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

DATE: June 2001

BUDGET ACTIVITY: 01 - Basic Research

PE NUMBER AND TITLE: 0601102F Defense Research Sciences

	COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
	Total Program Element (PE) Cost	208,178	212,688	220,869	213,788	218,015	222,679	227,606	232,731	Continuing	TBD
2301	Physics	25,029	25,303	22,308	22,719	23,370	24,352	24,896	25,459	Continuing	TBD
2302	Solid Mechanics and Structures	15,550	11,384	11,545	11,839	12,049	12,020	12,277	12,550	Continuing	TBD
2303	Chemistry	26,604	26,490	29,072	27,479	27,905	29,108	29,765	30,440	Continuing	TBD
2304	Mathematical and Computer Sciences	31,601	32,849	35,404	33,051	32,880	32,670	33,413	34,170	Continuing	TBD
2305	Electronics	23,603	24,023	26,453	24,477	24,496	24,378	24,925	25,488	Continuing	TBD
2306	Materials	12,808	13,952	16,506	14,950	15,575	16,515	16,877	17,254	Continuing	TBD
2307	Fluid Mechanics	9,637	9,623	10,046	10,561	11,275	12,180	12,440	12,717	Continuing	TBD
2308	Propulsion	19,577	21,449	20,819	19,121	19,636	20,162	20,608	21,073	Continuing	TBD
2310	Atmospheric Sciences	5,469	0	0	0	0	0	0	0	Continuing	TBD
2311	Space Sciences	8,334	14,758	15,095	15,475	16,066	16,650	17,015	17,397	Continuing	TBD
2312	Biological Sciences	12,850	14,432	13,972	14,331	14,732	15,066	15,394	15,737	Continuing	TBD
2313	Human Performance	12,403	14,081	13,004	12,997	13,113	12,504	12,764	13,054	Continuing	TBD
4113	External Research Programs Interface	4,713	4,344	6,645	6,788	6,918	7,074	7,232	7,392	Continuing	TBD

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Quantity of RDT&E Articles	0	0	0	0	0	0	0	0	0	0

Note: FY 2003- FY 2007 budget numbers do not reflect the DoD strategy review results.
In FY 2001, Project 2310, Atmospheric Sciences, was eliminated as a separate project with the space sciences efforts moved into Project 2311, Space Sciences.
In FY 2001, Congress added $1M to PE 0601102F, Defense Research Sciences, to develop rapid diagnostic and fingerprinting techniques along with molecular monitoring systems for the detection of nosocomial infections. In FY 2001, the funding was realigned to PE 0602202F, Human Effectiveness Applied Research, project 7757, to align funding with the appropriate PE for this effort. The funding database has not yet been updated to reflect this realignment. Funding for this effort is found in PE 0601102F, Project 2312. However, this effort is described in PE 0602202F, Project 7757.

(U) A. Mission Description

The Defense Research Sciences program comprises extramural research activities in academia and industry, and performs in-house investigations in the Air Force Research Laboratory. The program element funds fundamental broad-based scientific and engineering research in areas critical to Air Force weapon systems. These areas are: (1) physics; (2) solid mechanics and structures; (3) chemistry; (4) mathematical and computer sciences; (5) electronics; (6) materials; (7) fluid mechanics; (8) propulsion; (9) space sciences; (10) biological sciences; and (11) human performance. All projects are coordinated through the Defense Reliance process to harmonize efforts, eliminate duplication, and ensure the most effective use of funds across the Department of Defense. All research areas are subject to long-range planning and technical review by tri-Service scientific planning groups. Note: In FY 2001, Congress added $3.5 million for the Center for Adaptive Optics, $3.0 million for Coal-Derived Jet Fuel, $1.0 million for Chabot Observatory, and earmarked $0.6 million of appropriated funds for the National Solar Observatory.

(U) B. Budget Activity Justification

This program is Budget Activity 1, Basic Research, because it funds scientific study and experimentation. Through this program, the Air Force invests in research directed toward increasing knowledge and understanding in those fields of science and engineering related to long-term national security needs.

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

		FY 2000	FY 2001	FY 2002	Total Cost
(U)	Previous President's Budget (FY 2001 PBR)	213,822	206,149	204,094	
(U)	Appropriated Value	216,305	214,649		
(U)	Adjustments to Appropriated Value				
	a. Congressional/General Reductions	-2			
	b. Small Business Innovative Research	-5,118			
	c. Omnibus or Other Above Threshold Reprogram				
	d. Below Threshold Reprogram	-804			
	e. Rescissions	-2,203	-1,961		

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE June 2001
BUDGET ACTIVITY 01 - Basic Research	PE NUMBER AND TITLE 0601102F Defense Research Sciences

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

		FY 2000	FY 2001	FY 2002	Total Cost
(U)	Adjustments to Budget Years Since FY 2001 PBR			16,775	
(U)	Current Budget Submit/FY 2002 PBR	208,178	212,688	220,869	TBD

(U) Significant Program Changes:

Fiscal Year 2002 increase of $10.0M for nanosatellites, quantum computing, materials engineering, super energetic propellants, and plasma dynamics for next generation aerospace vehicles is part of the recent DoD Strategy Review.

Fiscal Year 2002 additional increase of $5.0M reflects zero percent real growth.

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

DATE: June 2001

BUDGET ACTIVITY: 01 - Basic Research

PE NUMBER AND TITLE: 0601102F Defense Research Sciences

PROJECT: 2301

COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
2301 Physics	25,029	25,303	22,308	22,719	23,370	24,352	24,896	25,459	Continuing	TBD

(U) A. Mission Description

The Physics project will provide fundamental knowledge to improve Air Force lasers, avionics, sensors, and satellites. The research also will enhance capabilities in electromagnetic countermeasures, protection against nuclear weapons effects, communications, small satellites, and non-destructive and non-intrusive testing and analysis. This project primarily supports research in laser and optical physics; atomic, molecular, and imaging physics; and plasma physics.

(U) FY 2000 ($ in Thousands)

(U) $9,514 Performed laser and optical physics research for new laser devices and controls to make possible spoofing and fatal damage of infrared-seeking missiles, improve high performance radars, and enable new directed energy weapons. Investigated the physics of semiconductor and solid state lasers and laser arrays through experiments and system modeling to advance laser technology. Studied a new high-power laser to replace oxygen-iodine for next generation airborne lasers. Examined pico-second and femto-second lasers for generation and control of millimeter waves and wideband optical modulation to enhance high-performance radars. Evaluated micro-electro-mechanical systems (MEMS) to enable specialized devices for micro-satellite applications.

(U) $7,313 Conducted research in plasma physics to investigate fundamental atomic and molecular interactions for future directed energy weapons, affordable low-observables, and space communications and surveillance. Examined the controlled resistive, dielectric, and conducting behavior of plasmas, and the effects of plasmas on transmission, reflection, and absorption of electromagnetic waves to enable novel stealth aircraft mechanisms.

(U) $4,423 Studied atomic, molecular, and imaging physics to evaluate the interaction of atoms, molecules, and ions to provide basic information for use in improved explosives and fuels, enhanced space surveillance, superior communications, and precision navigation. Identified interactions of atoms in strong electromagnetic fields to discover novel lasers for Air Force applications. Examined isomeric, high density energy storage for flash radiation devices and to make long flight missions possible without refueling.

(U) $3,779 Continued research on adaptive optics to study phenomena and devices associated with guide star adaptive optical telescopes for laser beam projection into space, and deep space surveillance and identification.

(U) $25,029 Total

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE June 2001
BUDGET ACTIVITY: 01 - Basic Research	PE NUMBER AND TITLE: 0601102F Defense Research Sciences
PROJECT: 2301	

(U) A. Mission Description Continued

(U) FY 2001 ($ in Thousands)

(U)	$9,896	Perform laser and optical physics research for new laser devices and controls to make possible spoofing and fatal damage of infrared-seeking missiles, improve high performance radars, and enable new directed energy weapons. Continue to investigate semiconductor and solid state lasers and laser arrays through experiments and system modeling to advance laser technology. Investigate a new high-power laser to replace oxygen-iodine for next generation airborne lasers. Examine pico-second and femto-second (extremely fast) lasers for generation and control of millimeter waves and wideband optical modulation to enhance high-performance radars. Expand studies of micro-electro-mechanical systems (MEMS) and laser photochemical processes to enable specialized devices for micro-satellite applications.
(U)	$7,631	Conduct research in plasma physics to investigate fundamental atomic and molecular interactions for future directed energy weapons, affordable low-observables, and space communications and surveillance. Explore physics issues relating to plasma processing of materials at atmospheric pressures to contribute to higher frequency, more efficient, high power microwave systems. Examine the controlled resistive, dielectric, and conducting behavior of plasmas, and the effects of plasmas on transmission, reflection, and absorption of electromagnetic waves to enable novel stealth aircraft mechanisms. Investigate the feasibility of using collisional ionized gas volumes to protect friendly assets from directed energy.
(U)	$4,276	Study atomic, molecular, and imaging physics to evaluate the interaction of atoms, molecules, and ions to provide basic information for use in improved explosives and fuels, enhanced space surveillance, superior communications, precision navigation, and the neutralization of biological threats. Investigate the trapping and cooling of atoms and ions to enrich high-resolution spectroscopy. Characterize interactions of atoms in strong fields to discover novel lasers for Air Force applications. Continue to examine isomeric, very high density energy storage for flash radiation devices and to make long flight missions possible without refueling.
(U)	$3,500	Study the performance of the new 30-meter infrared adaptive optical telescope at the Center for Astronomical Active Optics. Continue research on adaptive optics to enable adaptive telescopes for laser beam projection into space, space reconnaissance, space power collectors, and space-based lasers.
(U)	$25,303	Total

(U) FY 2002 ($ in Thousands)

(U)	$10,037	Perform laser and optical physics research for new concepts in solid state lasers, especially fiber lasers, to attain compact, inexpensive modules in the one kilowatt average power range. The results of this research will enable spoofing and fatal damage of infrared-seeking missiles, improve high performance radars, and new directed energy weapons. Study techniques for integrating modules to achieve multiple power levels at affordable cost and useful size for application to airborne or space platforms. Study concepts for achieving very high resolution of deep space objects using very large aperture adaptive telescopes. Explore novel low-cost light sources for high-power ultraviolet lasers capable of high intensity and spectral brightness for disinfection of biological agents, the synthesis of chemical agents, and safely stripping aircraft paint.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE: June 2001
BUDGET ACTIVITY: 01 - Basic Research	PE NUMBER AND TITLE: 0601102F Defense Research Sciences
PROJECT: 2301	

(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands) Continued

(U)	$7,807	Conduct research in plasma physics to investigate fundamental interactions between charged particles and electromagnetic fields for future directed energy weapons, affordable low-observables, and space communications/surveillance. Explore physics relating to the power-efficient production and maintenance of substantial volumes of low-temperature plasma at atmospheric pressures for plasma-based aerodynamic drag reduction. Investigate the controlled resistive, conducting, and dielectric behavior of plasmas, and the effects of plasmas on absorption, reflection, and transmission of electromagnetic waves to create new stealth aircraft mechanisms. Examine the viability of using collisional ionized gas volumes to shield friendly assets from directed energy threats.
(U)	$4,464	Study atomic, molecular, and imaging physics to evaluate the interaction of atoms, molecules, and ions for use in improved explosives and fuels, enhanced space surveillance, superior communications, precision navigation, and the neutralization of biological threats. Quantify interactions of atoms in strong electromagnetic fields to enable novel lasers for Air Force applications. Continue research on isomeric, very high density energy storage for flash radiation devices to diminish or eliminate refueling on long endurance flights. Investigate the use of holographic films for correction of distortion and aberration in space surveillance telescopes.
(U)	$22,308	Total

(U) B. Project Change Summary

Not Applicable.

