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

DATE: June 2001

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603401F Advanced Spacecraft Technology

	COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
	Total Program Element (PE) Cost	102,511	63,019	54,528	50,373	54,115	55,254	63,021	64,352	Continuing	TBD
1026	Space Structures and Controls Technology	6,226	0	0	0	0	0	0	0	Continuing	TBD
2181	Spacecraft Payloads	18,376	16,889	17,228	15,295	15,537	16,718	17,070	17,431	Continuing	TBD
3784	Space Sensors Technology	4,302	0	0	0	0	0	0	0	Continuing	TBD
3834	Integrated Space Technology Demonstrations	52,692	31,990	17,505	18,294	21,161	19,223	26,232	26,787	Continuing	TBD
4400	Space Systems Protection	4,516	5,560	6,109	7,156	7,525	8,590	8,770	8,954	Continuing	TBD
4844	Discoverer II	12,803	0	0	0	0	0	0	0	Continuing	TBD
4938	Space Developmental Planning	0	0	5,029	0	0	0	0	0	Continuing	TBD
682J	Spacecraft Vehicles	3,596	8,580	8,657	9,628	9,892	10,723	10,949	11,180	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0	0	0

Note: In FY 2000, the spectral sensing work in PE 0603605F, Project 3150, moved into this PE, Project 3784. Also in FY 2000, PE 0603302F, Project 0003, Launch Vehicle Technology, was combined with Project 1026 in this PE. In FY 2001, the Discoverer II program was terminated by Congress. In FY 2001, several of the projects in this PE were merged; Project 1026 work was moved to Project 682J, and Project 3784 work was moved to Project 2181. In FY 2002, in order to align projects within the Air Force Research Laboratory organization, all efforts in Program Element 0603410F were transferred into this PE, Project 4400. FY 2003 - FY 2007 budget numbers do not reflect the DoD strategy review results.

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(U) A. Mission Description

This program develops, integrates, and demonstrates space technologies in the areas of spacecraft payloads, space systems protection, and spacecraft and launch vehicles. The integrated space technologies are demonstrated by component or system level tests on the ground or in flight. Note: Congress added $25.1 million in FY 2001 ($6.5 million for Scorpius Low-Cost Launcher, $5.0 million for Upper Stage Flight Experiment, $6.5 million for Space Maneuver Vehicle, $2.6 million for Solar Orbit Transfer Vehicle, $1.5 million for Miniature Satellite Threat Reporting System, and $3.0 million for Satellite Survivability).

(U) B. Budget Activity Justification

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

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

		FY 2000	FY 2001	FY 2002	Total Cost
(U)	Previous President's Budget (FY 2001 PBR)	102,277	97,327	95,490	
(U)	Appropriated Value	103,529	63,602		
(U)	Adjustments to Appropriated Value				
	a. Congressional/General Reductions	-17			
	b. Small Business Innovative Research	-2,420			
	c. Omnibus or Other Above Threshold Reprogram				
	d. Below Threshold Reprogram	2,498			
	e. Rescissions	-1,079	-583		
(U)	Adjustments to Budget Years Since FY 2001 PBR			-40,962	
(U)	Current Budget Submit/FY 2002 PBR	102,511	63,019	54,528	TBD

(U) Significant Program Changes:

In FY 2001, the Discoverer II program was terminated by Congress.

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

DATE: June 2001

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603401F Advanced Spacecraft Technology

PROJECT: 1026

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
1026	Space Structures and Controls Technology	6,226	0	0	0	0	0	0	0	Continuing	TBD

Note: In FY 2001, efforts in this Project moved to Project 682J.

(U) A. Mission Description

This project develops and demonstrates advanced composite structures and structural control technologies for future Air Force space and launch systems. The goal is to significantly improve the payload mass fraction and reduce the overall time and cost of spacecraft fabrication. This project also funds for the development of advanced passive and active spacecraft structural control technologies. Structural vibration and shock suppression technologies are intended to significantly enhance space platform stability and improve the focusing/imaging ability of space-based optical components such as focal plane arrays.

(U) FY 2000 ($ in Thousands)

(U) $1,342 Developed composites for launch vehicle and spacecraft structures for applications such as the lightweight space antenna. Developed spacecraft to demonstrate multi-functional structures technologies. The composite and multi-functional structures will be lighter and more affordable, with improved functionality, reducing fabrication and launch costs and enabling applications such as large aperture sensing systems. Developed spacecraft that demonstrate inflatable and multi-functional structures technologies and fabricate inflatable and multi-functional structures for launch. Developed sub-scale secondary payload adapter structure.

(U) $335 Developed and demonstrated revolutionary spacecraft structural control and mechanisms technologies for on-orbit applications such as advanced high-power solar array subsystems, sensitive payload isolation systems, and miniature payload isolation systems for sensors and communications systems. These technologies will enhance platform stability, enabling applications such as precision pointing and sensing systems, as well as protect payloads on orbit and increase payload lifetime. Designed miniature vibration suppression systems. Launched complex sensor isolation platform for demonstration of vibration isolation and pointing. Launched second sensor isolation platform, which was simpler and more user friendly. Continued development of passive and active acoustic attenuation technologies.

(U) $977 Developed launch vibration isolation and primary and secondary payload isolation systems to meet specific launch vehicle requirements. Isolation systems will reduce the launch environment problems, decrease spacecraft weight, and reduce failures. Demonstrated low shock separation systems on the ground and in flight. Flight demonstrated first three-axis small launch vehicle isolation system.

(U) $663 Developed advanced composite launch vehicle structures such as grid stiffened shrouds for launch vehicles and lightweight thermal protection structures for reusable launch vehicles. Defined technological needs for future military launch vehicles. Composite structures will be lighter and more affordable, reducing fabrication and launch costs, and allowing larger and heavier payloads to be placed in higher orbits. Developed operational grid-stiffened structures.

