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

DATE: **February 1995**

BUDGET ACTIVITY: **2 - Exploratory Development**

PE NUMBER AND TITLE: **0602601F Phillips Laboratory**

COST (*In Thousands*)	FY 1994 Actual	FY 1995 Estimate	FY 1996 Estimate	FY 1997 Estimate	FY 1998 Estimate	FY 1999 Estimate	FY 2000 Estimate	FY 2001 Estimate	Cost to Complete	Total Cost
Total Program Element (PE) Cost	132,358	158,315	124,446	121,764	124,286	126,556	132,473	136,457	Continuing	Continuing
1010 Geophysics Technology	31,676	34,640	24,296	23,410	23,689	23,866	24,081	24,201	Continuing	Continuing
1011 Rocket Propulsion Technology	31,487	36,228	32,328	31,492	31,930	32,645	34,408	36,438	Continuing	Continuing
3326 Lasers and Imaging Technology	30,986	32,457	18,752	17,276	17,545	17,865	18,628	19,070	Continuing	Continuing
5797 Advanced Weapons Technology and Assessments	14,820	18,368	17,340	16,972	17,120	17,435	18,374	18,716	Continuing	Continuing
8809 Space Vehicle Technology	23,389	36,622	31,730	32,614	34,002	34,745	36,982	38,032	Continuing	Continuing

(U) Note: In FY 1995, the three Exploratory Development PEs at the Phillips Laboratory (PE 0602601F, Advanced Weapons; PE 0602101F, Geophysics; and PE 0602302F, Rocket Propulsion and Astronautics Technology) were combined into this PE. The funding for FY 1994 includes funding from all three PEs distributed according to the current project alignment.

(U) A. Mission Description and Budget Item Justification: This is the Exploratory Development technology program for the Phillips Laboratory's mission areas of spacecraft, launch vehicles, ballistic missiles, directed energy weapons (lasers and high power microwaves), long-range optical imaging, geophysics, and rocket propulsion (space launch, orbit transfer/maneuvering, ballistic and tactical missiles). All efforts in this program element contain the resources necessary, including civilian salaries, to manage, conduct, and document the technical activities.

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

	FY 1994	FY 1995	FY 1996	FY 1997	Total Cost
(U) Previous President's Budget	132,195	125,202	119,807	122,605	Cont
(U) Appropriated Value	132,878	159,502			
(U) Adjustments to Appropriated Value					
a. Congressional General Reductions	-683	-1,187			
b. SBIR	-974				
c. Below Threshold Reprogrammings	1,137				
(U) Current President's Budget	132,358	158,315	124,446	121,764	Cont

(U) Change Summary Explanation:

Funding: In FY 1995, Congressional actions impacted the following projects: 1010, $5 million added for High Altitude Active Auroral Research Program; 1011, $5 million added for Integrated High Performance Rocket Propulsion Technology; 3326, $13 million added for the Maui Supercomputer and $1.3 million added for the Advanced Electro-Optical System Spectrograph; and 8809, $10 million added for thermionics.

Schedule: Not Applicable.

Technical: Not Applicable.

(U) C. Other Program Funding Summary: Not Applicable.

(U) D. Schedule Profile: Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)			DATE February 1995
BUDGET ACTIVITY 2 - Exploratory Development	PE NUMBER AND TITLE 0602601F Phillips Laboratory		PROJECT 1010

COST (*In Thousands*)	FY 1994 Actual	FY 1995 Estimate	FY 1996 Estimate	FY 1997 Estimate	FY 1998 Estimate	FY 1999 Estimate	FY 2000 Estimate	FY 2001 Estimate	Cost to Complete	Total Cost
1010 Geophysics Technology	31,676	34,640	24,296	23,410	23,689	23,866	24,081	24,201	Continuing	Continuing

(U) A. Mission Description and Budget Item Justification: This project develops the technology to understand, mitigate, and exploit the effects of the natural environment on the design and operation of Air Force systems. This includes: defining, modeling, and developing techniques to predict the solar and space environment; developing models that specify and predict optical and infrared backgrounds and signatures of spacecraft and other targets; characterizing plasmas generated by aerospace vehicles; developing techniques to predict when and where ionospheric disturbances will occur; specifying atmospheric drag effects on satellites; measuring and modeling space debris; advancing technology in earth motions and seismology for nuclear test monitoring and test band treaty verification; and developing new techniques for measuring, modeling, simulating, and predicting meteorological properties impacting the Air Force mission. The project also develops modeling and simulation programs to enhance military system design and testing capabilities.

(U) FY 1994:

- (U) Continued development of space radiation specification and solar hazard prediction techniques for space system design and operations. ($5,570K)
  - (U) Delivered the first of the newly designed plasma and particle sensors for Block 5D3 (S-16) of the Defense Meteorological Satellite Program spacecraft.
  - (U) Delivered the Magnetospheric Specification and Forecasting Model for alerts of geomagnetic disturbances to spacecraft operators.
- (U) Continued development of atmospheric optical background simulations, models, and integrated codes for space system design and operation. ($4,950K)
  - (U) Delivered optical background and transmission codes for inclusion in the Standard Scene Generator Model.
  - (U) Delivered artificially obtained auroral data for use in the nuclear optical background codes needed to design systems that operate in a nuclear disturbed environment.
- (U) Continued development of active and passive remote sensing techniques for target signature identification and atmospheric wind profile measurements. ($2,970K)
  - (U) Used ballistic winds data obtained by laser imaging, detection, and ranging to improve targeting accuracy during AC-130H gunship live-fire and B-52G high altitude bombing exercises.
  - (U) Delivered extensive new infrared signature databases for the B-2, F-117, and C-17.
- (U) Continued development of global ionosphere models for communications, system applications, and neutral atmosphere models for satellite orbit forecasts. ($8,600K)
  - (U) Transitioned the Parameterized Real-Time Ionospheric Specification Model which has twice the accuracy of current operational models.
  - (U) Launched experiment on the Atmospheric Density Satellite to measure neutral densities for spacecraft operational specification and prediction models.

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	PROJECT 1010

– (U) Continued measuring and modeling effects of local plasmas on Air Force space systems. ($2,300K)
  – (U) Used a one-of-a-kind laboratory chamber to characterize plasmas associated with hypervelocity aerospace vehicles which degrade sensor performance and guidance accuracy.
– (U) Continued development of seismic event identification techniques for nuclear test ban treaty verification. ($2,256K)
  – (U) Delivered seismic attenuation and magnitude factors as well as a geophysical model for monitoring nuclear test activities.
– (U) Continued development of global and theater weather analysis, simulation, and prediction techniques for combat weather system applications. ($5,030K)
  – (U) Developed algorithms which will form the basis for a revolutionary upgrade to the Air Force Operational Global Cloud Analysis Capability.