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

(U) Related Activities:
(U) PE 0602203F, Aerospace Propulsion.
(U) PE 0602601F, Space Technology.
(U) PE 0602204F, Aerospace Sensors.
(U) PE 0602605F, Directed Energy Technology.

(U) D. Acquisition Strategy

Not Applicable.

(U) E. Schedule Profile

(U) Not Applicable.

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

DATE: June 2001

BUDGET ACTIVITY: 01 - Basic Research

PE NUMBER AND TITLE: 0601102F Defense Research Sciences

PROJECT: 2302

COST ($ in Thousands)		FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
2302	Solid Mechanics and Structures	15,550	11,384	11,545	11,839	12,049	12,020	12,277	12,550	Continuing	TBD

(U) A. Mission Description

The Solid Mechanics and Structures project seeks to improve the capabilities of existing aerospace materials and structures and to develop revolutionary and more affordable structures for future Air Force systems. This project will develop fundamental knowledge of the aero-elastic and acoustic behavior of airframes and engine structures. The project also will further basic understanding of the dynamic behavior of launch vehicles and space structures. Research topics include: the design of advanced material structures on a micro-scale; modeling and simulation of the dynamic behavior of aircraft, missiles, and large space structures; and technology integration for the performance and survivability enhancement of these systems. Primary research areas will be composite materials mechanics, structural mechanics, and structural dynamics.

(U) FY 2000 ($ in Thousands)

(U) $3,264 Studied mechanics of composite materials to investigate new structural concepts and the underpinning mechanics principles to enable revolutionary improvements in design and capability of air and space weapon systems. Examined the fundamental behavior of dynamic systems to enable the development of efficient computational techniques and design methodologies for turbine engines, air vehicles, launch systems, and orbital weapon systems. Sought fundamental knowledge on potential air vehicle components, including metallic and inter-metallic alloys, and solid rocket propellants and liners to enhance air and space vehicle performance and longevity.

(U) $10,010 Expanded structural mechanics research to examine innovative adaptive structure concepts for deployment of space-based systems and multi-mission uninhabited air vehicles. Evaluated the behavior of distributed sensor and actuator systems to achieve major improvements in the design and performance prediction of aerospace weapon systems. Identified system techniques to analyze vehicle integrity and achieve major increases in structural longevity of Air Force weapon systems.

(U) $2,276 Performed dynamics and shock physics research to identify the fundamental damage mechanisms in structural materials in order to model and predict effects of weapon impacts and assess damage of penetrating munitions. Devised fundamental mechanics principles and life-span prediction methodologies to significantly enhance design and life cycle management methodologies of Air Force weapon systems.

(U) $15,550 Total

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BUDGET ACTIVITY 01 - Basic Research	PE NUMBER AND TITLE 0601102F Defense Research Sciences
PROJECT 2302	

(U) A. Mission Description Continued

(U) FY 2001 ($ in Thousands)

(U) $2,389 Study mechanics of composite materials to investigate new structural concepts and the underpinning mechanics principles to enable revolutionary improvements in capability and design of air and space weapon systems. Continue to explore the fundamental behavior of dynamic systems and develop efficient computational techniques and design methodologies for turbine engines, air vehicles, launch systems, and orbital systems. Continue efforts to seek fundamental knowledge on air vehicle components, including metallic and inter-metallic alloys, advanced composite materials, and solid rocket propellants and liners to enhance air and space vehicle performance and longevity.

(U) $7,331 Conduct structural mechanics research to examine innovative adaptive structure concepts for deployment of space-based systems and multi-mission uninhabited air vehicles. Evaluate the behavior of distributed sensor and actuator systems to improve the design and performance prediction of aerospace systems. Identify fundamental structural design characteristics underpinning the life cycle of airframe structures. Develop techniques to analyze vehicle integrity and significantly increase the structural longevity of Air Force weapons.

(U) $1,664 Perform dynamics and shock physics research to identify the fundamental damage mechanisms in structural materials to model and predict effects of weapon impacts and assess damage of penetrating munitions. Devise fundamental mechanics principles and life-span prediction methodologies to significantly enhance design and life cycle management methodologies of Air Force weapon systems. Investigate the mechanical and dynamic behavior of micro-scale structures to enable micro-electro-mechanical systems (MEMS) that can sense environments and respond accordingly (smart structures).

(U) $11,384 Total

(U) FY 2002 ($ in Thousands)

(U) $2,423 Study mechanics of materials to accelerate utilization of advanced materials such as composites, high-temperature alloys, and ceramic matrix composites in aerospace vehicles, turbine engines, space systems, and weapon systems. Explore synergistic combinations of information technology and multiscale modeling to design new materials and new structures. Explore nanomechanics to bridge the gap between continuum mechanics and atomistic modeling. Establish theoretical foundations for multifunctional mechanics, including nonlinear behavior, to enable the development of multifunctional structures used in advanced space systems such as microsatellites and micro vehicles.

(U) $5,016 Conduct research into structural and material aspects of high-cycle metal fatigue and other aging mechanisms of aircraft. Develop techniques for predictive computer simulation of structural response. Research metal fatigue-generation due to vibration of jet engine compressor and turbine blades and the interaction of blade motion with fluid mechanics. Study material science to identify and mitigate material degeneration in a timely and cost-efficient manner. Develop techniques to analyze vehicle integrity and significantly increase the structural longevity of Air Force weapon systems.

(U) $4,106 Conduct structural mechanics research to examine innovative adaptive structure concepts for deployment of space-based systems and

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BUDGET ACTIVITY: 01 - Basic Research	PE NUMBER AND TITLE: 0601102F Defense Research Sciences
PROJECT: 2302	

(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands) Continued

multi-mission uninhabited air vehicles. Evaluate the behavior of distributed sensor and actuator systems to improve the design and performance prediction of aerospace systems. Research predictive techniques capable of modeling the interaction of structural motion with high-speed aerodynamics characteristic of uninhabited air vehicles. Continue investigating the mechanical and dynamic behavior of micro-scale structures to enable micro-electro-mechanical systems (MEMS) that can sense environments and respond accordingly (smart structures).

(U) $11,545 Total

(U) B. Project Change Summary

Not Applicable.

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

(U) Related Activities:
(U) PE 0602102F, Materials.
(U) PE 0602201F, Aerospace Flight Dynamics.
(U) PE 0602202F, Human Effectiveness Applied Research.
(U) PE 0603211F, Aerospace Structures.
(U) PE 0602203F, Aerospace Propulsion.

(U) D. Acquisition Strategy

Not Applicable.

(U) E. Schedule Profile

(U) Not Applicable.

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

DATE: June 2001

BUDGET ACTIVITY: 01 - Basic Research

PE NUMBER AND TITLE: 0601102F Defense Research Sciences

PROJECT: 2303

COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
2303 Chemistry	26,604	26,490	29,072	27,479	27,905	29,108	29,765	30,440	Continuing	TBD

(U) A. Mission Description

The Chemistry project supports research to significantly improve the ability to understand and control chemical reactions. The research will allow development of new materials and improve synthesis of existing materials. The research also will permit the improved control of energy flow/storage and better control of interactions between materials and their environments. Research will address chemical dynamics and energy transfer processes that foster advances in laser weaponry; allow prediction of infrared, optical, and radar signatures; and enable the synthesis of new propellants. Critical research topics will include novel synthesis and characterization of lower-cost and higher-performance functional and structural materials; electronic and photonic materials; nano-structures; electromagnetic and conventional weaponry; and propellants. The program also will explore surface interactions that limit the performance of electronic devices, compact power sources, and lubricant materials. The primary areas of research include molecular dynamics, theoretical chemistry, polymer chemistry, and surface and interfacial science.

(U) FY 2000 ($ in Thousands)

(U) $11,767 Performed molecular dynamics and theoretical chemistry research to identify and predict techniques to control molecular reactivity and energy flow, and develop predictive tools for designing new materials and processes for advanced propellants and high-energy lasers. Devised methods for predicting molecular-level energy transfer and chemical reactivity to simulate signatures and interactions of aerospace vehicles in extreme environments. Sought fundamental knowledge to formulate new high energy density materials for rocket propellants.

(U) $8,939 Conducted polymer chemistry research to improve fundamental understanding of chemical structures and processing conditions for advanced polymeric materials that significantly improve aircraft and spacecraft performance and life-spans. Evaluated spectral sensitivity of photo refractive polymers for crucial infrared applications. Investigated polymer coatings to enable advanced sensors applications. Developed fundamental knowledge to formulate materials that have suitable optical transitions for highly efficient optical limiting properties to enable flexible communications in space operations. Evaluated high temperature nanocomposite polymers for superior space propulsion.

(U) $5,898 Studied surface science to investigate the chemistry of surface processes for accurate detection and prevention of corrosion and degradation of air and space systems, and formulation of novel lubricants. Investigated surface chemical processes and structures to enhance performance, reduce maintenance, and increase the longevity of air and space systems. Explored the reactions and mechanisms for protection of aluminum aircraft from corrosion. Investigated novel three-dimensional surface nano-structures for sensor, optical, and power applications.

(U) $26,604 Total

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PROJECT 2303	

(U) A. Mission Description Continued

(U) FY 2001 ($ in Thousands)

(U)	$11,716	Perform molecular dynamics and theoretical chemistry research to identify and predict techniques to control molecular reactivity and energy flow, and develop predictive tools for designing new materials and processes for advanced propellants and high-energy lasers. Evaluate methods for predicting molecular-level energy transfer and chemical reactivity to simulate signatures and interactions of aerospace vehicles in extreme environments. Examine the use of molecular nano-clusters for use as catalysts and sensors. Develop new high energy density materials for rocket propellants and novel chemical laser systems.
(U)	$8,900	Conduct polymer chemistry research to improve fundamental understanding of chemical structures and processing conditions for advanced polymeric materials that significantly improve aircraft and spacecraft performance and life-spans. Improve spectral sensitivity of photo refractive polymers for crucial infrared applications. Investigate polymer coatings to enable smart skins and advanced sensors for air and space weapon systems. Evaluate the stability of functional polymers in space environments to enhance survivability of vehicles exposed to space radiation. Continue to seek fundamental knowledge to formulate materials that have optical transitions suitable for highly efficient optical limiting properties.
(U)	$5,874	Study surface science to investigate the chemistry of surface processes for accurate detection and prevention of corrosion and degradation of air and space systems, and formulation of novel lubricants. Continue investigation of surface chemical processes and structures to enhance performance, reduce maintenance, and increase the longevity of air and space systems. Develop predictive and experimental models for molecular lubrication in high-temperature, high-wear environments. Explore the reactions and mechanisms for protection of aluminum aircraft from corrosion. Examine surface structures with enhanced energy-densities for significantly improved weapon system energy storage and delivery.
(U)	$26,490	Total

(U) FY 2002 ($ in Thousands)

(U)	$11,910	Perform molecular dynamics and theoretical chemistry research to identify and predict techniques to control molecular reactivity and energy flow, and develop predictive tools for designing new materials and processes for advanced propellants and high-energy lasers. Seek understanding of mechanisms of using ion and plasma chemistry to reduce drag and/or enhance combustion. Synthesize novel chemical monopropellants for satellite and rocket applications. Determine the gain and loss mechanisms in chemical laser systems to permit operation at higher powers. Identify inputs required to model chemically reacting flows in rocket plumes. Develop theoretical methods to predict properties of structural materials.
(U)	$9,204	Conduct polymer chemistry research to improve fundamental understanding of chemical structures and processing conditions to develop advanced polymeric materials for significantly improved Air Force systems performance and life-spans. Explore chemistry concepts based on

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(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands) Continued

organic materials that will enable protection of Air Force personnel and sensors from agile lasers. Investigate nanocomposites to improve thermal and mechanical properties of polymers for lightweight aerospace structures. Devise controls of nanostructure assembly to attain new photonic and electronic functions.