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BUDGET ACTIVITY: 03 - Advanced Technology Development	PE NUMBER AND TITLE: 0603401F Advanced Spacecraft Technology	PROJECT: 1026

(U) A. Mission Description Continued

(U) FY 2000 ($ in Thousands) Continued

(U)	$2,909	Developed composite space launch payload dispenser for whole-constellation microsatellite deployment. Payload dispenser technologies will satisfy short- and long-term launch needs by making use of excess Enhanced Expendable Launch Vehicle (EELV) capacity. Designed and fabricated high-stiffness composite constellation payload dispenser.
(U)	$6,226	Total

(U) FY 2001 ($ in Thousands)

(U)	$0	Efforts transferred to Project 682J.
(U)	$0	Total

(U) FY 2002 ($ in Thousands)

(U)	$0	No Activity
(U)	$0	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 0602601F, Spacecraft Technology.
(U) PE 0603218C, Research and Support.
(U) PE 0603302F, Space and Missile Launch Technology.
(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.

(U) D. Acquisition Strategy

Not Applicable.

(U) E. Schedule Profile

(U) Not Applicable.

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

DATE: June 2001

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603401F Advanced Spacecraft Technology

PROJECT: 2181

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
2181 Spacecraft Payloads	18,376	16,889	17,228	15,295	15,537	16,718	17,070	17,431	Continuing	TBD

Note: In FY 2001, efforts in Project 3784 moved into this Project.

(U) A. Mission Description

This project funds the development, demonstration, and evaluation of radiation-hardened space electronic hardware, and satellite control hardware and software for advanced satellite surveillance operations. Improved space-qualifiable electronics and software for data and signal processing will be more interchangeable, interoperable, and standardized. In the near-term, this project's work concentrates on converting (i.e., radiation-hardening) commercial data and signal processor technologies for use in Air Force space systems. For mid-term applications, the Improved Space Computer Program (ISCP) will merge advanced, radiation-hardened space processor, memory, and interconnect technologies with commercially-derived, open system architectures to develop and demonstrate robust, on-board processing capabilities for 21st century DoD satellites. In the long-term, this project area focuses on developing low-cost, easily modifiable software and hardware architectures for fully autonomous constellations of intelligent satellites capable of performing all mission related functions without operator intervention.

(U) FY 2000 ($ in Thousands)

(U) $9,982 Developed advanced radiation-hardened microelectronic devices such as advanced space data processors and ultra-high density strategically hardened memories for next generation high performance on-board space electronics. Improved radiation-hardened fabrication technologies for component manufacturability. Performed functional proof of design of radiation-hardened Power PC processor. Redesigned commercial next generation space processor, accounting for single event upsets, ten times reduction in the amount of power required per instruction at a central processing unit level, and radiation-hardened fabrication. Provided software and hardware-in-the-loop simulators for advanced, user definable space processor architecture.

(U) $1,243 Developed space-qualifiable, high-density advanced packaging technology for digital, analog, and mixed-signal electronic devices and micro-electro-mechanical systems (MEMS) components and applications, including switches and optical components that exploit MEMS technologies. These technologies decrease size, weight, and power required for space electronic devices while also improving their performance, reliability, and affordability. Designed two-dimensional and three-dimensional space-qualified packaging technologies and reconfigurable electronics and plug-and-play system approaches for space. Developed technologies to enhance/enable optical cross-links such as light-emitting diodes, laser diodes, and MEMS optics which allow 400 Megabit per second data transfer.

(U) $1,529 Developed intelligent satellite system technologies for satellite control, precision spacecraft navigation, and formation flying. Developed cluster management technologies for spacecraft constellations. These intelligent satellite systems provide improved capabilities to monitor satellites in real-time, reduce the time required for data collection, processing, and dissemination, and decrease anomaly resolution time and ground operation

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BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603401F Advanced Spacecraft Technology	PROJECT 2181

(U) A. Mission Description Continued

(U) FY 2000 ($ in Thousands) Continued

requirements. Designed satellite cluster command and control, cluster formation flying, and executive cluster control software. Continued design of ground simulation testbed. Continued to build agent-based software architecture to increase satellite autonomy and simplify the development of complex systems. Demonstrated initial formation flying and orbit determination and satellite control ground station software.

(U) $773 Developed modeling, simulation, and analysis (MS&A) tools for space-based surveillance systems and distributed satellite architecture payloads. The MS&A tools provide data and validate research and development systems engineering level technology trade off decisions for space-based surveillance missions/campaign level assessments and for intelligent satellite systems testbeds. Delivered first version of the Next Generation Space Telescope simulation. Delivered existing space surveillance simulations to support New World Vista's Global Awareness Virtual Testbed. Delivered enhanced satellite toolkit which encompasses satellite constellation-level, distributed architecture modeling.

(U) $4,849 Developed key radiation-hardened microelectronics processes and components for space applications. Improved processes and higher performance components will create new markets and strengthen the radiation-hardened electronics industrial base, ensuring component availability at a reasonable cost. Improved fabrication process for, and performance of, radiation-hardened Application Specific Integrated Circuits. Fabricated and validated evaluation chips. Fabricated high performance, strategic hardened microprocessors (Power PC 603e equivalent) for space using hardened design techniques and transfer to hardened manufacturing fabrication line. Designed and fabricated a 16 Megabit radiation-hardened memory - a four-fold improvement over current technologies - using innovative techniques and new material application.

(U) $18,376 Total

(U) FY 2001 ($ in Thousands)

(U) $9,021 Develop advanced radiation-hardened microelectronic devices, including space data processors and ultra-high density strategically hardened memories, space-qualifiable, high density advanced packaging technology for digital, analog, and mixed-signal electronic devices, and micro-electro-mechanical systems (MEMS) components and applications, such as switches and optical components. These devices and technologies enable next generation high performance, small, lightweight, efficient, and reliable on-board space electronic systems. Fabricate and demonstrate radiation-hardened Power PC. Insert Next Generation Space Processor design and hardware into flight demonstration system. Design specifications, build, and demonstrate ground-based computer based on Improved Space Architecture concept. Demonstrate MEMS switches for reconfigurable space electronic applications. Continue the development of packaging and MEMS technologies that enhance/enable optical cross-links and demonstrate the 400 Megabit per second data transfer. Develop reconfigurable electronics and initial plug-and-play system approaches for space.

(U) $1,569 Continue to develop intelligent satellite system technologies for satellite control, precision spacecraft navigation, formation flying, and cluster

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(U) A. Mission Description Continued

(U) FY 2001 ($ in Thousands) Continued

management technologies for spacecraft constellations. Demonstrate intelligent satellite software in the distributed-cluster ground testbed for satellite cluster command and control, cluster formation flying, and executive cluster management. Complete and demonstrate enhanced executive cluster controller and begin developing formation flying and orbit determination flight test software and satellite control ground station software.