(U) FY 1995:
– (U) Continue development of space radiation specification and solar hazard prediction techniques for space system design and operations. ($6,370K)
  – (U) Formulate quasi-static radiation belt model for space systems design and operations.
  – (U) Deliver space sensors for Defense Meteorological Support Program satellite S-17.
– (U) Continue development of atmospheric optical background simulations, models, and integrated codes for space system design and operation. ($5,550K)
  – (U) Start transition of key optical background data from successful space shuttle and rocket-borne experiments into optical background codes for operational use.
– (U) Continue development of active and passive remote sensing techniques for target signature identification and atmospheric wind profile measurements. ($3,400K)
  – (U) Initiate measurements of effluent plumes and chemical clouds by an airborne laser imaging, detection, and ranging to develop stand-off measurement capabilities.
  – (U) Complete the analysis of ballistic wind tests of bombs dropped from B-52s for bombing correction capabilities.
– (U) Continue development of global ionosphere models for communications, system applications, and neutral atmosphere models for satellite orbit forecasts. ($6,050K)
  – (U) Complete development of a model to simulate radio frequency propagation anywhere in the world under all possible ionospheric conditions.
  – (U) Transition Ionospheric Forecast Model for operational use.
– (U) Continue measuring and modeling effects of local plasmas on Air Force space systems. ($2,600K)
– (U) Continue development of seismic event identification techniques for nuclear test ban treaty verification. ($530K)
  – (U) Deliver an improved seismic array analysis technique for monitoring foreign underground detonation.
– (U) Continue development of global and theater weather analysis, simulation, and prediction techniques for combat weather system applications. ($5,400K)
  – (U) Verify recently developed theater-scale atmospheric models using ground-based radar wind profiles.
  – (U) Complete an artificial intelligence-based theater forecast model to give 12-hour forecasts.
  – (U) Deliver a weather model that realistically and accurately depicts clouds and rain for use in tactical situations.
– (U) Continue the High Frequency Active Auroral Research Project. ($4,740K)

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	PROJECT 1010

- (U) Conduct research to characterize the background ionospheric and electrojet conditions.
- (U) Demonstrate utility for communications and subterranean tunnel detection.

(U) FY 1996:

- (U) Continue development of space radiation specification and solar hazard prediction techniques for space system design and operations. ($5,175K)
  - (U) Formulate and update advanced radiation belt models that are essential for Air Force and DOD space system designs and operations.
  - (U) Develop adaptive optical techniques for improved solar imaging of disruptive solar events.
- (U) Continue development of atmospheric optical background simulations, models, and integrated codes for space system design and operation. ($4,510K)
  - (U) Collect 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) Continue development of active and passive remote sensing techniques for target signature identification and atmospheric wind profile measurements. ($2,765K)
  - (U) Use the Flying Infrared Signatures Technology Aircraft to collect infrared signatures of the F-22 and other aircraft/missiles to validate the operational targets and scenes code.
  - (U) Test an airborne laser imaging, detection, and ranging demonstrator on the Flying Infrared Signatures Technology Aircraft to characterize the optical path between the aircraft and the target to increase the accuracy of target measurements.
- (U) Continue development of global ionosphere models for communications, system applications, and neutral atmosphere models for satellite orbit forecasts. ($4,915K)
  - (U) Extend the Parameterized Real-Time Ionospheric Specification Model to 22,000 kilometers and transition for operational use.
- (U) Continue measuring and modeling effects of local plasmas on Air Force space systems. ($2,115K)
  - (U) Measure degradation of radio frequency transmissions passing through plasmas generated around aerospace vehicles at shock tunnel and ballistic range facilities.
- (U) Continue development of seismic event identification techniques for nuclear test ban treaty verification. ($430K)
  - (U) Deliver a physical model for guided crustal waves for applications in the Eurasian and Middle East region.
- (U) Continue development of global and theater weather analysis, simulation, and prediction techniques for combat weather system applications. ($4,386K)
  - (U) Deliver an advanced parameter global cloud analysis model to Air Force Global Weather Central.
  - (U) Complete data fusion project to integrate disparate weather data in a battlefield setting to enhance theater weather forecasting.

(U) FY 1997:

- (U) Continue development of space radiation specification and solar hazard prediction techniques for space system design and operations. ($4,910K)
  - (U) Design the follow-on Compact Radiation Effects Satellite payload to characterize potentially dangerous high energy space particles.
  - (U) Deliver new spacecraft charging algorithms to assess spacecraft-plasma interactions.
- (U) Continue development of atmospheric optical background simulations, models, and integrated codes for space system design and operation. ($4,330K)

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- (U) Extend the wavelength coverage of the operational atmospheric backgrounds code into the ultraviolet and millimeter wavelength regions.
- (U) Continue development of active and passive remote sensing techniques for target signature identification and atmospheric wind profile measurements. ($2,770K)
  - (U) Use Flying Infrared Signatures Technology Aircraft measurements to expand and validate the spectral in-band radiance images of targets and scenes code.
- (U) Continue development of global ionosphere models for communications, system applications, and neutral atmosphere models for satellite orbit forecasts. ($4,740K)
  - (U) Obtain data from the instruments on the atmospheric density satellite to validate operational, global, neutral density specification, and forecast models.
- (U) Continue measuring and modeling effects of local plasmas on Air Force space systems. ($2,025K)
  - (U) Test chemical and other techniques for modifying plasma effects around aerospace vehicles to mitigate their effects.
- (U) Continue development of seismic event identification techniques for nuclear test ban treaty verification. ($430K)
  - (U) Deliver a model of Eurasian and Middle East crust and mantle structure to improve capabilities for monitoring these areas.
- (U) Continue development of global and theater weather analysis, simulation, and prediction techniques for combat weather system applications. ($4,205K)
  - (U) Transition techniques that will improve vehicle space launch capabilities by identifying potentially dangerous electric fields in clouds near launch sites.

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

	FY 1994	FY 1995	FY 1996	FY 1997	Total Cost
(U) Previous President's Budget	31,676	29,900	28,750	28,800	Cont
(U) Current President's Budget	31,676	34,640	24,296	23,410	Cont

(U) Change Summary Explanation:

Funding: In FY 1995, Congressional actions added $5 million for High Altitude Active Auroral Research Program. FY 1996 and 1997 changes are due to Air Force reprioritization.

Schedule: Not Applicable.

Technical: Not Applicable.

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(U) C. Other Program Funding Summary:

(U) Related Activities:
- (U) PE 0305160F, Defense Meteorological Satellite Program.
- (U) PE 0601102F, Defense Research Sciences.
- (U) PE 0602204F, Aerospace Avionics.
- (U) PE 0603410F, Space Systems Environmental Interactions Technology.
- (U) PE 0603707F, Weather Systems Advanced Development.
- (U) This project has been coordinated through the Project Reliance process to harmonize efforts and eliminate duplication.

(U) D. Schedule Profile: Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)			DATE February 1995
BUDGET ACTIVITY 2 - Exploratory Development	PE NUMBER AND TITLE 0602601F Phillips Laboratory		PROJECT 1011

COST (*In Thousands*)	FY 1994 Actual	FY 1995 Estimate	FY 1996 Estimate	FY 1997 Estimate	FY 1998 Estimate	FY 1999 Estimate	FY 2000 Estimate	FY 2001 Estimate	Cost to Complete	Total Cost
1011 Rocket Propulsion Technology	31,487	36,228	32,328	31,492	31,930	32,645	34,408	36,438	Continuing	Continuing

(U) A. Mission Description and Budget Item Justification: This project conducts exploratory development and transitions the most promising basic research and fundamental rocket propulsion technologies for boost and orbit transfer, satellite maneuvering, tactical, and ballistic missile applications into component and subsystem applications to demonstrate feasibility and potential mission payoffs. Technologies of interest are those which will improve reliability, operability, survivability, affordability, environmental compatibility, and performance of future propulsion systems while reducing material, manufacturing, and support costs. Technology will be developed to reduce the weight and cost of components using materials, improved designs, and improved manufacturing techniques. All efforts are part of the Integrated High Payoff Rocket Propulsion Technology (IHPRPT) initiative, a joint DOD, NASA, and industry effort to focus rocket propulsion technology to the needs of the nation.