(U) $5,958 Study the chemistry of surface and interfacial processes for accurate detection and prevention of corrosion and degradation of air and space systems, and development and design of novel lubricants. Develop new long-life, low-friction surface structures and coatings for terrestrial and space environments. Examine environmentally compliant nanostructured coating systems for corrosion protection of aluminum aircraft. Investigate novel three-dimensional surface nanostructures for sensor, optical, and power applications. Examine nanoscale surface structures with enhanced energy densities for significantly improved weapon system energy storage and delivery. Develop theoretical and predictive methods for surface and interfacial chemical processes.

(U) $2,000 Conduct research in chemical synthesis and detection techniques, chemical theory, and modeling and simulation that will lead to breakthroughs in new fuels and rocket propellants that are environmentally benign, have reduced signatures, and are less sensitive to accidental detonations. Investigate applications of these potential fuels in flight vehicles to study the benefits of increasing mass of payloads put into space and increasing the lifetime of satellites on orbit. Study application of any potential fuels breakthroughs to the development of hydrocarbon-fueled scramjets and combined-cycle engines for space applications.

(U) $29,072 Total

(U) B. Project Change Summary

Not Applicable.

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

(U) Related Activities:

(U) PE 0602102F, Materials.

(U) PE 0602203F, Aerospace Propulsion.

(U) PE 0602601F, Space Technology.

(U) PE 0602602F, Conventional Munitions.

(U) D. Acquisition Strategy

Not Applicable.

(U) E. Schedule Profile

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(U) E. Schedule Profile Continued

(U) Not Applicable.

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COST ($ in Thousands)		FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
2304	Mathematical and Computer Sciences	31,601	32,849	35,404	33,051	32,880	32,670	33,413	34,170	Continuing	TBD

(U) A. Mission Description

The Mathematical and Computer Sciences project will develop techniques for modeling and simulation, algorithm development, and control of complex systems. The program will also develop innovative analytical and high-performance computing methods for aerospace systems. The research will improve the performance of aerospace systems through the creation of accurate models and computational tools, enhanced artificial intelligence, and better programming techniques and theories. The primary research areas of this project are: dynamics and control; physical mathematics and applied analysis; computational mathematics; optimization and discrete mathematics; signals communication and surveillance; systems and software; and external aerodynamics and hypersonic flows.

(U) FY 2000 ($ in Thousands)

(U) $6,510 Performed dynamics and control research to develop new techniques for design and analysis of control systems to significantly enhance capabilities and performance of aerospace vehicles. Developed modeling, identification, and control capabilities necessary for the integrated control of vehicle aerodynamics and jet engine performance. Created control algorithms for optical components to handle extreme atmospheric turbulence encountered in target acquisition by deployable laser platforms. Formulated algorithms incorporating active control procedures to provide more efficient flow through jet engines.

(U) $6,483 Conducted computational systems, software, artificial intelligence, and software reliability research to investigate unique computer technologies to devise critical software and computational systems for battlespace information management. Expanded automatic large knowledge base construction from multiple, variant sources and automatic knowledge acquisition to enhance Air Force intelligence operations. Formulated distributed, automatic resource management approaches for new methods of mobile agent resource allocation and protection.

(U) $6,369 Conducted physical mathematics and applied analysis, and electromagnetics research to devise accurate models of physical phenomena to enhance controls and signal processing techniques. Predicted nonlinear optical effects within semiconductor lasers and through other nonlinear optical media for applications in laser beam control and stability. Modeled detonation shock dynamics to support reconfigurable conventional warhead design. Identified optimal electromagnetic wave propagation and scattering codes to provide accurate and timely target recognition. Refined physical mathematics, control and signal processing techniques, and modeled advanced electromagnetic materials, composites, and smart skins for air and space weapons.

(U) $4,608 Studied optimization and discrete mathematics to devise advanced mathematical methods for solving complex problems in logistics, engineering design, and strategic planning for battlespace information management. Expanded transportable agent technology to support defensive information warfare applications. Integrated new multidisciplinary optimization design strategies with higher order, time accurate flow solvers

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(U) A. Mission Description Continued

(U) FY 2000 ($ in Thousands) Continued

for improved design of jet engines, aircraft wings, and other aerospace components.

(U) $3,444 Performed computational mathematics research to devise unique simulations and designs of advanced Air Force systems. Integrated new multidisciplinary design optimization strategies with high-order, time-accurate solvers for superior design of jet engines, aircraft wings, and other aerospace components. Invented methods to reduce computation time for chemical laser simulations. Identified failure modes of bonded composite materials by inserting novel computational methods into mission-support software tools.

(U) $2,571 Studied signals communication and surveillance to expand quantitative methodologies that extended the capability of critical mobile, wireless, and networked communications systems, and strengthened performance of surveillance and targeting functions through autonomous and human-assisted sensing/response platforms. Analyzed irreducible expansions of signals, soft thresholding, and efficient source-channel coding in wireless communication to improve cost versus performance trade offs.

(U) $1,616 Researched the mathematical foundations of external aerodynamics flows to develop fundamental knowledge of basic fluid dynamics and plasma-aerodynamics to predict and control supersonic and hypersonic flows over combat maneuvering flight vehicle systems. Devised accurate computational flow solvers for optimal design of aircraft wings and novel aerospace components. Refined plasma-aerodynamic optimization algorithms to enable design of superior scramjets.

(U) $31,601 Total

(U) FY 2001 ($ in Thousands)

(U) $6,765 Perform dynamics and control research to develop new techniques for design and analysis of control systems to significantly enhance capabilities and performance of aerospace vehicles. Develop modeling, identification, and control capabilities necessary for the integrated control of vehicle aerodynamics and engine performance. Continue creating control algorithms for optical components to handle extreme atmospheric turbulence encountered in target acquisition by deployable laser platforms. Expand active and adaptive control algorithms to enable autonomous air, space, and ground operations.

(U) $6,738 Conduct computational systems, software, artificial intelligence, and software reliability research to investigate unique computer technologies to devise critical software and computational systems for battlespace information management. Continue automatic large knowledge base construction from multiple, variant sources and automatic knowledge acquisition to enhance Air Force intelligence operations. Refine distributed, automatic resource management approaches for advanced methods of mobile agent resource allocation and protection.

(U) $6,620 Conduct physical mathematics and applied analysis, and electromagnetics research to devise accurate models of physical phenomena to enhance controls and signal processing techniques. Investigate the feasibility of coherently propagating short laser pulses through the air for superior accuracy in laser-guided munitions. Predict nonlinear optical effects within semiconductor lasers and through other nonlinear optical media for

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PROJECT 2304	

(U) A. Mission Description Continued

(U) FY 2001 ($ in Thousands) Continued

applications in laser beam control and stability. Formulate optimal electromagnetic wave propagation/scattering codes to provide accurate and timely target recognition. Devise methods to penetrate tree cover and recognize targets.

(U) $4,790 Study optimization and discrete mathematics to devise advanced mathematical methods for solving complex problems in logistics, engineering design, and strategic planning for battlespace information management. Expand transportable agent technology to support defensive information warfare applications and formulate real-time problem solving strategies to support dynamic planning and execution.

(U) $3,579 Perform computational mathematics research to devise unique simulations and designs of advanced Air Force systems. Continue integrating new multidisciplinary design optimization strategies with high-order, time-accurate solvers for superior design of jet engines, aircraft wings, and other aerospace components. Devise methods to reduce computation time for chemical laser simulations from months to days. Investigate failure modes of bonded composite materials by inserting novel computational methods into mission support software tools.

(U) $2,673 Study signals communication and surveillance to expand quantitative methodologies that extend the capability of critical mobile, wireless, and networked communications systems, and strengthens performance of surveillance and targeting functions through autonomous and human-assisted sensing/response platforms. Investigate irreducible expansions of signals, soft thresholding, and efficient source-channel coding in wireless communication to achieve major improvements in cost versus performance trade offs. Expand probabilistic process theory, functional analysis techniques, and information theory to eliminate current limits of sensing and communication system performance.

(U) $1,684 Research the mathematical foundations of external aerodynamics to develop fundamental knowledge of basic fluid dynamics and plasma-aerodynamics to predict and control supersonic and hypersonic flows over combat maneuvering flight vehicles. Devise accurate flow solvers for optimal design of aircraft wings and novel aerospace components. Refine plasma-aerodynamic optimization techniques to enable design of superior aerospace vehicles.

(U) $32,849 Total

(U) FY 2002 ($ in Thousands)

(U) $7,014 Perform dynamics and control research to develop new techniques for design and analysis of control systems to significantly enhance capabilities and performance of aerospace vehicles. Expand program on cooperative control in dynamic, uncertain, adversarial environments with applications to swarms of smart munitions, unmanned vehicles, and constellations of small satellites. Develop new techniques for the control of nonequilibrium behavior of complex, unsteady fluid systems (chemically reacting flows) with applications to combustion and materials processing.

(U) $7,014 Conduct research in complex systems and software, artificial intelligence, automatic knowledge acquisition; study high performance knowledge bases to allow rigorous construction of highly complex battlefield information systems. Identify advanced techniques in intelligent and mobile

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(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands) Continued

agents for next generation information systems. Conduct research in information operations, including support for language-based security, mobile code security, protected execution, and dynamic, adaptive intrusion detection for protection of future battlespace and infosphere systems and networks.

(U) $6,679 Conduct physical mathematics/applied analysis and electromagnetics research to devise accurate models of physical phenomena to enhance controls and signal processing techniques. Investigate the feasibility of coherently propagating short laser pulses through the air for superior accuracy in laser-guided munitions. Predict nonlinear optical effects within semiconductor lasers and through other nonlinear optical media for applications in laser beam control and stability. Formulate optimal electromagnetic wave propagation/scattering codes to provide accurate and timely target recognition. Evaluate methods to penetrate tree cover and recognize targets with wide band radar. Investigate feasibility of incorporating virtual time-reversal methodology onboard a formation of small satellites to enhance imaging of radar-acquired moving targets.

(U) $4,677 Study optimization and discrete mathematics to devise advanced mathematical methods for solving complex problems in logistics, engineering design, and strategic planning for battlespace information management. Expand algorithmic research which produces a feasible solution within the time constraint of military operations. Develop techniques for hierarchical model building to accommodate multiple levels of aggregation and complexity, to reflect time and computational constraints.