(U) $1,435 Continue to develop modeling, simulation, and analysis (MS&A) tools and data exploitation methodologies for space-based surveillance systems and distributed satellite architecture payloads. Deliver simulation architecture tools for satellite constellation-level modeling and validate these tools across the broader modeling and simulation space community. Demonstrate existing space surveillance simulations to support New World Vista's Global Awareness Virtual Testbed. Demonstrate MS&A software and tools in the distributed satellite architecture simulation testbed. Complete exploitation of the hyperspectral imaging data received from the Fourier Transform Hyperspectral Imager payload and assemble data images for target identification and image evaluation for commercial and military purposes.

(U) $2,206 Develop advanced space infrared technology and hardened focal plane detector arrays to enable acquisition, tracking, and discrimination of hot targets, as well as 'cold body' targets such as decoys, satellites, and midcourse warheads. Design low temperature, multi-color, and low background detectors and focal plane arrays and higher temperature focal plane arrays with higher levels of radiation-hardness. Develop longer wavelength mercury cadmium telluride focal plane arrays, higher operating temperatures for mid-wavelength infrared focal plane arrays, and focal plane arrays with optimal background-limited performance for stressing space backgrounds.

(U) $2,658 Develop satellite antenna technologies that maximize the use of high density interconnects, embed the electronics directly onto the antenna itself, and use antenna modules to create large, light space antennas. Satellite antenna technologies will be used to improve affordability and capability of antenna modules for space-based payload subsystems for Air Force surveillance and navigation efforts. Complete design of selected embedded-structural transmit-receive electronics antenna modules. Design antenna modules which address the requirement for minimizing mass and power by embedding lightweight electronics in the structure itself. Continue fabrication of modular phased-array antenna tile. Complete data analysis on receive-only sub-antenna array data.

(U) $16,889 Total

(U) FY 2002 ($ in Thousands)

(U) $10,511 Develop spacecraft microelectronic devices which will include radiation-hardened data processors and ultra-high density strategically hardened memories, space-qualifiable, high density advanced packaging technology, and micro-electro-mechanical systems (MEMS) components and applications. Design advanced general purpose embedded processors capable of performing at 500 million instructions per second. Design digital signal processors capable of performing at 1 billion operations per second. Perform full-scale integration of chalcogenide programmable

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PROJECT 2181	

(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands) Continued

memory elements into high density, low power chips. Investigate integration of chalcogenide into other component applications. Extend fabrication capability for application specific integrated circuit technology for upwards to eight million gate devices. Develop and demonstrate a MEMS switch box that will use discrete components with non-radiation-hardened control circuitry. Investigate the miniaturization of optical cross-links for advanced packaging applications.

(U) $1,755 Continue to develop intelligent satellite system technologies for satellite control, precision navigation, formation flying, and cluster management technologies for spacecraft constellations. Develop flight-ready microsatellite cluster management software. Complete and demonstrate flight-ready microsatellite flying algorithms and initiate development of command and control and navigational capability to perform high-fidelity spacecraft proximity operations. Develop a virtual cluster control ground station capable of commanding and controlling multiple satellite clusters. Initiate development of automated planning and scheduling software and integration of distributed payload processing algorithms with the flight software. Develop a spacecraft and simulation data archiving and storage system.

(U) $866 Continue to develop modeling, simulation, and analysis tools and data exploitation methodologies for space-based surveillance systems and distributed satellite architecture payloads. Build models for sparse, distributed aperture radio frequency (RF) system simulation to support technology trades, systems engineering, and design reviews for near-term flight test experiments. Build models of sparse aperture RF distributed signal processing to be validated against flight experiment and for systems analysis.

(U) $2,552 Develop advanced space infrared technology and hardened focal plane detector arrays to enable acquisition, tracking, and discrimination of hot targets, as well 'cold body' targets such as decoys, satellites, and midcourse warheads. Fabricate and deliver low temperature multi-color and low background detectors and focal plane arrays, and higher temperature arrays with improved radiation-hardness. Continue iterative development of longer wavelength mercury cadmium telluride focal plane arrays, higher operating temperature mid-wavelength infrared focal plane arrays, and focal plane arrays with optimal background-limited performance for stressing space backgrounds.

(U) $1,544 Develop satellite antenna technologies that maximize the use of high density interconnects, embed the electronics directly onto the antenna itself, and use antenna modules to create large, light space antennas. Satellite antenna technologies will be used to improve the affordability and capability of antenna modules for space-based payload subsystems for surveillance and navigation efforts. Fabricate selected embedded-structural transmit-receive electronics antenna modules. Design antenna modules that address requirements for minimizing mass and power by embedding lightweight electronics in the structure. Complete fabrication of modular phased-array antenna tiles. Integrate tiles into modules for performance characterization.

(U) $17,228 Total

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PROJECT: 2181	

(U) B. Project Change Summary

Not Applicable.

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

(U) Related Activities:
(U) PE 0303601F, MILSTAR Satellite Communications System.
(U) PE 0305160F, Defense Meteorological Satellite Program (DMSP).
(U) PE 0602601F, Spacecraft Technology.
(U) PE 0603311F, Ballistic Missile Technology.
(U) PE 0603215C, Limited Defense System
(U) PE 0603218C, Research and Support.
(U) PE 0603226E, Experimental Evaluation of Major Innovative Technologies.
(U) PE 0604609F, Reliability and Maintainability Technology Insertion Program (RAMTIP).
(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.

(U) D. Acquisition Strategy

Not Applicable.

(U) E. Schedule Profile

(U) Not Applicable.

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PE NUMBER AND TITLE: 0603401F Advanced Spacecraft Technology

PROJECT: 3784

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
3784 Space Sensors Technology	4,302	0	0	0	0	0	0	0	Continuing	TBD

Note: In FY 2001, effort transferred to Project 2181.

(U) A. Mission Description

This project funds the development of military space-based ground surveillance technologies. The project focuses on advancing space-based applications of commercial sensors while improving the performance, schedule, maturity, cost, and/or risk reduction. The focus of the space sensor effort is meeting spaceborne sensor needs for national missile defense and intelligence, surveillance, and reconnaissance missions.