(U) FY 1994:
- (U) Continued development of components necessary for the incorporation of advanced environmentally friendly propellants into existing and future missile systems. ($13,627K)
  - (U) Completed studies which documented payoffs from non-toxic, non-cryogenic, high performance, storable liquid fuel/oxidizer ingredient development.
  - (U) Evaluated and selected ingredients to boost the performance of environmentally friendly solid rocket motor propellants.
- (U) Continued development of solid and liquid propulsion technology for environmentally safe and low-cost access to space. ($12,860K)
  - (U) Analyzed advanced fluid film bearing wear to quantify their benefits in turbopump assemblies for restartable engines.
  - (U) Designed a non-eroding altitude compensating nozzle which will increase solid rocket motor performance.
  - (U) Developed polymeric nozzles to decrease motor weight and increase reliability.
  - (U) Developed a computer code to model the structural and ballistic interaction of solid propellants and cases to allow motor designers to design lighter weight motors with more accurate margins of safety.
  - (U) Completed proof-of-concept development of a solid rocket motor with greatly reduced ozone depleting hydrochloric acid in the exhaust.
  - (U) Completed proof-of-concept development of a catalytic ignitor as a low-cost, multiple thrust chamber ignition source.
  - (U) Installed hydrostatic bearing test rig and performed initial screen testing of turbopump bearing coatings using liquid nitrogen.
- (U) Continued development of high energy density materials. ($5,000K)
  - (U) Identified possible high energy oxidizers and fuels, such as nitrogen, hydrogen, strained-ring hydrocarbon, and oxygen-based propellant ingredients.

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(U) FY 1995:

- (U) Continue development of components necessary for the incorporation of advanced environmentally friendly propellants into existing and future missile systems. ($11,800K)
  - (U) Develop non-toxic, non-cryogenic, high performance, storable liquid fuel/oxidizer ingredients.
  - (U) Analyze propellant, explosive, and pyrotechnic waste products.
  - (U) Complete scale-up and testing of energetic ingredients to boost the performance of environmentally friendly solid rocket motor propellants.
- (U) Continue development of solid and liquid propulsion technology for environmentally safe and low-cost access to space. ($18,728K)
  - (U) Develop and analytically validate a representative hydrogen turbopump design incorporating advanced fluid-film bearing technologies that meet the performance and system integrity requirements.
  - (U) Demonstrate fabrication techniques to reduce cost of investment casting of combustion chambers.
  - (U) Complete testing of hydrostatic bearing coatings in liquid hydrogen and quantify the life enhancement benefits.
  - (U) Develop carbon-carbon coating methods using a plasma torch to create lightweight, high strength, high temperature components.
  - (U) Demonstrate a new rapid densification process for carbon-carbon and ceramic nozzles that will greatly reduce manufacturing time and cost.
  - (U) Design a functionally integrated solid rocket motor which uses polymeric-based propellants and components to eliminate all bond lines and increase reliability.
  - (U) Perform proof-of-concept testing on the non-eroding altitude compensating nozzle which will increase motor performance.
  - (U) Formulate an environmentally friendly solid rocket motor propellant which will eliminate all toxic products from the manufacturing and operation process.
- (U) Continue development of high energy density materials. ($5,700K)
  - (U) Determine the chemical and physical properties of the oxidizer/fuel molecules and begin performance prediction analysis.
  - (U) Conduct synthetic and theoretical searches for new strained ring hydrocarbon and novel high energy compounds for both solid and liquid propulsion.
  - (U) Conduct analysis of potential cryogenic solid propellant ingredients.

(U) FY 1996:

- (U) Continue development of high energy density materials. ($5,600K)
  - (U) Determine feasibility of solid hydrogen and metallic clusters, metal atom doped cryogenic-solids, and solids with impurities as high energy density materials candidates.
  - (U) Continue development of cryogenic solids, high-pressure solids, extended solid properties, and maximized high energy density material additives in cryogenic solids for future use in a solid or hybrid rocket with revolutionary performance increases.
  - (U) Test fire solid oxygen combustor.
  - (U) Test fire first new liquid high energy density materials additive (quadricyclane) in a 4,000 pound engine and begin scale-up demonstrations.
  - (U) Continue searches for strained ring hydrocarbon and high energy compounds for solid and liquid propulsion.

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- (U) Conduct synthesis on new solid, non-halogenated oxidizers, which do not deplete the ozone, for environmentally safe rocket motors.
- (U) Develop scale-up capability for liquid high energy density materials.

– (U) Continue development of propulsion technologies for tactical missile system applications. ($2,900K)
- (U) Fabricate and begin demonstrations of component technologies such as no-erosion, altitude compensating nozzles (for use in solid missile systems).
- (U) Conduct analysis to develop lightweight liners.
- (U) Test environmental propellants and processes to produce minimum smoke, environmentally safe propellants for use in tactical missiles.

– (U) Continue development of propulsion technology to meet the needs of reliable, safe, and low-cost boost and orbit transfer applications. ($18,978K)
- (U) Manufacture low-cost, coated carbon-carbon ceramic components and hybrid polymers for future demonstration of high temperature, non-erosive, lightweight components for use in solid rocket motors.
- (U) Fabricate and assemble the fluid film bearings into the breadboard turbopump using advanced manufacturing and fabrication methods to validate added cost and weight savings, and begin testing hydrostatic bearings in turbopump assemblies (“real” conditions).
- (U) Fabricate a combustion chamber using powder metallurgy technology to increase their performance.
- (U) Design and fabricate an altitude compensating nozzle to integrate into a liquid engine.
- (U) Develop and evaluate new injector concepts that reduce costs, increase reliability, and increase engine performance.
- (U) Compile data on hybrid propulsion concepts to develop state-of-the-art hybrid rocket motor technologies.

– (U) Continue development of advanced boost and orbit transfer propellants which are environmentally safe during manufacture, storage, use, and disposal. ($2,900K)
- (U) Characterize and evaluate the synthesized non-toxic, non-cryogenic, high performance, storable liquid fuel/oxidizer components and identify candidate solutions.
- (U) Design non-toxic, non-cryogenic, high performance, storable liquid fuel/oxidizer components.
- (U) Develop and optimize lab procedures to minimize propellant, explosive, and pyrotechnic waste products and optimize disposal procedures.
- (U) Conduct sub-scale synthesis of alternate clean propellants to increase the ballistic mechanical and stability properties of the environmentally acceptable propellants.
- (U) Test to determine ways to increase the processability (e.g., rapid and more efficient manufacturing) of new environmentally compliant solid rocket fuels.
- (U) Manufacture and quantify laboratory quantities of new, high energy ingredients to be used in environmental propellants.