(U) $3,674 Perform computational mathematics research to devise unique simulations and designs of advanced Air Force systems. Integrate new multidisciplinary design optimization strategies with high-order, time-accurate solvers for superior design of jet engines, aircraft wings, munitions, and other aerospace components. Investigate efficient methods to quantify uncertainty in non-linear multidisciplinary design models. Continue devising methods to reduce computation time for chemical simulations from months to days. Improve algorithms for plasma dynamics simulations, munition penetration simulations, and ground-based image reconstruction.

(U) $2,674 Study signals communication and surveillance to expand quantitative methodologies that extend the capability of critical mobile, networked communications systems, and strengthen the performance of surveillance and targeting functions. Improve the efficiency of source-channel coding in wireless communication through technical advances such as optical transmission. Continue research in probabilistic and analytic theory to achieve higher information rates and greater reliability under stringent military covertness constraints. Develop promising areas such as super-resolution imaging and trellis-coded modulation.

(U) $2,000 Construct quantum computer devices that enable atomic level computing a million times faster than today's silicon chip. Design, implement, and test quantum computing algorithms and architectures enabling fast, accurate solutions of complex fluid dynamics problems eliminating the need for multiple design iterations and prototype testing. Develop scalable quantum computers for automatic target recognition and target characterization.

(U) $1,672 Explore mathematical and computational methods of external aerodynamics associated with hypersonic weapon release. Expand plasma

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(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands) Continued

aerodynamics algorithms to include magneto hydrodynamic (MHD) augmentation of complete scramjet engines. Computationally investigate the effects of dynamic aero structural tailoring during combat maneuvers on end-game targeting. Computationally explore hypersonic boundary layer transition on transatmospheric vehicles to reduce heat transfer and viscous drag to enable long-range, high-payload hypersonic vehicles.

(U) $35,404 Total

(U) B. Project Change Summary

Not Applicable.

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

(U) Related Activities:
(U) PE 0602201F, Aerospace Flight Dynamics.
(U) PE 0602203F, Aerospace Propulsion.
(U) PE 0602602F, Conventional Munitions.
(U) PE 0602702F, Command, Control, and Communications.
(U) PE 0603789F, C3I Advanced Development.

(U) D. Acquisition Strategy

Not Applicable.

(U) E. Schedule Profile

(U) Not Applicable.

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

DATE: June 2001

BUDGET ACTIVITY: 01 - Basic Research

PE NUMBER AND TITLE: 0601102F Defense Research Sciences

PROJECT: 2305

COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
2305 Electronics	23,603	24,023	26,453	24,477	24,496	24,378	24,925	25,488	Continuing	TBD

(U) A. Mission Description

The Electronics project furthers the fundamental understanding of electronic materials, devices, and systems. This knowledge will enhance Air Force operational capabilities in the areas of directed energy weapons, stealth technologies, electronic countermeasures, information and signal processing, and communications. The research will focus on developing electronic processes to model and predict performance of electronic materials, devices, and systems for power generation. The program also will focus on optical signal processing, radiation effects, and high-speed signal processing. The goals of this research are to minimize the complexity and maximize the reliability of electronic systems; increase data transmission and information-processing speeds of Air Force systems; and improve the security and reliability of electronic information. The primary areas of investigative research are space electronics, optoelectronic materials, optoelectronic information processing, and quantum electronic solids.

(U) FY 2000 ($ in Thousands)

(U) $7,709 Performed space electronics research to examine military unique low-power and complementary electronic circuits to greatly reduce the size and weight of space platforms. Characterized surface and interface states to prevent electronic device degradation in Air Force systems. Explored wide bandgap semiconductor materials ideal for radio frequency power sources and high-temperature operations for air and space weapon systems.

(U) $7,623 Conducted optoelectronic materials research to investigate detection of optical radiation from far infrared to the ultraviolet spectral range to achieve surveillance dominance of the battlespace. Developed unique materials to protect critical optical systems from enemy attack. Devised laser materials to detect, degrade, or blind an adversary's detection capabilities. Created models of new detectors for characterization of the battlespace and surveillance.

(U) $4,487 Studied optoelectronic information processing to explore development and application of optoelectronic materials and devices to enhance critical communication system accuracy, speed, and data storage. Formulated high bandwidth, multi-wavelength modulators and detectors for Air Force imaging and communication systems. Created optical materials for high-bandwidth communication and parallel signal processing for enabling the increased data transfer speeds required for military operations.

(U) $3,784 Performed quantum electronic solids research to investigate superconducting, magnetic, and nanoscopic materials, and devices for advanced sensing communications and signal processing, and superior data storage capabilities. Created high-current, high-temperature superconducting tapes and cables for enhanced power generation and storage on Air Force space platforms. Investigated measurement of corrosion in aircraft structures to extend performance life span.

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BUDGET ACTIVITY 01 - Basic Research	PE NUMBER AND TITLE 0601102F Defense Research Sciences
PROJECT 2305	

(U) A. Mission Description Continued

(U) FY 2000 ($ in Thousands) Continued

(U) $23,603 Total

(U) FY 2001 ($ in Thousands)

(U) $7,847 Performed space electronics research to examine military unique low-power and complementary electronic circuits to greatly reduce the size and weight of space platforms. Continued characterizing surface and interface states to prevent electronic device degradation. Explored wide bandgap semiconductor materials ideal for radio frequency (RF) power sources and high-temperature operations. Identified fundamental radiation effects on electronic and semiconductor materials and devised methods to prevent space system degradation or destruction.

(U) $7,759 Conducted optoelectronic materials research to investigate detection of optical radiation from far infrared to the ultraviolet spectral range to achieve surveillance dominance of the battlespace. Invented unique materials to protect critical optical systems from enemy attack. Devised laser materials to detect, degrade, or blind an adversary's detection capabilities. Created new detectors for characterization of the battlespace, surveillance, and to obtain target signatures in spectral ranges appropriate for quick target recognition.

(U) $4,567 Studied optoelectronic information processing to explore development and application of optoelectronic materials and devices to enhance critical communication system accuracy, speed, and data storage. Investigated high bandwidth, multi-wavelength modulators and detectors to refine complex semiconductor structures for imaging and communication systems. Created optical materials for maximum high-bandwidth communication and parallel signal processing for enabling secure satellite communications and the increased data transfer speeds required for military operations.

(U) $3,850 Performed quantum electronic solids research to investigate superconducting, magnetic and nanoscopic materials and devices for advanced sensing communications and signal processing, and superior data storage capabilities. Created high-current, high-temperature superconducting tapes and cables for enhanced power generation and storage on Air Force space platforms and directed energy weapons. Formulated innovative approaches to measure active corrosion in aircraft structures to extend performance lifespan.

(U) $24,023 Total

(U) FY 2002 ($ in Thousands)

(U) $8,069 Perform space electronics research to examine military unique low-power and complementary electronic circuits to greatly reduce the size and weight of space platforms. Study the effects of intense RF pulses on electronic circuits and systems. Devise means to prevent surface and interface states from degrading electronic device performance. Explore wide bandgap semiconductor materials as promising candidates for RF power sources and high-temperature operations. Identify fundamental radiation effects on electronic and semiconductor materials and devise methods to prevent space system degradation or destruction.

(U) $7,824 Conduct optoelectronic materials research for detection and emission of optical radiation from far infrared to the ultraviolet spectral range to

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(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands) Continued

achieve spectral dominance of the battlespace. Investigate new non-linear optical materials to protect critical optical systems from laser fire, and access laser wavelengths and power not available with solid state or semiconductor lasers. Study basic mechanisms that limit the efficiency and uncooled operation of lasers and detectors. Formulate laser materials to degrade or blind an adversary's detection and tracking capabilities. Investigate fast multiband detectors for characterization of the battlespace, surveillance, target tracking, and target signatures. Study unique properties available from nanoscale combinations of optoelectronic materials.

(U) $4,647 Study optoelectronic information processing to explore development and application of electro-optical materials and devices to enhance critical communication system accuracy, speed, and data storage. Investigate high bandwidth, multi-wavelength modulators and detectors to develop and refine complex semiconductor structures for imaging and communication systems. Create optical materials for maximum high-bandwidth communication and parallel signal processing. Investigate the use of new optical materials for enabling secure satellite communications and increased data transfer speeds required for military operations.

(U) $3,913 Perform quantum electronic solids research to investigate superconducting, magnetic, and nanoscopic materials and devices for advanced sensing communications and signal processing, and superior data storage capabilities. Improve high-temperature, high-current superconducting tapes and cables for enhanced storage and power generation on Air Force space platforms and directed energy weapons. Develop new techniques to quantify active corrosion in aircraft structures to increase lifespan. Investigate new high-temperature magnetic materials with sufficient mechanical strength for utilization in aircraft with higher electric workloads.

(U) $2,000 Conduct research addressing the scientific barriers to miniaturization of components enabling much lighter, more compact, highly capable microsatellites and nanosatellites. Research nanopropulsion and power schemes, smart skins, radiation hardening and quantum effect electronics to reduce satellite cost, weight, and size each by a factor of ten. Investigate nanosatellite benefits for improving access to space, mission flexibility, ease of augmentation and upgrade, and graceful degradation during end of service life.

(U) $26,453 Total

(U) B. Project Change Summary

Not Applicable.

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

(U) Related Activities:

(U) PE 0602204F, Aerospace Sensors.

(U) PE 0602702F, Command, Control, and Communications.

(U) PE 0603203F, Advanced Aerospace Sensors.

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PROJECT: 2305	

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

(U) PE 0603789F, C3I Advanced Development.

(U) D. Acquisition Strategy

Not Applicable.

(U) E. Schedule Profile

(U) Not Applicable.

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

DATE: June 2001

BUDGET ACTIVITY: 01 - Basic Research

PE NUMBER AND TITLE: 0601102F Defense Research Sciences

PROJECT: 2306

COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
2306 Materials	12,808	13,952	16,506	14,950	15,575	16,515	16,877	17,254	Continuing	TBD

(U) A. Mission Description

The Materials project seeks to significantly reduce the cost of structural materials while enhancing their performance and reliability. A key goal is to eliminate material reliability issues related to high-temperature strength, toughness, fatigue, and environmental conditions. The program's examination of material strength, toughness, fatigue resistance, and corrosion resistance will serve to enable novel materials for airframe, turbine engine, and spacecraft structures. The research will emphasize refractory alloys, intermetallics, polymer composites, and metal and ceramic matrix composites. The research also will focus on advanced ceramics, such as alumina, silicon carbide, silicon nitride, and carbon/carbon. The research will improve aerospace vehicle structural materials and increase the thrust-to-weight ratio of engines by increasing the operating temperature of engine materials. Research on new processing methods will complement research on materials properties. The program's primary areas of research will be ceramic and nonmetallic materials, metallic materials, and organic matrix composites.

(U) FY 2000 ($ in Thousands)

(U) $4,165 Performed ceramic and non-metallic materials research to examine the fundamentals of very-high temperature, non-metallic materials for airbreathing and rocket engines, and space vehicle applications. Investigated coupled thermal and mechanical stability of very-high temperature oxide composites and eutectics for jet engine blade applications.

(U) $6,781 Conducted metallic materials research to evaluate novel metallic systems for propulsion and airframe applications. Expanded investigations of thermal and mechanical stability of refractory metal systems for very-high temperature aircraft applications. Identified tailorable transition-phase materials for superior thermal barrier coatings.

(U) $1,862 Studied organic matrix composites to expand knowledge of polymer matrix composites for increasing the strength and life-span of air and space vehicle structures. Explored novel ring-opening chemistry to develop resins with controlled volume shrinkage to improve mechanical properties of high performance adhesives and matrix resins. Investigated moisture degradation of mechanical and electromagnetic properties in glass fiber reinforced composite structures.