(U) FY 2000 ($ in Thousands)

(U) $2,220 Developed advanced space infrared sensors and hardened focal plane detector arrays to enable acquisition, tracking, and discrimination of hot targets, as well as 'cold body' targets such as decoys, satellites, and midcourse warheads. Continued development of radiation-hardened mercury cadmium telluride 128 x 128 focal plane array. Developed 1024 x 1024 wavelength mercury cadmium telluride focal plane array. Demonstrated feasibility of a polarization autocue for focal plane arrays. Characterized performance of higher-temperature multispectral infrared focal plane arrays.

(U) $1,199 Developed satellite antenna technologies that maximize the use of high-density interconnects, embed the electronics directly onto the antenna itself, and use antenna modules to create large, light space antennas. Satellite antenna technologies will be used to improve the affordability and capability of antenna modules for space-based payload subsystems for Air Force surveillance and navigation efforts. Designed selected embedded-structural transmit-receive electronics antenna modules. Addressed requirement for minimizing mass and power by embedding lightweight electronics in the antenna structure. Fabricated a modular phased-array antenna tile. Completed fabrication and launch receive-only sub-antenna array and began data analysis.

(U) $883 Developed hyperspectral imaging data exploitation methodologies for military remote sensing applications with the Fourier Transform HyperSpectral Imager (FTHSI). The FTHSI payload will demonstrate the capability of providing the warfighter data concerning terrain categorization, feature extraction, geological formation mapping, and trafficability within an area observed from space. Launched the FTHSI payload on-board the MightySat II.1 satellite. Initiated analysis of the hyperspectral imaging data received from the FTHSI payload. Began assembly of data images for target identification and image evaluation for commercial and military purposes.

(U) $4,302 Total

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PROJECT 3784	

(U) A. Mission Description Continued

(U) FY 2001 ($ in Thousands)

(U)	$0	Efforts transferred to Project 2181.
(U)	$0	Total

(U) FY 2002 ($ in Thousands)

(U)	$0	No Activity
(U)	$0	Total

(U) B. Project Change Summary

Not Applicable.

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

(U) Related Activities:
(U) PE 0303601F, MILSTAR Satellite Communications System.
(U) PE 0602601F, Spacecraft Technology.
(U) PE 0602702F, Command/Control/Communication Technology.
(U) PE 0603226E, Experimental Evaluation of Major Innovative Technologies.
(U) PE 0604711F, Extremely High Frequency Satellite Communications Research and Development.
(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.

(U) D. Acquisition Strategy

Not Applicable.

(U) E. Schedule Profile

(U) Not Applicable.

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PE NUMBER AND TITLE: 0603401F Advanced Spacecraft Technology

PROJECT: 3834

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
3834	Integrated Space Technology Demonstrations	52,692	31,990	17,505	18,294	21,161	19,223	26,232	26,787	Continuing	TBD

(U) A. Mission Description

The Integrated Space Technology Demonstration (ISTD) program is a series of advanced technology demonstrations designed to address mission needs by applying emerging technologies from the Air Force Research Laboratory, other Government laboratories, and industry. These technologies are integrated into system-level demonstrations that are used to test, evaluate, and validate the technologies in an operational environment. Note: In FY 2001, Congress added $20.6 million ($6.5 million for Scorpius Low-Cost Launcher, $5.0 million for Upper Stage Flight Experiment, $6.5 million for Space Maneuver Vehicle, and $2.6 million for Solar Orbit Transfer Vehicle).

(U) FY 2000 ($ in Thousands)

(U) $9,130 Developed Warfighter-1, the first in a series of Integrated Space Technology Demonstration systems. Warfighter-1 will provide an inexpensive space-based hyperspectral imagery system for technology validation by a user in a tactical environment. Hyperspectral imaging sensors provide improved capabilities for the warfighter in target detection, terrain classification, and related surveillance applications. Developed the Warfighter-1 hyperspectral sensor, mission data center, and mobile ground station. Performed sensor characterization and integration and test on the payload, spacecraft, and space vehicle. Prepared for FY 2001 launch.

(U) $505 Developed and demonstrated precision ballistic missile navigation technologies that improve accuracy during reentry and in plasma and jamming environments. These technologies will mitigate the detrimental effects of reentry plasma and jamming on Global Positioning System (GPS) navigation performance. Conducted reentry plasma physics characterization studies and started development of miniaturized jam-resistant GPS receivers.

(U) $775 Developed hyperspectral imaging technologies for space-borne assets to provide improved capabilities for the warfighter in target detection, terrain classification, and related surveillance applications. Completed development of the Warfighter-1 hyperspectral imaging sensor payload on-board processing capability.

(U) $5,049 Developed microsatellite (10-100kg) technologies and integrated microsatellite technology concepts. Microsatellite technologies will revolutionize satellite operations and support applications such as near-earth object inspection and satellite servicing. Delivered first microsatellite in the XSS microsatellite series and began system integration in preparation for testing autonomous microsatellite operations, including satellite inspection.

(U) $2,909 Developed scalable booster technologies for low-cost launch vehicles. These technologies will reduce launch vehicle life cycle cost by five to ten times. Initiated development of the Sprite orbital vehicle for launching small payloads at significantly reduced cost. Developed and tested

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(U) A. Mission Description Continued

(U) FY 2000 ($ in Thousands) Continued

20,000-lb. thrust hardware chamber for the Sprite booster engine. Completed initial demonstration of the hydroxyl ammonium nitrate/triethanol amine nitrate (HAN/TEAN) mixing gas generator tank pressurization technology.

(U) $19,775 Developed and demonstrated technologies for a military-unique reusable satellite bus and upper stage for the Military Spaceplane system. This effort will provide the Air Force with a method for demonstrating critical Air Force technologies and concept of operations. Developed technologies for a second tail number, leveraging the technology investment in the NASA X-37, and addressed specific Air Force requirements including space operations and operability technologies.

(U) $14,549 Developed and demonstrated a low-cost, liquid propellant rocket engine for an expendable upper stage in a cooperative effort with NASA. These technologies will meet Air Force requirements for an affordable expendable upper stage for the Military Spaceplane system, including non-toxic, storable liquid propellants. Built a fuel enrichment system that produces the highly concentrated hydrogen peroxide required for optimal engine performance. Built a sub-scale upper stage common bulkhead composite tank and flight structure to reduce risk in fabrication process; refined process and fabricated the full-scale components. Designed, fabricated, and tested a full-scale integrated upper stage ground test article.