– (U) Continue development of satellite propulsion technology for control and on-orbit transfer. ($1,950K)
- (U) Investigate the beam divergence of a 1000-watt anode layer thruster and evaluate methods that could reduce divergence.

(U) FY 1997:

– (U) Continue development of high energy density materials. ($5,642K)
- (U) Complete studies and analysis of solid hydrogen and metallic clusters, metal atom doped cryogenic solids, and solids with impurities. Write final technical report and transition best high energy density materials candidates into the cryogenic solid properties and combustion programs.

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- (U) Finish exploring cryogenic solid, high-pressure solid, and extended solid properties. Determine candidate selections for cryogenic solid and extended solid combustion programs.
- (U) Develop techniques to accurately measure high energy density materials additive concentrations in cryogenic solids.
- (U) Test fire cryogenic hybrid rocket demonstrator.
- (U) Perform large-scale quadricyclane engine tests/demonstrations.
- (U) Complete strained ring hydrocarbon high energy compound development. Write final technical reports identifying the best candidates for a scale-up program.
- (U) Select solid, non-halogenated oxidizer, candidates and other synthesized new high energy density materials ingredients for scale-up programs.
- (U) Scale-up solid and liquid high energy density materials to begin large-scale thrust demonstrations.

– (U) Continue development of propulsion technologies for tactical missile system applications. ($2,800K)
- (U) Test fabrication techniques to manufacture lightweight liners.
- (U) Complete testing and demonstration of environmental propellants and processes to produce minimum smoke, environmentally safe tactical missiles.
- (U) Evaluate commercial technologies and practices for incorporation into low-cost, high performance, environmentally compliant tactical missiles.
- (U) Analyze new propellant and component technologies to develop a lightweight, highly maneuverable propulsion system that will assure high kill ratios against the next generation of highly maneuverable planes and meet tactical performance goals.

– (U) Continue development of propulsion technology to meet the needs of reliable, safe, and low-cost boost and orbit transfer applications. ($18,250K)
- (U) Demonstrate low-cost, high temperature, non-erosive, lightweight coated carbon-carbon ceramic and hybrid polymer components for use in solid rocket motors.
- (U) Demonstrate the fluid film bearing designs and verify the performance and integrity of the turbopump.
- (U) Test and evaluate the performance increase obtained by integrating an altitude compensating nozzle in a liquid engine.
- (U) Hot fire test and demonstrate the long life capabilities of a high performance thrust cell.
- (U) Fabricate a thrust chamber designed to extend thermal cycle life.
- (U) Design low torque valves, electromechanical actuators, and connectors which are leak-free with non-precision alignment during installation in cryogenic systems to increase system reliability and operability while reducing maintenance costs.
- (U) Analyze new, low-cost, and highly reliable manufacturing techniques such as electron beam cure and new design tools to improve solid rocket motor flaws and ballistic interactions.
- (U) Design injectors that enable reduced cost, increased reliability, and increased engine performance.
- (U) Analyze and quantify the benefits of hybrid rocket motor technology and report on best candidate technologies available to create a hybrid rocket motor for enhanced operational flexibility and low-cost, assured space access.

– (U) Continue development of advanced boost and orbit transfer propellants which are environmentally safe during manufacture, storage, and use. ($2,800K)
- (U) Evaluate ignition characteristics, determine combustion efficiencies, and report the results of the synthesized non-toxic, non-cryogenic, high performance, storable liquid fuel/oxidizer components.
- (U) Fabricate and test non-toxic, non-cryogenic, high performance, storable liquid fuel/oxidizer components.

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- (U) Determine alternative disposal procedures/technologies to thermolyze or breakdown propellant, explosive, and pyrotechnic wastes into their non-hazardous constituent parts.
- (U) Scale-up and demonstrate state-of-the-art ingredients to bolster the performance of the next generation of environmentally acceptable propellants.
- (U) Integrate all of the current solid propellant work being done under high energy density materials and incorporate the most promising ingredients into state-of-the-art propellants.
- (U) Evaluate and analyze radically new methods of solid rocket motor manufacture to develop low-cost solid rocket motors that exceed the performance of current liquid rocket propellants.
- (U) Scale-up and demonstrate the innovative energetic ingredients that are currently being built within government and contractor laboratories. The most promising ingredients (solid or liquid) will be fed into an innovative propellants type project to be used in next generation propellant.

– (U) Continue development of satellite propulsion technology for control and on-orbit transfer. ($2,000K)
- (U) Optimize the internal magnetic field for the 1000-watt anode layer thruster.
- (U) Develop and evaluate improved designs to fabricate a pulsed plasma thruster.

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

	FY 1994	FY 1995	FY 1996	FY 1997	Total Cost
(U) Previous President's Budget	31,487	31,500	30,600	30,800	Cont
(U) Current President's Budget	31,487	36,228	32,328	31,492	Cont

(U) Change Summary Explanation:

Funding: In FY 1995, Congressional actions added $5 million for Integrated High Performance Rocket Propulsion Technology.

Schedule: Not Applicable.

Technical: Not Applicable.

(U) C. Other Program Funding Summary:

(U) Related Activities:
- (U) PE 0602111N, Anti-Air/Anti-Surface Warfare Technology.
- (U) PE 0602303A, Missile Technology.
- (U) PE 0603302F, Space and Missile Rocket Propulsion Technology.

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– (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. Schedule Profile: Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)			DATE February 1995
BUDGET ACTIVITY 2 - Exploratory Development	PE NUMBER AND TITLE 0602601F Phillips Laboratory		PROJECT 3326

COST (*In Thousands*)	FY 1994 Actual	FY 1995 Estimate	FY 1996 Estimate	FY 1997 Estimate	FY 1998 Estimate	FY 1999 Estimate	FY 2000 Estimate	FY 2001 Estimate	Cost to Complete	Total Cost
3326 Lasers and Imaging Technology	30,986	32,457	18,752	17,276	17,545	17,865	18,628	19,070	Continuing	Continuing

(U) A. Mission Description and Budget Item Justification: This project examines the technical feasibility of moderate to high power lasers, associated optical components, and long-range optical imaging concepts for Air Force mission requirements. This includes: advanced short wavelength laser devices for applications such as illuminators and imaging sources; advanced optical imaging techniques for target identification and assessment as well as aimpoint selection, maintenance, and damage assessment; high power laser device and optical component technology; advanced beam control and atmospheric compensation technology, tools, and techniques for laser target vulnerability assessments; and nonlinear optics processes and techniques.