(U) $12,808 Total

(U) FY 2001 ($ in Thousands)

(U) $4,537 Perform ceramic and non-metallic materials research to examine the fundamentals of very-high temperature, non-metallic materials for airbreathing and rocket engines, and space vehicle applications. Investigate coupled thermal and mechanical stability of very-high temperature oxide composites and eutectics for jet engine blade applications. Seek fundamental knowledge to formulate ultra-high temperature materials systems based on carbides for rocket propulsion applications.

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BUDGET ACTIVITY 01 - Basic Research	PE NUMBER AND TITLE 0601102F Defense Research Sciences
PROJECT 2306	

(U) A. Mission Description Continued

(U) FY 2001 ($ in Thousands) Continued

(U)	$7,386	Conduct metallic materials research to evaluate novel metallic systems for propulsion and airframe applications. Explore thermal and mechanical stability of refractory metal systems for very-high temperature aircraft applications. Evaluate tailorable transition-phase materials for superior thermal barrier coatings.
(U)	$2,029	Study organic matrix composites to expand knowledge of polymer matrix composites and increase the strength and life-span of air and space vehicle structures. Explore thermal cycling effects of polymer matrix composites down to cryogenic temperature range to better understand durability issues in liquid fuel tank environments. Investigate innovative fiber sizing techniques to minimize moisture degradation of mechanical and electromagnetic properties in glass fiber reinforced composite structures.
(U)	$13,952	Total

(U) FY 2002 ($ in Thousands)

(U)	$4,787	Perform ceramic and non-metallic materials research to understand optimum strength of very-high temperature, non-metallic materials for airbreathing and rocket engines, and space vehicle applications. Study thermal and mechanical stability interaction of very-high temperature oxide and non-oxide composites for jet engine blade applications. Advance fundamental materials knowledge to develop ultra-high temperature material systems based on carbides for rocket propulsion applications.
(U)	$7,542	Conduct metallic materials research to develop affordable and durable metallic systems for advanced engines and aerospace structural applications. Expand investigations of thermal and mechanical stability of metal refractory alloys, intermetallics, and composites for very-high temperature aircraft applications. Research tailorable transition-phase materials for superior thermal barrier coatings and develop advanced metals for multifunctional space systems.
(U)	$2,177	Perform organic matrix composites research to advance polymer matrix composite knowledge and increase the life-span and strength of aerospace structures. Study thermal cycling effects of polymer matrix composites at cryogenic temperatures to improve material durability in liquid fuel tank environments. Research novel fiber sizing techniques to minimize moisture degradation of mechanical and electromagnetic properties in glass fiber reinforced composite structures.
(U)	$2,000	Develop new mathematical and computational strategies to reduce maturity time for new materials by ~50% and to minimize the costs of new structural materials for aerospace systems. Explore scientific basis for computational design to reduce amount of costly experimentation required. Develop high performance materials more affordably through synchronization of material development and engineering system design.
(U)	$16,506	Total

(U) B. Project Change Summary

Not Applicable.

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PROJECT 2306	

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

(U) Related Activities:

(U) PE 0602102F, Materials.

(U) PE 0603211F, Aerospace Structures.

(U) PE 0708011F, Industrial Preparedness.

(U) PE 0602203F, Aerospace Propulsion.

(U) PE 0602201F, Aerospace Flight Dynamics.

(U) PE 0602601F, Space Technology.

(U) D. Acquisition Strategy

Not Applicable.

(U) E. Schedule Profile

(U) Not Applicable.

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

DATE: June 2001

BUDGET ACTIVITY: 01 - Basic Research

PE NUMBER AND TITLE: 0601102F Defense Research Sciences

PROJECT: 2307

COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
2307 Fluid Mechanics	9,637	9,623	10,046	10,561	11,275	12,180	12,440	12,717	Continuing	TBD

(U) A. Mission Description

The Fluid Mechanics project supports research to achieve substantial improvements in the efficacy, reliability, and cost-effectiveness of aerospace vehicles. The goal is to obtain major advances in understanding complex unsteady flows, hypersonic aerodynamics, turbulence, active flow control, and turbomachinery flows that will lead to superior new aerospace vehicles and their subcomponents. The research will lead to techniques to minimize drag and heat transfer, reduce flow separation, and create flow-control techniques to greatly expand current combat envelopes. The primary areas of research will be unsteady aerodynamics, hypersonic aerodynamics, turbulence and flow control, and rotating flows.

(U) FY 2000 ($ in Thousands)

(U) $2,890 Researched unsteady aerodynamics to provide fundamental knowledge of high-speed air flow to optimize current Air Force air vehicle designs and enable revolutionary future weapon systems. Investigated unsteady, complex, three-dimensional flows to refine the control and flight performance of unmanned air vehicles. Devised flow control design tools used to minimize flow separation and air vehicle drag. Developed fluid/structural interaction design tools to predict vehicle failure modes in rapid maneuvers.

(U) $2,409 Conducted hypersonic aerodynamics research to investigate complex flowfield phenomena for enabling the design of future Air Force trans-atmospheric vehicles and their flight control systems. Formulated concepts for hypersonic flow control, including plasma and magneto-hydrodynamic techniques to enable new high-speed weapon systems. Developed high-speed flow prediction codes to quantify thermal stresses in high performance air and space weapon systems.

(U) $2,410 Sought fundamental knowledge of turbulence and flow control to enhance the performance, controllability, and stability in high performance air vehicles. Created novel micro-electromechanical systems (MEMS) actuators, and investigated actuation coupling mechanisms in turbulent flows to enable agile flight vehicles with significantly reduced power requirements. Evaluated the use of MEMS devices for flow control on swept wing air vehicles to substantially reduce drag.

(U) $1,928 Studied rotating flows to evaluate internal flow characteristics for enabling significant enhancement of performance and reliability/ maintainability of airbreathing propulsion systems. Fabricated promising MEMS devices for turbine engine control and Large Eddy Simulation methodology for affordable, high fidelity predictions of gas turbine engine flow fields.

(U) $9,637 Total

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BUDGET ACTIVITY 01 - Basic Research	PE NUMBER AND TITLE 0601102F Defense Research Sciences
PROJECT 2307	

(U) A. Mission Description Continued

(U) FY 2001 ($ in Thousands)

(U)	$2,406	Perform unsteady aerodynamics research to provide fundamental knowledge of high-speed air flows to optimize current Air Force air vehicle designs and enable revolutionary future weapon systems. Investigated unsteady, complex, three-dimensional flows to refine the control and flight performance of unmanned air vehicles. Continue to devise design tools for flow control to minimize flow separation and air vehicle drag. Continue to develop fluid/structural interaction design tools to predict vehicle failure modes in rapid maneuvers.
(U)	$2,886	Conduct hypersonic aerodynamics research to investigate complex flowfield phenomena for enabling the design of future Air Force trans-atmospheric vehicles and their flight control systems. Advance concepts for hypersonic flow control, including plasma and magneto-hydrodynamic techniques. Develop high-speed flow prediction codes to quantify thermal stresses.
(U)	$2,407	Seek fundamental knowledge of turbulence and flow control to enhance the performance, controllability, and stability in air vehicles. Evaluate novel micro-electromechanical systems (MEMS) actuators, and investigate actuation coupling mechanisms in turbulent flows to enable agile flight vehicles with significantly reduced power requirements. Evaluate the use of MEMS devices for flow control on swept wing air vehicles with a goal of substantial drag reduction.
(U)	$1,924	Study rotating flows to evaluate internal flow characteristics for enhancing the performance and reliability/maintainability of airbreathing propulsion systems. Evaluate promising MEMS devices for turbine engine control and Large Eddy Simulation methodology for affordable high fidelity predictions of gas turbine engine flow fields and heat transfer effects.
(U)	$9,623	Total

(U) FY 2002 ($ in Thousands)

(U)	$2,513	Perform unsteady aerodynamics research to provide fundamental knowledge of high-speed air flows to optimize future Air Force air vehicle designs and enable revolutionary future weapon systems. Investigate unsteady, complex, three-dimensional flows to refine the control and flight performance of unmanned air vehicles. Complete the development of design tools for flow control to minimize flow separation and air vehicle drag. Complete the development of fluid/structural interaction design tools to predict vehicle failure modes in rapid maneuvers.
(U)	$3,015	Conduct hypersonic aerodynamics research to investigate complex flowfield phenomena for enabling the design of future Air Force trans-atmospheric vehicles and their flight control systems. Research advanced concepts for hypersonic flow control such as plasma or magneto-hydrodynamic techniques. Develop high-speed flow prediction codes to quantify thermal stresses. Investigate high temperature mitigation techniques for hypersonic flight vehicles.
(U)	$2,510	Seek fundamental knowledge of turbulence in coordinated experimental and computational simulation efforts. Investigate flow control concepts to enhance the performance, controllability, and stability in air vehicles. Develop new predictive tools for the air vehicle design process. Evaluate promising flow control actuation concepts and investigate flow control coupling mechanisms in turbulent flows to enable agile flight vehicles

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BUDGET ACTIVITY: 01 - Basic Research	PE NUMBER AND TITLE: 0601102F Defense Research Sciences
PROJECT: 2307	

(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands) Continued

with significantly reduced power requirements.

(U) $2,008 Study complex rotating flow phenomena as they relate to turbomachinery and jet engine applications. Evaluate unsteady flow phenomena for enhancing the performance and reliability/maintainability of airbreathing propulsion systems. Continue development of Large Eddy Simulation methodology for affordable high fidelity predictions of gas turbine engine flow fields and heat transfer effects. Develop understanding of high cycle fatigue aerodynamic forcing. Evaluate possible flow control applications in turbine engines.

(U) $10,046 Total

(U) B. Project Change Summary

Not Applicable.

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

(U) Related Activities:
(U) PE 0602102F, Materials.
(U) PE 0602203F, Aerospace Propulsion.
(U) PE 0602201F, Aerospace Flight Dynamics.
(U) PE 0603211F, Aerospace Structures.

(U) D. Acquisition Strategy

Not Applicable.

(U) E. Schedule Profile

(U) Not Applicable.

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

DATE: June 2001

BUDGET ACTIVITY: 01 - Basic Research

PE NUMBER AND TITLE: 0601102F Defense Research Sciences

PROJECT: 2308

COST ($ in Thousands)		FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
2308	Propulsion	19,577	21,449	20,819	19,121	19,636	20,162	20,608	21,073	Continuing	TBD

(U) A. Mission Description

Propulsion research seeks to increase the efficiency of energy usage in airbreathing engines, chemical and non-chemical rockets, and combined-cycle propulsion systems. The research will emphasize airbreathing propulsion, space power and propulsion, high-altitude signature characterization and contamination, propulsion diagnostics, and thermal management of space-based power and propulsion systems. Research will investigate chemically reacting flows that involve the complex coupling between energy release through chemical reactions and the flow processes that transport chemical reactants, products, and energy. Research on non-chemical energetic systems will include plasma and beamed energy propulsion for orbit-raising space missions and efficient ultrahigh-energy techniques for space-based energy use. The primary areas of research involved in this project will be space power and propulsion, combustion, and diagnostics.