(U) $52,692 Total

(U) FY 2001 ($ in Thousands)

(U) $6,423 Continue to develop Warfighter-1, the first in the series of Integrated Space Technology Demonstration systems. Launch and start on-orbit evaluation of the hyperspectral sensor and associated ground operations. Conduct Warfighter-1 user utility demonstrations, satellite technology validation, and data exploitation analysis and assessment. Start final report detailing the evaluation and lessons learned from the technology demonstration and commercial leveraging.

(U) $0 Develop and demonstrate precision ballistic missile navigation technologies to improve accuracy during reentry and in plasma and jamming environments. Conduct reentry plasma physics characterization and demonstration planning, and continue development and demonstration of miniaturized jam-resistant Global Positioning System receivers.

(U) $2,951 Develop microsatellite (10-100kg) technologies and integrated microsatellite technology concepts. Begin design of second satellite in the XSS microsatellite series. Study bus requirements and potential designs. Develop guidance and navigation and maneuvering software and hardware technologies and proximity operations sensor package.

(U) $2,206 Develop technologies for the Communications/Navigation Outage Forecasting System (C/NOFS) demonstration. C/NOFS will demonstrate the capability for forecasting outages to Global Positioning System (GPS) navigation and satellite communications links, providing the warfighter with information on communications and navigation outages. This allows the preemptive use of backup systems and alternate links, which aids anomaly resolution, and facilitates mission/operations planning. Develop data processing unit. Verify payload interface and support spacecraft

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PROJECT 3834	

(U) A. Mission Description Continued

(U) FY 2001 ($ in Thousands) Continued

development and pre-planning of sensor suite integration and testing.

(U) $6,440 Develop scalable booster technologies for low-cost launch vehicles. Continue development of the Sprite orbital demonstration vehicle for launching small payloads at significantly reduced cost. Develop and test 20,000-lb. thrust flight-weight ablative Sprite booster engine. Develop and test all composite liquid oxygen propellant tank for the Sprite vehicle. Begin systems analysis for a Sprite 2,000-lb. thrust upper stage engine. Continue development and demonstration of hydroxyl ammonium nitrate/triethanol amine nitrate (HAN/TEAN) mixing gas generator tank pressurization technology.

(U) $4,954 Develop and demonstrate a low-cost, liquid propellant, expendable upper stage in a cooperative effort with NASA. Design, fabricate, and test a flight ready integrated expendable upper stage.

(U) $6,440 Develop and demonstrate technologies for a military-unique, reusable, satellite bus and upper stage for the Military Spaceplane system. Develop advanced reusable rocket engine technologies for the Space Maneuver Vehicle (SMV) X-40 second tail number flight test article. Continue to develop technologies for the SMV, such as retractable solar arrays for longer on-orbit duration and fine attitude control system to enable proximity operations and precision sensor pointing, and apply the technologies to the X-37 demonstrator to improve military utility and leverage the NASA investment.

(U) $2,576 Develop and demonstrate propulsion and power technologies for solar thermal orbit transfer vehicle (SOTV). These technologies will enable an affordable orbit transfer vehicle for inspection, reposition, and servicing of space assets above low earth orbit. Develop and build modular heat exchanger to enable scaling to operational size. Develop and build flight experiment scale test article of the inflatable concentrator and feedback control sensor and actuators. Develop control system algorithms and simulations and ground test algorithms with feedback control sensor.

(U) $31,990 Total

(U) FY 2002 ($ in Thousands)

(U) $3,619 Continue to develop Warfighter-1, the first in the series of Integrated Space Technology Demonstrations. Continue on-orbit evaluation of the hyperspectral sensor and associated ground operations. Conduct Warfighter-1 user utility demonstrations, satellite technology validation, and data exploitation analysis and assessment. Complete final report detailing the evaluation and lessons learned from the technology demonstration and commercial leveraging.

(U) $2,400 Develop autonomous micro-satellite (10-100kg) technologies for an integrated, robust, flexible, modular micro-satellite technology concept. Develop micro-satellite technologies for non-cooperative/uncooperative, autonomous operational concept and mission planning tools.

(U) $10,486 Design, develop, integrate and test an autonomous microsatellite to demonstrate integrated technology concepts for operations around a non-cooperative/uncooperative, resident space object. Perform design reviews and begin component/hardware fabrication for an autonomous

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(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands) Continued

operations micro-satellite.

(U) $1,000 Develop micro-satellite system test scenarios and design micro-satellite hardware-in-the-loop, software simulations, and mission planning/training tools.

(U) $17,505 Total

(U) B. Project Change Summary

Not Applicable.

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

(U) Related Activities:

(U) PE 0602601F, Spacecraft Technology.

(U) PE 0603605F, Advanced Weapons Technology.

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

(U) D. Acquisition Strategy

Not Applicable.

(U) E. Schedule Profile

(U) Not Applicable.

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

DATE: June 2001

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603401F Advanced Spacecraft Technology

PROJECT: 4400

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
4400	Space Systems Protection	4,516	5,560	6,109	7,156	7,525	8,590	8,770	8,954	Continuing	TBD

Note: In FY 2002, all efforts in Program Element 0603410F were transferred into this Project.

(U) A. Mission Description

This project develops and demonstrates tools, instruments, and mitigation techniques required to assure operation of U.S. space assets in both natural and potentially hostile warfighting environments. The project performs assessments of critical components, subsystems, and evaluates susceptibility and vulnerability to radio frequency and laser threats. This project also develops technologies that mitigate identified vulnerabilities. Technologies are developed and demonstrated to support balanced satellite protection strategies for detecting, avoiding, and operating in a hostile space environment. Note: In FY 2001, Congress added $4.5 million ($1.5 million for Miniature Satellite Threat Reporting System and $3.0 million for Satellite Survivability).