(U) FY 1994:

- (U) Continued development of various laser device technologies for applications such as illuminators and wavelength-specific military missions. ($5,742K)
  - (U) Demonstrated high efficiency, solid-state, frequency-doubled neodymium-yttrium-aluminum-garnet laser.
  - (U) Demonstrated near diffraction-limited diode-pumped solid-state laser for use as a master oscillator for illuminator applications.
  - (U) Demonstrated power scaling for laser at four micrometers wavelength, addressing requirements for countermeasure applications.
- (U) Continued development of long-range optical imaging technologies for increased resolution and data fusion to support missions such as space object identification. ($5,240K)
  - (U) Applied hyperspectral sensing techniques to demonstrate feasibility of satellite spectral “fingerprinting” to support space object identification.
  - (U) Completed analytical evaluation of interferometric imaging concepts, demonstrating payoff for passive deep space imaging.
  - (U) Demonstrated three-dimensional imaging of turbulent flow fields in laboratory testing.
- (U) Continued to investigate and develop nonlinear optics technologies. ($4,128K)
  - (U) Demonstrated intracavity nonlinear optics concept for high efficiency wavelength shifting to arbitrary wavelengths.
- (U) Continued the investigation and development of advanced high energy laser optical components. ($235K)
  - (U) Completed development of advanced optical coating process and demonstrated ultra-low absorption, high reliability optical coatings at 1.3 micron wavelength.
- (U) Continued laser assessment studies to identify technologies required for high payoff military applications of laser and optical systems. ($641K)
  - (U) Completed laser effects tests and initial assessment of the potential of laser concepts to degrade or destroy infrared guidance systems in tactical missiles.
- (U) Continued development of the Maui supercomputer facility. ($15,000K)
  - (U) Maui High Performance Computing Center became operational.
  - (U) Upgraded facility from 80 processors to 400 processors.

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- (U) Established capability to process classified data.

(U) FY 1995:

- (U) Continue development of generic high energy laser device technology for applications such as illuminators and wavelength-specific military missions. ($2,251K)
  - (U) Develop high-average power diode-pumped lasers.
  - (U) Demonstrate power scaling for wavelength agile laser in mid-infrared wavelength region.
- (U) Develop basic laser source and target coupling technology for high payoff applications such as laser-induced microwave emission effects phenomenology. ($4,125K)
  - (U) Complete development and deliver an improved laser source for fundamental target coupling phenomenology studies to address the potential of laser-induced microwave effects.
- (U) Continue developing long-range optical imaging technologies for increased resolution and data fusion to support missions such as space object identification. ($6,383K)
  - (U) Begin investigation of improved image reconstruction algorithms applicable to sparsely-filled, synthetic aperture imaging concepts (active and passive).
  - (U) Complete theory development for daytime imaging using adaptive optics to support optimum configuration of field experiments under advanced development funding.
  - (U) Transition hyperspectral imaging technology to standoff detection applications.
  - (U) Complete evaluation of the payoff of hyperspectral “fingerprinting” to the space object identification/mission payload assessment mission for deep space objects.
- (U) Continue to develop nonlinear optics technologies to support imaging and other applications. ($2,403K)
  - (U) Demonstrate feasibility of using chaos control concepts with laser devices to produce wavelength agility.
  - (U) Complete evaluation of nonlinear optics concepts for scaling visible wavelength lasers to kilowatt average power.
- (U) Continue the investigation and development of advanced high energy laser optical components. ($2,995K)
  - (U) Complete fabrication and delivery of high performance, low-cost cooled deformable mirror.
  - (U) Initiate development and scaling of low-flow cooled optics concepts to meet requirements for mirrors, aperture sharing elements, and cooled windows in full-scale laser systems.
  - (U) Complete evaluation of environmental and thermal cycling stability for high performance coating samples.
- (U) Continue development of the Maui supercomputer facility. ($13,000K)
  - (U) Increase high speed storage capability by 20 trillion bytes.
  - (U) Provide near-real-time images to Air Force Space Command.
- (U) Develop the advanced electro-optical system spectrograph. ($1,300K)

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(U) FY 1996:
- (U) Continue development of generic high energy laser device technology for applications such as illuminators and wavelength-specific military missions. ($3,639K)
  - (U) Complete development and delivery of a high power (up to one kilowatt), wavelength agile, visible laser source.
- (U) Continue to develop basic laser source and target coupling technology for high payoff applications such as the laser-induced microwave effects phenomenology. ($2,874K)
  - (U) Complete initial investigation of laser-induced microwave effects phenomenology.
  - (U) Begin evaluation of laser-induced microwave effect on military system materials.
- (U) Continue development of long-range optical imaging technologies for increased resolution and data fusion to support missions such as space object identification. ($5,413K)
  - (U) Conduct fundamental risk reduction experiments and demonstrations for technology critical to selected deep space imaging concepts.
  - (U) Identify and begin investigation of key fundamental technologies to establish the feasibility of high-payoff applications identified in the Imaging and Sensing Mission study.
  - (U) Initiate effort to incorporate real-time imaging processing algorithms into generic on-board processing schemes.
- (U) Continue to investigate and develop nonlinear optics technologies to support imaging and other applications. ($3,491K)
  - (U) Demonstrate high-power frequency conversion to visible wavelengths from solid-state lasers using nonlinear optics concepts.
  - (U) Demonstrate ultra-fast (gigahertz) control mechanisms using nonlinear optics concepts in unstable laser systems.
- (U) Continue the investigation and development of advanced high energy laser optical components. ($3,335K)
  - (U) Demonstrate producibility of low-flow cooled optics as a precursor to full-scale development.

(U) FY 1997:
- (U) Continue development of generic high energy laser device technology for applications such as illuminators and wavelength-specific military missions. ($3,200K)
  - (U) Demonstrate a multi-joule, frequency agile laser device for remote sensing applications.
- (U) Continue to develop basic laser source and target coupling technology for high payoff applications such as the laser-induced microwave effects phenomenology. ($2,612K)
  - (U) Complete experiment evaluation and analysis to assess the effectiveness of laser-induced microwave effects technology in specific military applications.
- (U) Continue development of long-range optical imaging technologies for increased resolution and data fusion to support missions such as space object identification. ($5,135K)
  - (U) Complete initial development and laboratory experiments on a key technology for high-payoff imaging applications and transition to advanced development.

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– (U) Complete laboratory demonstration of breadboard on-board image processing concept.

– (U) Continue to investigate and develop nonlinear optics technologies to support imaging and other applications. ($4,000K)

– (U) Demonstrate multi-gigahertz control mechanisms in laser sources suitable for high-data rate laser communications applications.

– (U) Continue the investigation and development of advanced high energy laser optical components. ($2,329K)

– (U) Complete development and testing of full-scale optical components based on low-flow cooling concepts.

– (U) Complete assessment of advanced coating processes and materials, recommending best coatings for full-scale laser system applications.

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

	FY 1994	FY 1995	FY 1996	FY 1997	Total Cost
(U) Previous President's Budget	30,986	18,400	17,050	17,900	Cont
(U) Current President's Budget	30,986	32,457	18,752	17,276	Cont

(U) Change Summary Explanation:

Funding: In FY 1995, Congress added $13 million for the Maui supercomputer and $1.3 million for the advanced electro-optical system spectrograph.

Schedule: Not Applicable.

Technical: Not Applicable.

(U) C. Other Program Funding Summary:

(U) Related Activities:

– (U) PE 0602101N, Directed Energy Weapons.

– (U) PE 0602307A, Laser Weapon Technology.

– (U) PE 0603314A, High Energy Laser and Directed Energy Components.

– (U) PE 0603319F, Airborne Laser Demonstrator.

– (U) PE 0603605F, Advanced Weapons Technology.

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

(U) D. Schedule Profile: Not Applicable.