(U) FY 2000 ($ in Thousands)

(U) $6,486 Performed research on space power and propulsion to investigate novel propulsion mechanisms to enable superior satellite propulsion performance. Modeled satellite propulsion characteristics for high-precision clusters of cooperating autonomous micro-satellites. Examined self-consuming satellites to increase payload and thrust capabilities. Created new concepts, such as pulsed detonation rocket and hybrid rocket engines, for optimal rocket propulsion. Identified experimental and numerical characteristics of high-altitude ultraviolet and infrared light satellite contamination to develop techniques to protect space assets.

(U) $6,062 Studied combustion to evaluate airbreathing propulsion systems for hypersonic, supersonic, and subsonic flight to enhance air warfare capabilities. Developed computer models to increase weapon system efficiency by predicting unsteady behavior such as combustion instability. Examined the coupling mechanisms between turbulence and liquid hydrocarbon fuel injection in gas turbine and scramjet engines to increase thrust output and enable significantly advanced weapon systems.

(U) $4,041 Investigated advanced diagnostic systems for data reduction and interpretation to create concepts for novel propulsion system applications. Extended diode-laser spectroscopic technique for on-board control of propulsion system operation and performance.

(U) $2,988 Continued coal-derived jet fuels research to investigate refinery processing techniques for coal processing with petroleum, additives to suppress fuel system fouling, combustion characteristics of candidate fuels, and fuel-material interactions.

(U) $19,577 Total

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE June 2001
BUDGET ACTIVITY 01 - Basic Research	PE NUMBER AND TITLE 0601102F Defense Research Sciences
PROJECT 2308	

(U) A. Mission Description Continued

(U) FY 2001 ($ in Thousands)

(U)	$7,220	Perform space power and propulsion research to investigate novel propulsion mechanisms to enable superior satellite propulsion performance. Increase thrust and control of micro-satellite and nano-satellite propulsion systems to enable high-precision clusters of cooperating autonomous micro-satellites. Examine self-consuming satellites and mechanical-electric energy conversion to increase payload and thrust capabilities. Continue to develop new concepts, such as pulsed detonation, hybrid rockets, and combined cycle engines, to enable very high temperature and pressure (supercritical) combustion for optimal rocket propulsion. Study experimental and numerical characteristics of high-altitude ultraviolet and infrared signatures and satellite contamination to develop techniques to protect space assets.
(U)	$6,738	Study combustion to evaluate airbreathing propulsion systems for hypersonic, supersonic, and subsonic flight to enhance air warfare capabilities. Enhance computer models to increase efficiency by predicting unsteady behavior such as combustion instability. Examine primary and secondary atomization and mixing of fuels to optimize fuel injection to increase thrust output.
(U)	$4,491	Investigate advanced diagnostics systems for data reduction and interpretation to create concepts for novel propulsion system applications. Obtain essential data through multiplexed diode-laser spectroscopy, enabling simultaneous detection of temperature and pressure within chemical propulsion systems to increase their thrust and efficiency.
(U)	$3,000	Continue coal-derived jet fuels research to investigate refinery processing techniques for coal processing with petroleum, additives to suppress fuel system fouling, combustion characteristics of candidate fuels, and fuel-material interactions. Produce small quantities (50 gallons) of coal-derived fuel for large-scale combustion, fuel system fouling, and ignition experiments.
(U)	$21,449	Total

(U) FY 2002 ($ in Thousands)

(U)	$7,339	Perform space power and propulsion research to investigate novel propulsion mechanisms to enable superior satellite propulsion performance. Enable clusters of cooperating autonomous micro-satellites by improving thrust and control of micro- and nano-satellite propulsion systems. Research mechanical-electric energy conversion and self-consuming satellites to increase payload and thrust. Explore supercritical combustion for optimal rocket propulsion using hybrid rockets and/or combined cycle engines. Perform research on digital propulsion and pulsed detonation rocket engines. Exploit experimental university satellites to measure thrust and cross-contamination in microsatellite constellations. Develop novel space diagnostic techniques and 100 gram class sensors for accurate measurements on micro- and nano-satellites.
(U)	$6,963	Study combustion to evaluate airbreathing propulsion systems for hypersonic, supersonic, and subsonic flight to enhance air warfare capabilities. Increase combustion efficiency and reduce fuel consumption through enhanced computer models that can predict unsteady behavior such as combustion instability. Advance the state of turbulent combustion simulation methods by incorporating refined models for chemistry and fuel droplets. Investigate enhancements to ignition and flame stabilization by weakly ionized flows.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE: June 2001
BUDGET ACTIVITY: 01 - Basic Research	PE NUMBER AND TITLE: 0601102F Defense Research Sciences
PROJECT: 2308	

(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands) Continued

(U)	$4,517	Investigate advanced diagnostics systems for data reduction and interpretation to create concepts for novel propulsion system applications. Apply picosecond spectroscopic techniques to characterize turbulent combustion statistical behavior and supercritical fuel properties.
(U)	$2,000	Research methods for improving aerodynamics for next generation aerospace vehicles for long range strike. Expand research to develop sound scientific basis for how plasmas are used to improve aerodynamic characteristics and propulsive efficiencies enabling hypersonic vehicles by reducing drag and improving range by more than 10%. Perform demonstrations to prove plasma control effects and to determine how to engineer them into operational systems. Investigate plasma effects on lowering fuel consumption, improving propulsion system performance, providing on-board power generation, and alleviating sonic boom and engine noise.
(U)	$20,819	Total

(U) B. Project Change Summary

Not Applicable.

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

(U) Related Activities:
(U) PE 0602102F, Materials.
(U) PE 0602203F, Aerospace Propulsion.
(U) PE 0602601F, Space Technology.
(U) PE 0603211F, Aerospace Structures.
(U) PE 0602269F, Hypersonic Technology Program.

(U) D. Acquisition Strategy

Not Applicable.

(U) E. Schedule Profile

(U) Not Applicable.

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

DATE: June 2001

BUDGET ACTIVITY: 01 - Basic Research

PE NUMBER AND TITLE: 0601102F Defense Research Sciences

PROJECT: 2310

COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
2310 Atmospheric Sciences	5,469	0	0	0	0	0	0	0	Continuing	TBD

Note: In FY 2001, effort was eliminated as a separate project with the space sciences efforts moved into Project 2311, Space Sciences.

(U) A. Mission Description

The Atmospheric Sciences project supports research on the Earth's upper atmospheric characteristics to better predict and control the effects the upper atmosphere has on Air Force tactical and strategic operations. The goal is to accurately model ionospheric irregularities and thermospheric dynamics to provide reliable and continuous command, control, and communications. The program will use innovative techniques to evaluate the structure and chemistry of the mesosphere and thermosphere. By modeling the physics and dynamics of the ionosphere, the program will create enhanced global surveillance, geolocation, and communication capabilities. Research activities will include the observation and modeling of atmospheric tides and gravity waves, geomagnetic disturbances, auroral and airglow emissions, and plasma turbulence and dynamics. The research focus will be space weather, optical and auroral emission, and ionospheric scintillation and turbulence.

(U) FY 2000 ($ in Thousands)

(U) $2,187 Performed space weather research to refine space phenomena prediction models to enable optimal design and protection of Air Force space assets. Developed satellite-based analysis techniques to examine the coupling between the solar wind, the interplanetary magnetic field, and the Earth's magnetosphere, and its effect on space operations. Supported the space weather Coordinated Community Modeling Center to transition information directly to the Air Force Space Forecast Center.

(U) $1,367 Conducted optical and auroral emission research to characterize the chemical and physical dynamics of the mesosphere, thermosphere, and ionosphere to develop a comprehensive map of regions that cause mission failure in space assets. Investigated atmospheric gravity wave interactions from high-latitude observation sites, using powerful new Light Detection and Ranging (LIDAR) techniques, to enable accurate interpretation of optical emissions and refined modeling of the operational space environment.

(U) $1,915 Studied ionospheric scintillation and turbulence to formulate prediction models to enhance global surveillance, geolocation, and communication capability. Investigated ionosphere plasma phenomena created by man-made radio waves, to enable active control of the operational space environment. Analyzed and interpreted signatures of solar activity to provide fundamental knowledge to design techniques to prevent disruption of global radio communications, geolocation, and space surveillance.

(U) $5,469 Total

(U) FY 2001 ($ in Thousands)

(U) $0 Effort moved to Project 2311.

(U) $0 Total

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE: June 2001
BUDGET ACTIVITY: 01 - Basic Research	PE NUMBER AND TITLE: 0601102F Defense Research Sciences
PROJECT: 2310	

(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands)

(U)	$0	Effort moved to Project 2311.
(U)	$0	Total

(U) B. Project Change Summary

Not Applicable.

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

(U) Related Activities:
(U) PE 0305160F, Defense Meteorological Satellite Program.
(U) PE 0602601F, Space Technology.
(U) PE 0603220C, Surveillance, Acquisition, Tracking, and Kill.

(U) D. Acquisition Strategy

Not Applicable.

(U) E. Schedule Profile

(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE: June 2001
BUDGET ACTIVITY: 01 - Basic Research	PE NUMBER AND TITLE: 0601102F Defense Research Sciences	PROJECT: 2311

COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
2311 Space Sciences	8,334	14,758	15,095	15,475	16,066	16,650	17,015	17,397	Continuing	TBD

Note: In FY 2001, efforts moved from Project 2310, Atmospheric Sciences.

(U) A. Mission Description

The Space Sciences project seeks to increase the understanding of the space environment and to optimize the design of future Air Force systems operating in near-Earth orbit, geosynchronous orbit, and deep-space. The goal is to enhance the protection of space assets against threats of space debris, solar wind, solar flares, cosmic rays, and geomagnetic storms. The focus will be on specifying the flow of mass, momentum, and energy through space to develop a global model that connects solar activity with the deposition of energy at the Earth. The project will develop methods to forecast turbulent plasma phenomena that mediate the energy flow through space in order to improve the Air Force's ability to operate in space. The research will focus on astrophysical observation techniques; solar physics; solar wind transport; magnetospheric physics; magnetosphere-ionosphere coupling; ionospheric physics and scintillation; and the energization processes in the Earth's radiation belts.

(U) FY 2000 ($ in Thousands)

(U) $3,334 Analyzed solar phenomena to characterize and model solar phenomena for much better prediction of large-scale disruptions in the space environment, and to advance development of protective spacecraft structures and defensive operational techniques. Investigated sunspots, solar oscillation modes, and solar magnetic fields to enable forecasting of solar eruptions.

(U) $2,083 Studied solar wind transport to evaluate the magnetic transport of solar eruptions to formulate accurate maps of environmental vulnerability and to identify orbits that ensure continued, reliable performance of Air Force satellites. Evaluated effects of solar wind, interplanetary magnetic field, and Earth’s magnetosphere to enhance space weather specification and forecast models.

(U) $2,917 Studied the transient and long-term effects of the Earth's magnetospheric and radiation belt energization processes to predict performance degradation levels in Air Force space systems. Examined charged particle dynamics for formulation of an accurate geomagnetic substorm onset model to calculate radiation effect longevity in the Earth’s satellite environment. Investigated turbulence and ionospheric scintillation to enhance design and operation of surveillance, geolocation, and communication satellites.