(U) FY 2000 ($ in Thousands)

(U)	$50	Prepared and used multi-threat assessment tool to evaluate space-based electro-optical sensor responses to various candidate laser countermeasures. Provides space platform designers a rapid and robust assessment tool for accurate assessment of various countermeasures. Identified passive satellite countermeasures and developed appropriate mitigation techniques.
(U)	$352	Developed satellite threat warning technologies and tools for on-board satellite use to detect, geolocate, and characterize the receipt of intentional and unintentional ground-based radio frequency (RF) and laser signals. Satellite threat warning technologies provide the warfighter information related to possible hostile acts directed at mission critical satellites and aid in satellite anomaly resolution. Fabricated and tested space-qualified RF hardware and developed proof of concept laser sensor design and laboratory brassboard.
(U)	$234	Coordinated integration and testing of Miniature Satellite Threat Reporting System (MSTRS) on host experiment platform for Space Shuttle risk reduction flight scheduled for FY 2001. The flight test will provide performance analysis of key MSTRS hardware components in a space environment and provide users early insight into MSTRS operational performance characteristics.
(U)	$3,880	Continued evolution of MSTRS that warns against ground-based, broad-band RF threats to satellites using a radar warning receiver as well as meakoning, intrusion, jamming, and interference receivers. Miniaturization enables incorporation of threat warning technologies on a variety of space platforms. Developed receiver system miniaturization technologies for power and weight savings.
(U)	$4,516	Total

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE: June 2001
BUDGET ACTIVITY: 03 - Advanced Technology Development	PE NUMBER AND TITLE: 0603401F Advanced Spacecraft Technology	PROJECT: 4400

(U) A. Mission Description Continued

(U) FY 2001 ($ in Thousands)

(U)	$50	Use multi-threat assessment tool to evaluate space-based electro-optical sensor responses to various candidate laser countermeasures. Begin development of passive satellite countermeasures and appropriate mitigation techniques.
(U)	$659	Continue to develop on-board satellite warning technologies and tools to detect, geolocate, and characterize the receipt of intentional and unintentional ground-based radio frequency (RF) signals. Begin design of integrated RF receiver/laser sensor hardware with weight and power savings compared to individual sensor packages.
(U)	$392	Develop RF threat warning receiver for a one-year space flight. Complete RF receiver data analysis, evaluate receiver performance to identify design changes to optimize performance, and incorporate changes into receiver design to reduce performance risk for the one-year flight. Conduct assessment of weapons effects on satellite components and systems.
(U)	$1,486	Develop and demonstrate technologies for the Miniature Satellite Threat Reporting System (MSTRS). MSTRS technologies enable detection of ground-based RF threats to satellites from a variety of space platforms. Demonstrate threat reporting package on shuttle flight STS-107. Design, fabricate, and demonstrate miniaturized instantaneous frequency measurement unit, power divider circuits, and high frequency circuit interconnects.
(U)	$2,973	Develop spacecraft protection technologies applicable to commercial and military space satellites to assure operation of space assets. Develop the capability to assess hardware/software threat susceptibility and vulnerability and develop technologies to mitigate identified vulnerabilities. Develop and exercise modeling and simulation tools to extend the current understanding of susceptibility of different commercial satellite subsystems to multi-threat environments. Develop RF and laser threat and effects models to evaluate case studies of existing and developing space systems.
(U)	$5,560	Total

(U) FY 2002 ($ in Thousands)

(U)	$50	Use multi-threat assessment tool to evaluate space-based electro-optical responses to various candidate RF and laser countermeasures. Add interface for analyzing RF and laser interaction effects on satellites. Add response models for satellite subsystems, such as communications, power, and inertial measurement units.
(U)	$2,293	Develop passive satellite countermeasures and mitigation techniques for current and future threats to satellites. Conduct plasma shield experiments to determine effectiveness of filtering the radio frequencies to allow only selected frequencies to reach the satellite communications antennas. Initiate evaluations and ground-based demonstrations of visible and near infra-red laser protection techniques in preparation for space demonstrations.
(U)	$1,455	Develop sensors to specify and forecast conditions in the space environment that degrade the operation of space-based systems. Support

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(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands) Continued

integration, launch, and on-orbit operations of instrumentation to improve space radiation hazard specification and forecasting. Specifying and forecasting hazardous space conditions will improve space system designs and lifetime, and enhance operational capabilities for the warfighter. Initiate integration of plasma sensor for the Communications/Navigation Outage Forecasting System onto payload. Launch all-sky camera to detect solar disturbances one to three days prior to Earth impact and complete initial on-orbit validation. Complete integration of relativistic detector for mission to map the dynamic radiation belts and quantify hazards to space systems.

(U) $1,006 Conduct collaborative experiments and develop tools to improve the survivability of advanced spacecraft power, communications, and surveillance systems. Develop preliminary design of second-generation miniaturized charge control system to autonomously protect satellites from harsh charging environments. Initiate conceptual design of an experiment to quantify the effects of space plasma on tethered power generation systems. Develop interface between dynamic space plasma and meteor specification and forecast models and web-based spacecraft charging design tool.

(U) $1,305 Develop technology to warn of spacecraft charging, chemical contamination, and kinetic impact hazards and to mitigate the effect of the space environment on DoD space systems. Space environment hazard warnings minimize loss of space assets due to component and system level failures and, when widely deployed, provide global situational awareness of hazards. Control of spacecraft charging levels and high-energy radiation effects will significantly improve space system reliability and availability and reduce operational costs. Complete validation of compact environment anomaly sensor for geosynchronous and highly elliptic orbits and transition to operational use. Develop detailed design for miniaturized space environment distributed anomaly resolution sensor for on-orbit detection of space particle, chemical, and impact hazards. Complete ground tests of particle enhancement and depletion technologies and begin conceptual design of active wave and electron beam space experiment to demonstrate the feasibility of satellite protection technologies.

(U) $6,109 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 0602601F, Spacecraft Technology.

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

(U) PE 0603605F, Advanced Weapons Technology.

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PROJECT: 4400	

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

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

(U) D. Acquisition Strategy

Not Applicable.

(U) E. Schedule Profile

(U) Not Applicable.

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

DATE: June 2001

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603401F Advanced Spacecraft Technology

PROJECT: 4844

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
4844 Discoverer II	12,803	0	0	0	0	0	0	0	Continuing	TBD

Note: In FY 2001, the Discoverer II program was terminated by Congress.