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BUDGET ACTIVITY 2 - Exploratory Development	PE NUMBER AND TITLE 0602601F Phillips Laboratory		PROJECT 5797

COST (*In Thousands*)	FY 1994 Actual	FY 1995 Estimate	FY 1996 Estimate	FY 1997 Estimate	FY 1998 Estimate	FY 1999 Estimate	FY 2000 Estimate	FY 2001 Estimate	Cost to Complete	Total Cost
5797 Advanced Weapons Technology and Assessments	14,820	18,368	17,340	16,972	17,120	17,435	18,374	18,716	Continuing	Continuing

(U) A. Mission Description and Budget Item Justification: This project explores high power microwave and other unconventional weapon concepts using innovative technologies such as compact toroids. Technologies are developed that support a wide range of Air Force missions such as space control, command and control warfare, and counter-air warfare. This project also provides 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.

(U) FY 1994:

- (U) Develop generic advanced weapon technologies that support many Air Force applications. ($3,051K)
  - (U) Completed new design of a pulse forming network for high power microwave ultra-wideband sources to increase efficiency to 100%.
  - (U) Obtained first radio frequency power from magnetic injection line oscillator device.
  - (U) Completed pyramidal horn antenna to obtain 70 kilovolts per meter from ultra-wideband source at ten meters.
  - (U) Developed high-power solid-state gallium arsenide switching technology that provided 10,000 shots, a 100 times improvement to previous design.
  - (U) Began development of solid-liner plasma-driven hypervelocity projectiles.
- (U) Continue to assess effects/lethality of directed energy weapon technologies against representative air and ground military systems. ($1,134K)
  - (U) Completed low frequency, high power microwave effects on F-16.
  - (U) Completed assessment of Stinger launch tube high power microwave susceptibilities.
- (U) Develop high power microwave technologies that will support applications such as suppression of enemy air defense, counter-air, command and control warfare, and aircraft self-protection. ($4,510K)
  - (U) Developed miniature monocone antenna to support command and control warfare using high power microwaves.
  - (U) Developed new virtual antenna design to support command and control warfare applications using high power microwaves.
  - (U) Completed concept exploration development for suppression of enemy air defense using high power microwaves.
- (U) Continued to develop high power microwave technologies, including susceptibility and effects experiments and modeling and data base development, to support space control applications. ($3,005K)
  - (U) Completed high power microwave effects tests of first generation silicon focal plane arrays and single element mercury/cadmium/telluride detectors.

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- (U) Completed preliminary assessment of Global Positioning System receiver susceptibility to high power microwaves and made recommendations to Global Positioning System program office.

– (U) Continued to assess the vulnerability of various space assets to natural and man-made threats such as solar radiation, space debris, and directed energy weapons. ($3,120K)
  - (U) Completed predictive radio frequency effects coupling tool that performs end-to-end simulation and investigates component/subsystem susceptibilities.
  - (U) Collected shuttle engine thruster plume spectra to characterize optical missions and identify contaminants.
  - (U) Develop satellite directed energy weapon lethality and assessment models for four assets.

(U) FY 1995:

– (U) Develop generic advanced weapon technologies that support many Air Force applications. ($3,726K)
  - (U) Develop alternative directed energy weapon sources that will destroy advanced/future enemy integrated air defense systems.
  - (U) Continue to develop advanced pulse power technologies that will power new high power microwave source designs.
  - (U) Continue development of solid-liner plasma-driven hypervelocity projectiles.

– (U) Continue to assess effects/lethality of directed energy weapons technologies against representative air and ground military systems. ($1,460K)
  - (U) Complete fixed-site design for high power microwave effects hardening testing for command and control warfare applications.
  - (U) Complete communications network response experiments to identify network susceptibilities to high power microwaves.

– (U) Develop high power microwave technologies that will support applications such as suppression of enemy air defenses, counter-air, command and control warfare, and aircraft self-protection. ($5,590K)
  - (U) Complete high power microwave weapons concept investigations for command and control warfare mission.
  - (U) Downselect wideband high power microwave source which provides aircraft self-protection.

– (U) Continue to develop high power microwave technologies, including susceptibility and effects experiments and modeling and data base development, to support space control applications. ($3,725K)
  - (U) Perform tests of susceptibility of advanced focal plane arrays to electromagnetic emissions.
  - (U) Begin multi-threat directed energy weapon warning/reporting/protection technology efforts.
  - (U) Deliver integrated multi-subsystem survivability/vulnerability modeling capability.

– (U) Continue to assess the vulnerability of various space assets to natural and man-made threats such as solar radiation, space debris, and directed energy weapons. ($3,867K)
  - (U) Develop satellite directed energy weapon lethality and assessment models for five assets.
  - (U) Develop multi-threat survivability/vulnerability capability.
  - (U) Continue space payload assessment and environmental interaction experiments and quantify ultraviolet/visible/infrared satellite signatures.

(U) FY 1996:

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– (U) Develop generic advanced weapon technologies that support many Air Force applications. ($6,871K)
  – (U) Develop advanced pulse power technologies that will power new high power microwaves source designs.
  – (U) Continue development of narrowband and ultra-wideband high power microwave sources and antennas for command and control warfare efforts.
  – (U) Develop high performance computer codes to support plasma and pulsed power research.
  – (U) Investigate agent defeat technology, using high power microwaves, to neutralize biological weapons.
  – (U) Transition ultra-wideband antenna to PE 0603605F.
– (U) Continue to assess effects/lethality of directed energy weapon technologies against representative air and ground military systems. ($3,005K)
  – (U) Develop computer modeling codes that predict high power microwave coupling into aircraft and complete B-2 shielding survey.
  – (U) Develop technologies to harden military assets against high power microwave damage and effects.
  – (U) Continue high power microwave upset characterization of various system hardware, including command and control network equipment.
  – (U) Develop specifications and standards and hardness maintenance technologies for systems such as F-16, Hawk missile, and F-22.
  – (U) Complete counter-air effectiveness analyses of high power microwave weapons.
– (U) Develop high power microwave technologies that will support applications such as suppression of enemy air defenses, counter-air, command and control warfare, and aircraft self-protection. ($3,528K)
  – (U) Complete high power microwave weapons concept exploration for command and control warfare.
  – (U) Continue theoretical analysis of predicted high power microwave weapon effectiveness for suppression of enemy air defense and command and control warfare.
  – (U) Develop downselected narrowband source technology for suppression of enemy air defense applications.
  – (U) Complete high power microwave weapons application analysis for counter-air applications.
– (U) Continue to develop high power microwave technologies, including susceptibility and effects experiments and modeling and data base development, to support space control applications. ($1,836K)
  – (U) Continue multi-threat warning/protection technologies.
  – (U) Develop hardened space sensor.
  – (U) Develop high power microwave weapon applications concept designs.
– (U) Continue to assess the vulnerability of various space assets to natural and man-made threats such as solar radiation, space debris, and directed energy weapons. ($2,100K)
  – (U) Develop satellite lethality and assessment models for four assets.
  – (U) Provide advanced sensor design and assessments for multi-spectral, multi-sensor data analysis workstation.
  – (U) Complete space payload assessment and environmental interaction experiments.

(U) <u>FY 1997</u>:
– (U) Continue to develop generic advanced weapon technologies that support many Air Force applications. ($6,390K)
  – (U) Develop advanced pulse power technologies.