(U) $8,334 Total

(U) FY 2001 ($ in Thousands)

(U) $5,902 Continue support to Sacramento Peak Solar Observatory to analyze solar phenomena to characterize and model solar phenomena for much better prediction of large-scale disruptions in the space environment, and to advance development of protective spacecraft structures and defensive operational techniques. Discover the physics of solar plasma arcades, solar flares, and coronal mass ejections to establish the physical basis for solar disturbance models. Continue investigating sunspots, solar oscillation modes, and solar magnetic fields to enable forecasting of solar

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE June 2001
BUDGET ACTIVITY 01 - Basic Research	PE NUMBER AND TITLE 0601102F Defense Research Sciences
PROJECT 2311	

(U) A. Mission Description Continued

(U) FY 2001 ($ in Thousands) Continued

eruptions, and predict risk to critical Air Force space operations.

(U) $4,427 Study solar wind transport to evaluate the magnetic transport of solar eruptions to formulate accurate maps of environmental vulnerability, and to identify orbits that ensure continued, reliable performance of Air Force satellites. Integrate solar magnetic field and coronal data to discover the science underpinning solar ejection paths and devise accurate modeling techniques. Evaluate effects of the solar wind, the interplanetary magnetic field, and the Earth's magnetosphere to enhance space weather specification and forecast models.

(U) $4,429 Study the transient and long-term effects of the Earth's magnetospheric and radiation belt energization processes to predict performance degradation levels in Air Force space systems. Examine charged particle dynamics and magnetohydrodynamic fluid flow for formulation of an accurate geomagnetic substorm onset model to calculate radiation effect longevity in the Earth's satellite environment. Relate fundamentals of turbulence and ionospheric scintillation to enhance design and operation of surveillance, geolocation, and communication satellites.

(U) $14,758 Total

(U) FY 2002 ($ in Thousands)

(U) $3,773 Analyze, characterize, and model solar phenomena for much better prediction of large-scale solar disruptions in the space environment, and to advance development of protective spacecraft structures and defensive operational techniques. Obtain high-resolution observations of solar plasma arcades, solar flares, and coronal mass ejections to establish the physical basis for solar disturbance models. Continue investigating sunspots, solar oscillation modes, and solar magnetic field spin states to enable forecasting of solar eruptions and predict environmental risks to critical Air Force space operations. Develop solar vector magnetographs using adaptive optics.

(U) $3,774 Study solar wind effects on the Earth's magnetospheric and radiation belt energization processes and morphology. Enhance space systems performance degradation models. Develop models that provide realistic coupling of the magnetosphere - ionosphere system. Conceive magnetohydrodynamic (MHD) models to develop a theoretical understanding of magnetic reconnection and self-organized criticality in the magnetosphere.

(U) $4,528 Study ionospheric scintillation and turbulence to enhance global surveillance, geolocation, and communication. Observe atmospheric gravity wave interactions from high-latitude and tropical observation sites using light detection and ranging (LIDAR) techniques. Conduct airglow and auroral emission observations and characterize the chemical and physical dynamics of the mesosphere, thermosphere, and ionosphere to develop comprehensive seasonal and climatic maps of high-altitude phenomena.

(U) $3,020 Characterize the populations of space debris particles derived from comets and asteroids to predict threats to Air Force spacecraft. Provide a test bed for advanced deep space surveillance techniques through new astronomical instrumentation and observational methods. Expand laser guide-star development and observations of space backgrounds and optical signatures of orbital targets over the tropics. Research the variable

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE June 2001

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
01 - Basic Research	0601102F Defense Research Sciences	2311

(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands) Continued

energy deposited in near-Earth space by cosmic rays and energetic particles from deep space to identify risks to Air Force systems.

(U) $15,095 Total

(U) B. Project Change Summary

Not Applicable.

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

(U) Related Activities:

(U) PE 0602601F, Space Technology.

(U) PE 0602702F, Command, Control, and Communications.

(U) PE 0603410F, Space System Environmental Interactions Technology.

(U) D. Acquisition Strategy

Not Applicable.

(U) E. Schedule Profile

(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE: June 2001
BUDGET ACTIVITY: 01 - Basic Research	PE NUMBER AND TITLE: 0601102F Defense Research Sciences — PROJECT: 2312

COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
2312 Biological Sciences	12,850	14,432	13,972	14,331	14,732	15,066	15,394	15,737	Continuing	TBD

In FY 2001, Congress added $1M to PE 0601102F, Defense Research Sciences, to develop rapid diagnostic and fingerprinting techniques along with molecular monitoring systems for the detection of nosocomial infections. In FY 2001, the funding was realigned to PE 0602202F, Human Effectiveness Applied Research, project 7757, to align funding with the appropriate PE for this effort. The funding database has not yet been updated to reflect this realignment. Funding for this effort is found in PE 0601102F, Project 2312. However, this effort is described in PE 0602202F, Project 7757.

(U) A. Mission Description

The Biological Sciences project investigates biological processes important to Air Force applications. Research will explore the interaction of Air Force chemical and physical agents (lasers and microwaves) with human tissues and consequent potential hazardous effects. This research will generate safety strategies to ensure the hazard-free development of future aerospace materials and directed energy systems. Research in biomimetic sensors will study the biological detection systems of organisms at the molecular level and apply this knowledge to develop novel man-made sensors. Biocatalysis research will attempt to discover and characterize cellular enzymes that catalyze the synthesis of chemical feedstocks used in the safe production of aerospace materials. The research in neuroscience and chronobiology will create new strategies to prevent impaired performance due to jet lag, shift-work, and night operations. This research will create new strategies to prevent the loss of life and/or aircraft due to stress, inattention, or lack of vigilance. The primary areas of research will be bioenvironmental sciences, biocatalysis, chronobiology and neural adaptation, and biomimetic sensors.

(U) FY 2000 ($ in Thousands)

(U) $7,454 Studied bioenvironmental sciences to investigate and predict biological effects of novel aerospace chemicals and directed energy systems to assure the safety, health, and high-performance of military personnel during and after mission-directed activities. Evaluated underlying biochemical alterations related to the adverse effects of JP-8 jet fuel. Explored in vitro biodynamic alterations that together with biokinetic parameters can aid in predicting toxicity and be integrated into the early computational design of new, safer aerospace materials. Examined the effects of novel forms of directed energy (microwaves and lasers) on gene expression as an approach to identifying the specific sub-cellular targets of directed energy.

(U) $1,285 Researched biocatalysis to discover and characterize enzymes from living cells that can be used as biocatalysts to reduce cost, increase efficiency, and assure safety in the process of synthesizing chemical feedstocks used in the manufacture of aerospace materials. Identified and isolated bacteria strains capable of performing efficient biochemical reaction mechanisms to reduce cost and increase efficiency of aerospace materials synthesis.

(U) $2,570 Performed chronobiology and neural adaptation research to examine the biological mechanisms responsible for crew fatigue, adaptation to the

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE June 2001
BUDGET ACTIVITY 01 - Basic Research	PE NUMBER AND TITLE 0601102F Defense Research Sciences
PROJECT 2312	

(U) A. Mission Description Continued

(U) FY 2000 ($ in Thousands) Continued

environment, and individual performance capabilities to improve skilled human performance. Devised and tested new preventative countermeasures for human errors induced by fatigue and jet lag, and performed fundamental research on the biophysical basis of alert cognitive performance.

(U) $1,541 Investigated biomimetic sensors to develop understanding of visual, auditory, and vestibular systems, and identified methods to enhance them. Investigated, predicted, and modeled biological characteristics, behaviors, and functions for development of novel processes and mechanisms for physical and chemical system requirements. Devised techniques to model alternate mechanisms of near ambient infrared sensing systems in snakes and beetles to enable room-temperature, compact infrared sensors.

(U) $12,850 Total

(U) FY 2001 ($ in Thousands)

(U) $6,584 Study bioenvironmental sciences to investigate and predict biological effects of novel aerospace chemicals and directed energy systems to assure the safety, health, and high-performance of military personnel during and after mission-directed activities. Evaluate underlying biochemical alterations related to the adverse effects of JP-8 jet fuel and began to identify specific protein targets responsible for triggering the toxic responses. Explore in vitro biodynamic alterations that together with biokinetic parameters can aid in predicting toxicity and be integrated into the computational design of new, safer, aerospace materials. Examine the effects of novel forms of directed energy (microwaves and lasers) on gene expression and identify the specific sub-cellular targets of directed energy.

(U) $3,358 Research biocatalysis to discover and characterize enzymes from living cells that can be used as biocatalysts to reduce cost, increase efficiency, and assure safety for synthesizing chemical feedstocks for manufacturing aerospace materials. Sub-clone various bacterial enzymes to enhance the level of gene expression so the enzymes can be produced in sufficient yields for additional research and biotechnology development. Identify and isolate bacteria strains capable of performing efficient biochemical reaction mechanisms to reduce cost and increase efficiency of aerospace materials synthesis.

(U) $1,882 Perform chronobiology and neural adaptation research to examine the biological mechanisms responsible for crew fatigue, adaptation to the environment, and individual performance capabilities to improve skilled human performance. Interpret the mechanism by which serotonin regulates the circadian clock, determine if modafinil can prevent adverse effects on performance without disrupting sleep, and investigate the combination of countermeasures such as optimally-timed rest periods and wake promoting compounds.

(U) $1,610 Investigated biomimetic sensors to develop understanding of visual, auditory, and vestibular systems, and identify methods to enhance these systems. Analyze, predict, and model biological characteristics, behaviors, and functions for development of novel processes and mechanisms for physical and chemical system requirements. Isolate and begin to model alternate mechanisms of near ambient infrared sensing systems in snakes

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE June 2001
BUDGET ACTIVITY 01 - Basic Research	PE NUMBER AND TITLE 0601102F Defense Research Sciences
PROJECT 2312	

(U) A. Mission Description Continued

(U) FY 2001 ($ in Thousands) Continued

and beetles to enable room-temperature, compact infrared sensors. Investigate and adapt chromophores and photoluminescent characteristics in microbial and protein-based biological systems for insights to military sensor applications.

(U) $998 The activity for this effort is described in PE 0602202F, Project 7757.

(U) $14,432 Total

(U) FY 2002 ($ in Thousands)

(U) $6,846 Study bioenvironmental sciences to investigate the biological effects of exposure to military aerospace chemicals and directed energy systems used by the military to assure the safety, health, and high performance of personnel before, during, and after mission-directed activities. Explore the molecular and cellular effects of JP-8 jet fuel on the lung, brain, skin, and immune system and continue to identify specific molecular pathways involved in eliciting and blocking toxic responses. Continue to develop reliable in vitro simulators of in vivo toxic responses and learn to use them to rapidly acquire and predict toxic profiles at a sub-cellular level. Continue to identify and quantify subtle, gene-induced effects of directed energy (microwaves and lasers) on cellular targets and determine the approximate exposure levels at which these effects are significant.

(U) $3,494 Research biocatalysis to discover and characterize enzymes from living cells for use as biocatalysts to reduce cost, increase efficiency, and assure safety in chemical feedstocks synthesis for aerospace materials. Discover, isolate, clone, and sequence genes of novel enzymes of use to the military. Biochemically characterize the enzymes and investigate their mechanisms of reaction, kinetics, substrate range, and specificity.

(U) $1,955 Perform chronobiology and neural adaptation research to examine the biological mechanisms responsible for crew fatigue, adaptation to the environment, and individual performance capabilities to improve skilled human performance. Continue to analyze the mechanism by which serotonin regulates the circadian clock. Continue researching the effect of modafinil on preventing adverse performance effects without disrupting sleep. Optimize the combination of fatigue countermeasures such as optimally-timed rest periods and alertness promoting compounds.