(U) A. Mission Description

Discoverer II (D-II) is a space-based radar/ground moving target indicator (SBR/GMTI) risk-reduction demonstration. The program, a two-satellite technical demonstration recommended by the Defense Science Board, develops and demonstrates the technologies that would be inherent in an SBR/GMTI tactical surveillance architecture. The cost goal of the program is to enable affordable acquisition of an operational SBR architecture for worldwide surveillance and targeting by mitigating the technical risks through the D-II demonstration. The National Reconnaissance Office (NRO) is an investment partner in this project and submits its budget request under the 'Discoverer II MTI Demo.' The Defense Advanced Research Projects Agency (DARPA) is also a funding partner due to the technical innovation and development nature of D-II. DARPA submits its budget request under the 'Aerospace Surveillance Technologies, Project SGT-02.' The Air Force also budgets for the launch integration and vehicle costs under PE 0305953F, Evolved Expendable Launch Vehicle. A senior oversight group consisting of SAF/AQ, the Director of NRO, and the Director of DARPA oversees D-II. The Air Force has the Senior Acquisition Executive responsibilities and DARPA has Program Executive Officer responsibilities (through Critical Design Review).

(U) FY 2000 ($ in Thousands)

(U) $8,144 Supported jointly funded effort to complete objective system and demonstration system preliminary designs through conduct of a competitive downselect process culminating in selection of a single System Integrator contractor's design. Conducted risk mitigation and demonstration test planning.

(U) $4,659 Supported jointly funded risk reduction efforts in key risk areas to include: design and fabrication for a low-cost, lightweight, space-qualifiable, Electronically Scanned Array antenna; and advanced signal processing for High-Range-Resolution Ground Moving Target Indicators, high resolution Synthetic Aperture Radar mode imaging, and terrain mapping technical feasibility and implementation concerns for Digital Terrain Elevation Data. Conducted mission utility analysis and concept of operations studies.

(U) $12,803 Total

(U) FY 2001 ($ in Thousands)

(U) $0 The D-II program was terminated by Congress.

(U) $0 Total

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE June 2001
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603401F Advanced Spacecraft Technology
PROJECT 4844	

(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands)

(U)	$0	No Activity.
(U)	$0	Total

(U) B. Project Change Summary

Not Applicable.

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

(U) Related Activities:
(U) PE 0305953F, Evolved Expendable Launch Vehicle.
(U) National Reconnaissance Office (NRO) MTI Radar Technology Project.
(U) SGT-02, DARPA Aerospace Surveillance Technologies.
(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.

(U) D. Acquisition Strategy

Not Applicable.

(U) E. Schedule Profile

(U) Not Applicable.

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

DATE: June 2001

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603401F Advanced Spacecraft Technology

PROJECT: 4938

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
4938 Space Developmental Planning	0	0	5,029	0	0	0	0	0	Continuing	TBD

(U) A. Mission Description

This project funds the developmental planning for military space technologies. The project focuses on the Pre-Milestone I systems engineering and integration, studies and analysis, concept development, and architecture efforts needed to transition technology into promising space concepts, capabilities, and systems. Of particular importance is the analysis work performed to link military technologies to mission needs through the strategy-to-task methodology of the Air Force modernization process (AFPD 10-14). Another key aspect of this project is the defining, refining, and demonstrating of select space concepts offering significant future military utility to the warfighter, especially those that integrate existing or planned capabilities from across the entire national space community. A key component of this program is the demonstration of future space capabilities for wargames, exercises, experiments, and demonstrations. This project also funds Modeling and Simulation tools and related infrastructure development that are necessary to conduct studies and provide analysis on future space concepts and capabilities.

(U) FY 2000 ($ in Thousands)

(U) $0 No Activity

(U) $0 Total

(U) FY 2001 ($ in Thousands)

(U) $0 No Activity

(U) $0 Total

(U) FY 2002 ($ in Thousands)

(U) $1,064 Conduct concept development on promising space concepts. Products include comprehensive, high-level, integrated and scientifically sound design solutions across the myriad of space disciplines. Functions include space concept design, cost engineering, and measure of performance/ effectiveness inputs to Air Force Space Command's Optimizer of Utility Toolkit model.

(U) $1,186 Conduct in-depth studies and analysis to assess and quantify the military worth of select space concepts. Provides decision-aiding analysis on space capabilities 15 to 25 years into the future.

(U) $1,027 Conduct continuing system-of-systems engineering and integration for promising space concepts. Defines and refines concepts offering significant military utility to the warfighter, focusing on the integration of air and space capabilities. Supports systems security protection measures for current and planned capabilities across the national space community.

(U) $963 Develop capability to demonstrate relationship, impacts, and effects of space assets on the military campaign in Air Force campaign and theater

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE: June 2001
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PROJECT: 4938	

(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands) Continued

simulation models/tools to include processing and presentation hardware and software, model database upgrades, and networking and leased communications lines to support virtual and distributed simulation capability.

(U)	$512	Develop and integrate architectural concepts addressing technology transition opportunities against space mission deficiencies and needs.
(U)	$277	Decrease the time to transition innovative space technology to the warfighter by demonstrating promising future space capabilities in exercises, wargames, experiments, and demonstrations.
(U)	$5,029	Total

(U) B. Project Change Summary

Not Applicable.

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

(U) Not Applicable.

(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: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603401F Advanced Spacecraft Technology

PROJECT: 682J

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
682J	Spacecraft Vehicles	3,596	8,580	8,657	9,628	9,892	10,723	10,949	11,180	Continuing	TBD

(U) A. Mission Description

This project develops and demonstrates compact, low-cost, spacecraft and launch vehicle power generation, storage, distribution, and thermal management technologies, including cryogenic cooling technologies. Power generation activities focus on lightweight, low-cost, low-volume, and survivable solar cell arrays. Energy storage work focuses on lightweight nickel hydrogen and sodium sulfur spacecraft batteries and flywheel energy storage systems for extended (five to ten year) satellite missions. The project's power distribution efforts focus on producing lightweight, high-efficiency, standardized power busses for use on future Air Force space programs.