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- (U) Develop high performance computer codes to support plasma and pulsed power research.
- (U) Continue to investigate agent defeat technology, using high power microwave technologies, to neutralize biological weapons.
- (U) Continue to develop narrowband and wideband sources and antennas and complete compact toroid effort.

– (U) Continue to assess effects/lethality of directed energy weapon technologies against representative air and ground military systems. ($3,051K)
- (U) Develop computer modeling codes that predict high power microwave coupling into advanced technology aircraft and complete F-22 coupling experiments.
- (U) Develop fratricide protection technology for advanced technology fighter aircraft.
- (U) Complete command and control warfare effectiveness analyses using high power microwaves.
- (U) Transition specifications and standards and high power microwave hardness surveillance technologies to F-16 and F-22 program offices.
- (U) Continue directed energy weapon lethality/survivability enhancements and equipment upset characterization of various foreign and U.S. systems.
- (U) Develop high power microwave hardening criteria for large aircraft, such as cargo transport, air refueling, and bomber aircraft.

– (U) Develop high power microwave technologies that will support applications such as suppression of enemy air defenses, counter-air, command and control warfare, and aircraft self-protection. ($3,671K)
- (U) Continue in situ experimentation with installed systems for command and control warfare using high power microwaves.
- (U) Begin in situ demonstrations of selected high power microwave 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 defense.

– (U) Continue to develop high power microwave technologies, including susceptibility and effects experiments and modeling and data base development, to support space control applications. ($1,760K)
- (U) Select one high power microwave weapon concept for development.

– (U) Continue to assess the vulnerability of various space assets to natural and man-made threats such as solar radiation, space debris, and directed energy weapons. ($2,100K)
- (U) Develop directed energy weapon lethality and assessment models for five satellites.
- (U) Transition satellite survivability/vulnerability/lethality assessments to the ground-based laser technology program.
- (U) Transition advanced data fusion techniques to the multi-spectral, multi-sensor data analysis workstation.

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

	FY 1994	FY 1995	FY 1996	FY 1997	Total Cost
(U) Previous President's Budget	14,820	18,505	17,104	17,977	Cont
(U) Current President's Budget	14,820	18,368	17,340	16,972	Cont

(U) Change Summary Explanation:
Funding: Changes due to budget constraints.

Schedule: Not Applicable.

Technical: Not Applicable.

(U) C. Other Program Funding Summary:

(U) Related Activities:
- (U) PE 0602120A, Electronic Survivability and Fuzing Technology.
- (U) PE 0602111N, Anti-Air/Anti-Surface Warfare Technology.
- (U) PE 0602202F, Human Systems Technology.
- (U) PE 0603605F, Advanced Weapons Technology.
- (U) This project has been coordinated through the Project Reliance process to harmonize efforts and eliminate duplication.

(U) D. Schedule Profile: Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)			DATE: February 1995
BUDGET ACTIVITY: 2 - Exploratory Development	PE NUMBER AND TITLE: 0602601F Phillips Laboratory		PROJECT: 8809

COST (*In Thousands*)	FY 1994 Actual	FY 1995 Estimate	FY 1996 Estimate	FY 1997 Estimate	FY 1998 Estimate	FY 1999 Estimate	FY 2000 Estimate	FY 2001 Estimate	Cost to Complete	Total Cost
8809 Space Vehicle Technology	23,389	36,622	31,730	32,614	34,002	34,745	36,982	38,032	Continuing	Continuing

(U) A. Mission Description and Budget Item Justification: In FY 1995, this project consolidated all Air Force spacecraft, launch vehicle, and ballistic missile Exploratory Development efforts from several prior program elements and projects. 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 survivable electronics); satellite control technologies (e.g., spacecraft software and modeling/simulation), vehicle integration technologies (e.g., payload/platform/launch vehicle merging); and ballistic missile/launch vehicle specific technologies (e.g., astrodynamics and guidance, navigation, and control avionics).

(U) FY 1994:
- (U) Continued developing hardening technologies for future space systems. ($1,000K)
  - (U) Discovered previously unknown space induced vulnerability in critical semiconductor devices.
  - (U) Developed first ever silicon-on-diamond transistor.
- (U) Continued developing wide range of advanced spacecraft platform and payload technologies. ($10,726K)
  - (U) Conducted proof-of-concept non-pyrotechnic release device development experiments.
  - (U) Initiated multi-functional structures technology development program.
  - (U) Fabricated thin-film on flexible metal foil solar cells.
  - (U) Completed initial investigation of solid-state energy storage cells for future space applications.
  - (U) Characterized thermal control device components and spacecraft thermal bus components.
- (U) Developed thermionic space power technology. ($10,000K)
  - (U) Ground tested alkali metal thermal to electric conversion cells.
  - (U) Designed and developed a tacitron device.
  - (U) Initiated an in-house bimodal conceptual design study for near-space experience.
- (U) Continue developing balloon, sounding rocket, and small satellite integration technologies for space and near-space experiments. ($1,663K)
  - (U) Completed user friendly sounding rocket trajectory prediction program.
  - (U) Developed standard telemetry interface and control system for balloon, sounding rocket, and small satellite control.
  - (U) Supported and participated in off-board balloon jammer system tests and super pressure balloon flight tests.
  - (U) Developed and launched a triggered lightening sounding rocket experiment.

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(U) FY 1995:

- (U) Continue developing technologies for space platform subsystems such as cryocoolers, space vehicle thermal management, compact solar power cells, lightweight batteries, and innovative power generation concepts. ($14,325K)
  - (U) Design and fabricate flex-array deployment mechanisms, increasing overall efficiency to 15% solar to electric energy conversion.
  - (U) Assemble solid-state primary battery for future space and missile launch vehicle applications.
  - (U) Develop alkali metal thermal to electric conversion power subsystem components.
  - (U) Complete bimodal conceptual design study.
  - (U) Continue former Ballistic Missile Defense Organization 35-80 degrees kelvin cryocooler development work.
- (U) Continue developing technologies for space platform structures such as spacecraft structural controls for vibration suppression and lightweight composite satellite and launch vehicle structures. ($6,900K)
  - (U) Complete first experiments on adaptive neural control concepts for spacecraft structural vibration suppression.
  - (U) Complete carbon-carbon radiator structure fabrication.
  - (U) Initiate the launch vibration isolation technology development program.
  - (U) Complete preliminary concept design for the multi-functional structures technology program.
- (U) Continue developing technologies for space-based payload subsystems such as hardened sensors and satellite communications. ($6,000K)
  - (U) Initiate improvements to long wavelength mercury cadmium telluride infrared detectors under low background (space) conditions.
  - (U) Develop and characterize low noise, high performance quantum well infrared photodetectors.
  - (U) Evaluate and characterize radio frequency and laser communication modem and modem controller components.
  - (U) Develop integrated space-based surveillance performance models for technology trade studies.
  - (U) Complete space-based surveillance antenna architecture technology surveys and trade studies.
- (U) Continue developing technologies for space-based payload components such as hardened electronics and memories. ($3,900K)
  - (U) Investigate space radiation effects on advanced electronics materials including silicon-on-diamond.
  - (U) Investigate potential for orders of magnitude improvements in commercial device space radiation tolerance by processing improvements.
- (U) Continue developing technologies for satellite control such as standardized, reusable software, astrodynamics, and modeling/simulation. ($1,397K)
  - (U) Complete development and test the multi-mission advanced ground intelligent control architecture for telemetry analysis and install in the Space Operations Complex at Falcon Air Force Base.
  - (U) Enhance the expert system in multi-mission advanced ground intelligent control to provide intelligent assistance to satellite operators in anomaly resolution.
  - (U) Demonstrate integration of high accuracy laser measurements for orbit determination into astrodynamics routines.
  - (U) Develop algorithms to improve current operational orbit accuracy by several orders of magnitude.
- (U) Continue developing balloon, sounding rocket, and small satellite integration technologies for space and near-space experiments. ($3,000K)
  - (U) Initiate the MightySat technology evaluation program, providing frequent access to space for exploratory development space qualification.