(U) $1,677 Conduct biomimetic research to enable the development of novel sensors, engineering processes, and mechanisms. Investigate fundamental biological properties and processes of infrared sensitive biosystems at the cellular, sub-cellular, and molecular levels to enable the development of novel infrared materials and devices with enhanced structural and functional capabilities. Identify, isolate, and model alternate mechanisms of near ambient infrared sensing in biosystems to enable and/or enhance compact, room-temperature infrared sensors. Probe the functionality of alternative sensors for time-response characteristics. Investigate biochromophores and biophotoluminescent characteristics in microbial and protein-based biosystems for application to military sensors.

(U) $13,972 Total

(U) B. Project Change Summary

Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE June 2001
BUDGET ACTIVITY: 01 - Basic Research	PE NUMBER AND TITLE: 0601102F Defense Research Sciences
PROJECT: 2312	

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

(U) Related Activities:

(U) PE 0602202F, Human Effectiveness Applied Research.

(U) PE 0602204F, Aerospace Sensors.

(U) PE 0602602F, Conventional Munitions.

(U) PE 0602702F, Command, Control, and Communication.

(U) D. Acquisition Strategy

Not Applicable.

(U) E. Schedule Profile

(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE: June 2001
BUDGET ACTIVITY: 01 - Basic Research	PE NUMBER AND TITLE: 0601102F Defense Research Sciences	PROJECT: 2313

COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
2313 Human Performance	12,403	14,081	13,004	12,997	13,113	12,504	12,764	13,054	Continuing	TBD

(U) A. Mission Description

Human Performance research examines aspects of human information processing critical to Air Force operations. The objective is to develop useful quantitative models of the way humans perceive, navigate, and manipulate their environment; make decisions when performing complex tasks under stress or uncertainty; and adapt to extreme sensory, biophysical, or cognitive workloads. The sensory component of the research will emphasize visual, auditory, vestibular, and kinesthetic systems and their optimal integration. The research will contribute to the design of interactive displays, virtual-reality simulators, intelligent control systems, sensors and fused-image displays, and adaptive systems for personnel training and selection. The primary areas of research will be sensory and perceptual systems, cognition, and cognitive workload.

(U) FY 2000 ($ in Thousands)

(U) $3,349 Performed sensory and perceptual system research to investigate sensory and perceptual systems to enhance human-machine interaction in Air Force weapon systems. Expanded theories of visual search and scene analysis and control of attention for optimal cockpit performance. Investigated the perceptual and cognitive requirements for accurate simulation of virtual environments.

(U) $4,713 Conducted cognition research to measure and analyze cognitive dimensions of human performance in complex command and control tasks with multiple crew-member interactions. Formulated models of intelligent systems that aid human behavioral and cognitive functions or compensate for human limitations.

(U) $4,341 Studied cognitive workload research to formulate behavioral and physiological measures of cognitive workload, alertness, and vulnerability to sleep loss to enable cognitive performance modeling and prediction. Devised innovative approaches to understanding individual skill differences, and identify new training and selection system models relevant to modern, technology-dependent environments.

(U) $12,403 Total

(U) FY 2001 ($ in Thousands)

(U) $3,533 Perform sensory and perceptual system research to investigate sensory and perceptual systems to enhance human-machine interaction in Air Force weapon systems. Refine theories of visual search and scene analysis, control of attention, perception of orientation, and localization of sound for optimal cockpit performance. Analyze the perceptual and cognitive requirements for accurate simulation of virtual environments and for effective design of informative displays. Gain understanding of human multisensory integration to enable the design of automated sensing devices.

(U) $4,971 Conduct cognition research to measure and analyze cognitive dimensions of human performance in complex command and control tasks with

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE June 2001
BUDGET ACTIVITY 01 - Basic Research	PE NUMBER AND TITLE 0601102F Defense Research Sciences
PROJECT 2313	

(U) A. Mission Description Continued

(U) FY 2001 ($ in Thousands) Continued

multiple crew member interactions. Enhance human performance via intelligent systems that aid human behavioral and cognitive functions or compensate for human limitations. Develop and test training protocols to maximize team effectiveness under stress and sustained operation.

(U) $4,577 Study cognitive workload to formulate behavioral and physiological measures of cognitive workload, alertness, and vulnerability to sleep loss to enable cognitive performance modeling and prediction. Invent innovative approaches to understanding individual skill differences, and create new training and selection systems relevant to modern, technology-dependent environments. Study behavioral and physiological measures to avert human error in conditions of information overload and fatigue.

(U) $1,000 Support basic research and educational outreach projects at the Chabot Observatory and Science Center to assure the Air Force access to superior scientific and engineering talent in future years. Efforts include research to increase the fundamental understanding of the upper atmosphere.

(U) $14,081 Total

(U) FY 2002 ($ in Thousands)

(U) $3,512 Perform sensory and perceptual system research to investigate sensory and perceptual systems to enhance human-machine interaction in Air Force weapon systems. Develop theories for models of human-machine interaction in Air Force weapon systems. Critically test theories of visual search and scene analysis, and control of attention using measures of performance identified in several task domains. Create models for perceptual and cognitive requirements for accurate simulation and for effective design of informative displays. Develop laboratory apparatus to test theories of sensory integration for image understanding.

(U) $4,940 Conduct cognition research to measure and analyze cognitive dimensions of human performance in complex command and control tasks with multiple crew-member interactions. Develop models of enhanced human performance aided or augmented by intelligent systems. Discover and evaluate theories of training for operator and team effectiveness under stress and sustained operation.

(U) $4,552 Study cognitive workload to validate behavioral and physiological measures of cognitive workload, alertness, and vulnerability to sleep loss in several domains of operator performance. Model relationships between individual skill differences and interactions with new training methodologies. Study behavioral and physiological measures to avert human error in conditions of information overload and fatigue.

(U) $13,004 Total

(U) B. Project Change Summary

Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE June 2001
BUDGET ACTIVITY: 01 - Basic Research	PE NUMBER AND TITLE: 0601102F Defense Research Sciences
PROJECT: 2313	

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

(U) Related Activities:

(U) PE 0602202F, Human Effectiveness Applied Research.

(U) PE 0602702F, Command, Control, and Communication.

(U) D. Acquisition Strategy

Not Applicable.

(U) E. Schedule Profile

(U) Not Applicable.

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

DATE: June 2001

BUDGET ACTIVITY: 01 - Basic Research

PE NUMBER AND TITLE: 0601102F Defense Research Sciences

PROJECT: 4113

COST ($ in Thousands)		FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
4113	External Research Programs Interface	4,713	4,344	6,645	6,788	6,918	7,074	7,232	7,392	Continuing	TBD

(U) A. Mission Description

The External Research Programs Interface project promotes the interaction between the international and domestic civilian research community and Air Force researchers. The research will stimulate scientific and engineering education that will benefit the Air Force and increase the awareness of basic Air Force research priorities. These activities will help to attract talented scientists and engineers to address Air Force needs. The primary elements of this research will emphasize international strategy, international technology liaison, and scientist and engineer research interchange.

(U) FY 2000 ($ in Thousands)

(U) $1,554 Supported the Air Force Research Laboratory international strategy mission to provide centralized international expertise to assist formulation of optimal cooperation with, and leveraging of, international science programs to the benefit of the Air Force. Provided primary interface with the Office of the Secretary of Defense, the Office of the Secretary of the Air Force, and Air Force Materiel Command to coordinate international participation among appropriate United States Department of Defense organizations.

(U) $1,848 Supported international technology liaison missions to identify unique international research capabilities, and make them available to the Air Force. Used the European Office of Aerospace Research and Development and the Asian Office of Aerospace Research and Development to provide on-site coordination with international research organizations, and support international visits of high level Department of Defense delegations. Sustained and funded Air Force commitment to NATO-affiliated research institutes, such as the Von Karman Institute.

(U) $1,311 Supported scientist and engineer research interchange to assure the Air Force of continuing availability of superior scientific and engineering talent by supporting exceptional individuals and forging relationships between premiere scientists and the Air Force Research Laboratory. Improved awareness of Air Force research needs throughout the civilian scientific community while simultaneously identifying and recruiting the best scientific talent to participate in critical Air Force research.

(U) $4,713 Total

(U) FY 2001 ($ in Thousands)

(U) $1,434 Support the Air Force Research Laboratory international strategy mission to provide centralized international expertise to assist formulation of optimal cooperation with, and leveraging of, foreign science programs to the benefit of the Air Force. Provide the primary interface with the Office of the Secretary of Defense, the Office of the Secretary of the Air Force, and Air Force Materiel Command to coordinate international participation among appropriate U.S. Department of Defense organizations.

(U) $1,704 Support international technology liaison missions to identify unique international research capabilities, and make them available to the Air Force.

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(U) A. Mission Description Continued

(U) FY 2001 ($ in Thousands) Continued

Use the European Office of Aerospace Research and Development and the Asian Office of Aerospace Research and Development to provide on-site coordination with international research organizations, and support international visits of high level Department of Defense delegations. Sustain and fund Air Force commitment to NATO-affiliated research institutes, such as the Von Karman Institute.

(U) $1,206 Support scientist and engineer education to assure the Air Force of continuing availability of superior scientific and engineering talent by supporting exceptional individuals and forging relationships between premiere scientists and the Air Force Research Laboratory. Improve awareness of Air Force research needs throughout the civilian scientific community while simultaneously identifying and recruiting the best scientific talent to participate in critical Air Force research.

(U) $4,344 Total

(U) FY 2002 ($ in Thousands)

(U) $2,190 Support the Air Force Research Laboratory international strategy mission to provide centralized international expertise to assist formulation of optimal cooperation with, and leveraging of, foreign science programs to the benefit of the Air Force. Provide the primary interface with Office of the Secretary of Defense, the Office of the Secretary of the Air Force, and Air Force Materiel Command to coordinate international participation among appropriate U.S. Department of Defense organizations.

(U) $2,593 Support international technology liaison missions to identify unique international research capabilities, and makes them available to the U.S. Air Force. Use the European Office of Aerospace Research and Development and the Asian Office of Aerospace Research and Development to provide on-site coordination with international research organizations, and support international visits of high level Department of Defense delegations. Sustain and fund Air Force commitment to NATO-affiliated research institutes, such as the Von Karman Institute.

(U) $1,862 Support scientist and engineer exchange efforts to assure the Air Force of continuing availability of superior scientific and engineering talent by supporting exceptional individuals and forging relationships between premiere scientists and the Air Force Research Laboratory. Improve awareness of Air Force research needs throughout the civilian scientific community while simultaneously identifying and recruiting the best scientific talent to participate in critical Air Force research.

(U) $6,645 Total

(U) B. Project Change Summary

Not Applicable.

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PROJECT: 4113	

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

(U) Related Activities:

(U) PE 0601103D, University Research Initiative.

(U) PE 0602102F, Materials.

(U) PE 0602202F, Aerospace Flight Dynamics.

(U) PE 0602202F, Human Effectiveness Applied Research.

(U) PE 0602203F, Aerospace Propulsion.

(U) PE 0602204F, Aerospace Avionics.

(U) PE 0602269F, Hypersonic Technology Program.

(U) PE 0602601F, Space Technology (formerly Phillips Lab).

(U) PE 0602602F, Conventional Munitions.

(U) PE 0602702F, Command, Control and Communication.

(U) D. Acquisition Strategy

Not Applicable.

(U) E. Schedule Profile

(U) Not Applicable.