launch. - (U) Demonstrate the capability to perform precision wavefront control of large aperture, sparse optical arrays via a fully integrated UltraLITE ground experiments. - (U) Continue the development of near-space capabilities and bus technologies for experiments requiring high altitudes, long durations, and guided recovery systems. - (U) \$1,471 Develop technologies such as guidance, navigation, and control avionics to support launch vehicles and ballistic missile flights. <ul style="list-style-type: none"> - (U) Complete improved techniques to determine accurate gravity field values, a major source of error in space inertial navigation systems. - (U) \$28,469 Total 		
(U) FY 1999 (\$ in Thousands)		
<ul style="list-style-type: none"> - (U) \$6,429 Develop technologies for space platform subsystems such as cryocoolers, space vehicle thermal management, compact solar power cells, lightweight batteries, and innovative power generation concepts <ul style="list-style-type: none"> - (U) Continue thin film solar cell development. - (U) Complete solid state secondary (rechargeable) battery cell design for space and missile launch vehicle applications - (U) Begin development of advanced deployable radiator. - (U) \$5,476 Develop technologies for space platform structures such as spacecraft structural controls for vibration suppression and lightweight composite satellite and launch vehicle structures. <ul style="list-style-type: none"> - (U) Conduct proof-of-concept experiments for the launch vehicle avionics isolation program. - (U) Continue the advanced launch vehicle structure technology development program. - (U) Continue feasibility demonstrations of autonomous active structural controls to dynamic precision spacecraft structures. - (U) Initiate the advanced multi-functional electronics and electrical system structures technology development program. - (U) \$2,404 Develop technologies for space-based payload subsystems such as hardened sensors and satellite communications. <ul style="list-style-type: none"> - (U) Continue improvement of long-wavelength mercury cadmium telluride detectors and optimize for large focal plane arrays - (U) Begin development of optical links, ultraviolet sensor and large format quantum well arrays. 		
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BUDGET ACTIVITY 2 - Applied Research	PE NUMBER AND TITLE 0602601F Phillips Laboratory Exploratory Development	
		PROJECT 8809
– (U) \$3,948	<ul style="list-style-type: none"> – (U) Continue developing very low absorption, low-scatter optical, thin-film coatings. Transfer technology to industry for scaling. 	
– (U) \$3,489	<ul style="list-style-type: none"> – (U) Develop technologies for space-based payload components such as hardened electronics and memories. – (U) Continue evaluation and fabrication of advanced packaging technology whose goal is ten times size/volume/weight reduction. – (U) Transition interconnect and die advancement technologies to PE 0603401F, Advanced Spacecraft Technology. – (U) Begin advanced device insulation technology development 	
– (U) \$3,489	<ul style="list-style-type: none"> – (U) Develop technologies for satellite control such as standardized reusable software for astrodynamics and autonomous operations – (U) Continue development of satellite control software for applications such as multi-mission advanced ground intelligent control. – (U) Demonstrate the use of wide area surveillance and distributed network for observation collection and processing. – (U) Combine software routines for integrated space technology product development into wargaming exercises 	
– (U) \$9,517	<ul style="list-style-type: none"> – (U) Develop ground and small satellite integration technologies for space and near-space experiments – (U) Conclude MightySat-I flight operations. Develop and distribute final report. – (U) Complete payload integration and launch vehicle integration of MightySat II.1 to launch aboard Multi-Service Launch System in FY 2000. – (U) Begin initial design of modifications to baseline MightySat II vehicle to accommodate experiments on autonomous navigation and control, autonomous decision-making, threat-warning component technologies, and a fly wheel-storage device. – (U) Begin the concept phase of the second integrated ground demonstration program. – (U) Continue the development of near-space capabilities and bus technologies for experiments requiring high altitudes, long durations, and guided recovery systems. 	
– (U) \$31,263	Total	

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BUDGET ACTIVITY 2 - Applied Research		PE NUMBER AND TITLE 0602601F Phillips Laboratory Exploratory Development			PROJECT 8809	
(U) B. <u>Program Change Summary (\$ in Thousands)</u>						
		<u>FY 1996</u>	<u>FY 1997</u>	<u>FY 1998</u>	<u>FY 1999</u>	<u>Total</u>
(U) Previous President's Budget		30,566	35,675	38,040	42,536	Cost
(U) Current Budget Submit/FY 1998 PB		30,567	53,513	28,469	31,263	Cont
 (U) Change Summary Explanation:						
Funding: Changes to this project since the previous President's Budget are due to budget constraints and priorities within the Science and Technology (S&T) Program.						
Schedule: Not Applicable.						
Technical: Not Applicable.						
 (U) C. <u>Other Program Funding Summary</u>						
(U) <u>Related Activities</u>						
- (U) PE 0602203F, Aerospace Propulsion.						
- (U) PE 0602102F, Materials.						
- (U) PE 0603302F, Space and Missile Rocket Propulsion.						
- (U) PE 0603311F, Ballistic Missile Technology.						
- (U) PE 0603401F, Advanced Spacecraft Technology.						
- (U) PE 0603410F, Space Systems Environmental Interactions.						
- (U) This project has been coordinated through the Project Reliance process to harmonize efforts and eliminate duplication.						
 (U) D. <u>Schedule Profile</u> Not Applicable.						
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