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- (U) Develop standard telemetry interface and control program for balloon, sounding rocket, and small satellite control.
- (U) Evaluate balloon, sounding rocket, and small satellite integration techniques, and concepts.

– (U) Continue developing technologies supporting launch vehicles and ballistic missile such as guidance, navigation, and control avionics. ($1,100K)
- (U) Design and fabricate advanced navigational instruments for ballistic missile applications.
- (U) Design next generation thrust axis accelerometer.

(U) FY 1996:

– (U) Continue developing technologies for space platform subsystems such as cryocoolers, space vehicle thermal management, compact solar power cells, lightweight batteries, and innovative power generation concepts. ($6,500K)
- (U) Fabricate and test solar cell flex array deployment and solar to electric energy conversion efficiency.
- (U) Fabricate and evaluate solid-state primary battery for space and missile launch vehicle applications.
- (U) Characterize and evaluate lightweight thermal bus components for future space vehicle thermal management subsystems.

– (U) Continue developing technologies for space platform structures such as spacecraft structural controls for vibration suppression and lightweight composite satellite and launch vehicle structures. ($6,000K)
- (U) Initiate advanced ‘mechanisms’ technology development program to replace current generation pin pullers, tie down bolts, reaction wheels, etc.
- (U) Complete non-pyrotechnic release device technology development.
- (U) Complete preliminary design for the launch vibration isolation program.
- (U) Complete multi-functional structures technology program.

– (U) Continue developing technologies for space-based payload subsystems such as hardened sensors and satellite communications. ($6,000K)
- (U) Continue improvements to long-wavelength mercury cadmium telluride detectors under low background and space radiation conditions.
- (U) Develop optimized low noise, high performance quantum well infrared photodetectors in the mid-, long-, and very long-wavelength spectral regions.
- (U) Design radio frequency and laser communication modem and modem controller components for evaluation and characterization.
- (U) Continue development of integrated space-based surveillance models and address background clutter, target cross section, and propagation losses.
- (U) Evaluate candidate component technologies for large aperture space-based surveillance antennas.

– (U) Continue developing technologies for space-based payload components such as hardened electronics and memories. ($4,224K)
- (U) Design and evaluate advanced packaging technology whose goal is a ten times size/volume/weight reduction.
- (U) Fabricate standard space-based surveillance signal processing module.

– (U) Continue developing technologies for satellite control such as standardized, reusable software, astrodynamics, and modeling/simulation. ($3,128K)
- (U) Design and develop satellite control software common architectures.
- (U) Develop astrodynamics, parallel processing for propagation, and differentiated correction program.
- (U) Construct modeling and simulation routines for integrated space technology product development.

– (U) Continue developing balloon, sounding rocket, and small satellite integration technologies for space and near-space experiments. ($5,027K)

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- (U) Launch the MightySat-1 experiment, demonstrating space exploratory development technologies.
- (U) Assemble the MightySat-2 experiment to demonstrate hyperspectral imaging exploratory development technologies.
- (U) Design high altitude balloon, sounding rocket, and small satellite payload integration technologies, techniques, and concepts.

– (U) Continue developing technologies supporting launch vehicles and ballistic missile such as guidance, navigation, and control avionics. ($851K)
- (U) Design solid-state micro-mechanical guidance instruments for future Air Force ballistic missile environments.
- (U) Fabricate next generation thrust axis accelerometer which could provide low life cycle cost Minuteman III guidance upgrade.

(U) FY 1997:

– (U) Continue developing technologies for space platform subsystems such as cryocoolers, space vehicle thermal management, compact solar power cells, lightweight batteries, and innovative power generation concepts. ($6,435K)
- (U) Complete solar cell flex array exploratory 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) Continue developing technologies for space platform structures such as spacecraft structural controls for vibration suppression and lightweight composite satellite and launch vehicle structures. ($5,929K)
- (U) Initiate 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.

– (U) Continue developing technologies for space-based payload subsystems such as hardened sensors and satellite communications. ($6,000K).
- (U) Continue improvements to long-wavelength mercury cadmium telluride detectors and optimize for large focal plane arrays.
- (U) Develop large format quantum well infrared photodetector focal plane arrays.
- (U) Continue to evaluate and characterize radio frequency and laser communications modem and modem controller 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) Continue developing technologies for space-based payload components such as hardened electronics and memories. ($4,224K)
- (U) Evaluate and fabricate advanced packaging technology whose goal is a ten times size/volume/weight reduction.
- (U) Construct a standard space-based surveillance signal processing module.

– (U) Continue developing technologies for satellite control such as standardized, reusable software, astrodynamics, and modeling/simulation. ($3,141K)
- (U) Develop satellite control software architectures for applications such as multi-mission advanced ground intelligent control.
- (U) Assemble next generation gravitational astrodynamics model, permitting non-maintainable orbits analysis.
- (U) Write modeling and simulation routines for integrated space technology product development.

– (U) Continue developing balloon, sounding rocket, and small satellite integration technologies for space and near-space experiments. ($6,034K)

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 1995
BUDGET ACTIVITY 2 - Exploratory Development	PE NUMBER AND TITLE 0602601F Phillips Laboratory

PROJECT 8809

- (U) Complete MightySat-1 mission to validate a large set of space exploratory development technologies having operational user interest.
- (U) Assemble and integrate exploratory balloon, sounding rocket, and small satellite technologies, techniques, and concepts onto flight platforms.
- (U) Integrate hyperspectral imaging payload onto MightySat-2 satellite technology demonstrator for planned FY 1998 launch.

– (U) Continue developing technologies supporting launch vehicles and ballistic missile such as guidance, navigation, and control avionics. ($851K)

- (U) Fabricate solid-state micro-mechanical guidance instruments for future ballistic missile environments.
- (U) Evaluate and test next generation thrust axis accelerometer.

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

	FY 1994	FY 1995	FY 1996	FY 1997	Total Cost
(U) Previous President's Budget	23,226	26,897	26,303	27,128	Cont
(U) Current President's Budget	23,389	36,622	31,730	32,614	Cont

(U) Change Summary Explanation:

Funding: In FY 1995, Congressional actions added $10 million for thermionics. FY 1996 and FY 1997 changes reflect increased Air Force priority on space-related Science and Technology efforts.

Schedule: Not Applicable.

Technical: Not Applicable.

(U) C. Other Program Funding Summary:

(U) Related Activities:

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

(U) D. Schedule Profile: Not Applicable.