(U) FY 2000 ($ in Thousands)

(U) $1,455 Developed and evaluated performance of space conventional power generation technologies such as multi-junction solar cells, advanced thin film solar cells, lightweight flexible arrays of thin film solar cells, and radiation resistant solar cell modules. Advanced conventional power generation technologies will make more power available for satellites with high power requirements, require less storage for launch, use new and easier methods to deploy, and be lighter and more affordable. Began development of lightweight flexible arrays of thin film solar cells and radiation resistant solar cell modules. Continued development and evaluation of 35% efficient multi-junction solar cells and 12% efficient thin film solar cells.

(U) $1,186 Developed innovative space conventional energy storage technologies such as the lightweight flywheel integrated power and attitude control system. These advanced energy storage technologies will reduce energy storage mass, replace separate spacecraft attitude control systems, and enable satellites with high peak power requirements such as space antennas and space-based laser systems. Began flywheel ground demonstration. Began development of technologies to increase flywheel safety.

(U) $955 Developed technologies for long-life, efficient, low vibration, lightweight mechanical cryocoolers for space applications at temperatures ranging from 10K to 150K. Cryocoolers enable extended missions for infrared sensor-based space surveillance systems, as well as increase the operational range, life, and reliability of very long wavelength infrared sensors. Completed a five-year life cycle test of a 60K cryocooler. Integrated the Reverse Brayton cryocooler into the Hubble telescope. Continued development of 10K model cryocooler.

(U) $3,596 Total

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE June 2001
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603401F Advanced Spacecraft Technology
PROJECT 682J	

(U) A. Mission Description Continued

(U) FY 2001 ($ in Thousands)

(U)	$2,081	Develop and evaluate the performance of space conventional power generation technologies such as multi-junction solar cells, advanced thin film solar cells, lightweight flexible arrays of thin film solar cells, and radiation resistant solar cell modules. Continue development of lightweight flexible arrays of thin film solar cells and radiation resistant solar cell modules. Continue evaluation of 35% efficient multi-junction solar cells and 12% efficient thin film solar cells.
(U)	$904	Develop innovative space conventional energy storage technologies such as the lightweight flywheel integrated power and attitude control system which employs non-electrochemical energy storage. Continue flywheel ground demonstration and development of flywheel safety technologies. Begin microflywheel development.
(U)	$1,178	Develop technologies for long-life, efficient, low vibration, lightweight mechanical cryocoolers for space applications at temperatures ranging from 10K to 150K. Complete 10K model cryocooler.
(U)	$2,040	Develop composites for launch vehicles and spacecraft structures, including grid stiffened launch vehicle shrouds and lightweight thermal protection structures for reusable launch vehicles, and for space applications, such as lightweight space antennas. Develop spacecraft to demonstrate multifunctional structures technologies. Composite and multi-functional structures will be lighter and more affordable, with improved functionality, reducing fabrication and launch costs and enabling applications such as large aperture sensing systems. Ground test and characterize operational grid stiffened structure. Continue development of inflatable structures. Begin ground test of multi-functional structures. Develop full-scale secondary payload adapter structure for an expendable launch vehicle.
(U)	$2,377	Develop and demonstrate revolutionary spacecraft structural control and mechanisms technologies for on-orbit applications such as advanced high power solar array subsystems, sensitive payload isolation systems, and miniature payload isolation systems for sensors and communications systems. Develop launch vibration isolation and primary and secondary payload isolation systems to meet specific launch vehicle requirements. These technologies will enhance platform stability, enable applications such as precision pointing and sensing, protect payloads on orbit and increase payload lifetime, reduce launch environment problems, decrease spacecraft weight, and reduce failures. Test miniature vibration suppression systems. Develop smart passive payload isolation systems. Ground demonstrate active acoustic attenuation system. Flight demonstrate simplified low shock separation device.
(U)	$8,580	Total

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(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands)

(U)	$2,010	Develop and evaluate performance of space conventional power generation technologies such as multi-junction solar cells, advanced thin film solar cells, lightweight flexible solar cell arrays, and radiation resistant solar cell modules. Ground demonstrate deployment and operation of large, free-flying, lightweight, flexible, radiation resistant, array of thin film solar cells. Integrate 35% efficient multi-junction solar cells and 12% efficient thin film solar cells into large modules. Begin integration into full arrays.
(U)	$830	Develop space conventional energy storage technologies such as the lightweight flywheel integrated power and attitude control system. Ground demonstrate integrated attitude control and energy storage system. Evaluate feasibility of microflywheel technology based on conceptual design; fabricate and test microflywheel components.
(U)	$1,369	Develop technologies for long-life, efficient, low vibration, lightweight mechanical cryocoolers for space applications. Characterize performance of 10K model cryocooler. Develop and deliver high efficiency multi-stage cryocooler with radiation-hardened control electronics. Begin development of high capacity multi-stage 10K cryocooler system for advanced space surveillance and tracking sensor.
(U)	$2,053	Develop composites for launch vehicle and spacecraft structures and space applications, such as launch vehicle shrouds, thermal protection structures, and space antennas. Develop spacecraft to demonstrate multi-functional structures technologies. Flight demonstrate grid stiffened shrouds and thermal protection structures. Complete development of inflatable support structures. Continue ground test of multi-functional structures. Initiate integration of power and thermal technologies into multi-functional structures. Ground test full-scale secondary payload adapter structure for an expendable launch vehicle.
(U)	$2,395	Develop technologies for spacecraft structural controls and mechanisms for on-orbit applications such as advanced high power solar array subsystems, sensitive payload isolation systems, and miniature payload isolation systems. Develop launch vibration isolation and primary and secondary payload isolation systems to meet specific launch vehicle requirements. Ground demonstrate smart passive payload isolation systems. Design operational active acoustic attenuation system. Develop and ground demonstrate passive acoustic attenuation system. Integrate low shock separation devices and whole spacecraft vibration isolation systems. Develop autonomous satellite docking and deployment mechanisms. Develop modular vibration-isolating spacecraft transport container.
(U)	$8,657	Total

(U) B. Project Change Summary

Not Applicable.

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PROJECT 682J	

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

(U) Related Activities:

(U) PE 0602203F, Aerospace Propulsion.

(U) PE 0602601F, Spacecraft Technology.

(U) PE 0603302F, Space and Missile Launch Technology.

(U) PE 0603218C, Research and Support.

(U) PE 0603226E, Experimental Evaluation of Major Innovative Technologies.

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

(U) D. Acquisition Strategy

Not Applicable.

(U) E. Schedule Profile

(U) Not Applicable.