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

DATE: February 1999

BUDGET ACTIVITY: 3 - Advanced Technology Development

PE NUMBER AND TITLE: 0603401F Advanced Spacecraft Technology

	COST *($ In Thousands*)	FY 1998 Actual	FY 1999 Estimate	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
	Total Program Element (PE) Cost	91,754	75,542	76,229	116,300	100,863	74,852	64,876	54,501	Continuing	Continuing
1026	Space Structures and Controls Technology	1,520	1,773	3,700	4,390	3,953	4,134	4,220	4,308	Continuing	Continuing
2181	Space Electronics and Software Technology	11,223	12,864	13,295	13,104	14,387	12,206	12,500	12,871	Continuing	Continuing
3784	Space Sensors and Satellite Communication Technology	2,410	1,745	4,702	5,913	4,080	3,426	3,473	3,544	Continuing	Continuing
3834	Integrated Space Technology Demonstrations	46,185	33,172	18,893	18,792	20,009	22,862	24,235	22,735	Continuing	Continuing
4400	Satellite Survivability Technology	5,353	5,779	2,616	3,859	4,773	4,661	4,340	4,006	Continuing	Continuing
4599	Reusable Launch Vehicle Technology	21,780	0	0	0	0	0	0	0	TBD	TBD
4782	Discoverer II	0	15,479	28,670	67,216	48,501	21,522	9,668	0	0	191,056
682J	Space Power and Thermal Management Technology	3,283	4,730	4,353	3,026	5,160	6,041	6,440	7,037	Continuing	Continuing
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0	0	0

Note: In FY 1998, the low-cost launch vehicle technology development program was moved from PE 0603302F, Project 4373, to this PE in Project 4599. Discoverer II funding has been moved from PE 0603856F to Project 4782 for FY 1999 and beyond. In FY 2000, the spectral sensing work in PE 0603605F, Project 3150, moves into this PE, Project 3784. Also in FY 2000, PE 0603302F, Project 0003, Launch Vehicle Technology, was combined with Project 1026 in this PE.

(U) A. <u>Mission Description</u>: This Advanced Technology Development program develops advanced spacecraft technologies such as structures, electronics, thermal management systems, power, and sensors and demonstrates them in an appropriate fashion (i.e., component or system, ground, or flight). The broad goals of the program are to decrease the time for innovative space technology to be transitioned to the warfighter and to reduce the associated development costs and risks of future Air Force space-based systems. Developmental efforts are focused on six high-payoff, satellite technology areas: (1) reusable and low-cost launch vehicle technologies; (2) advanced space structures and structural controls; (3) radiation hardened space electronics, satellite control software, and intelligent satellite systems; (4) advanced passive/active

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space-based sensors; (5) compact, low-cost space power and thermal management; and (6) satellite survivability and protection. In FYs 1999 and out, additional emphasis has been placed

on evolutionary growth in space technologies. Also starting in FY 1999, the technology development work supporting the integrated demonstrations of advanced guidance, navigation, and control packages for ballistic missiles is funded by this PE. Note: Congress added $57.5 million in FY 1998 ($5 million for Low-Cost Launch Vehicle Technologies (previously funded in PE 0603302F/0634373), $7.5 million for Solar Thermionics Orbital Transfer Vehicle, $5 million for Miniature Threat Reporting System (MSTRS), $10 million for Reusable Launch Vehicle (Military Spaceplane), and $30 million for Microsat Technology (Clementine 2)), and $18 million in FY 1999 ($2.5 million for Low-Cost Launch Vehicle Technologies, $4.5 million for Solar Thermionics Orbital Transfer Vehicle (SOTV), $5 million for Miniature Threat Reporting System, and $6 million for Microsat Technology). The Low-Cost Launch Vehicle Technologies and Solar Thermionics Orbital Transfer Vehicle Congressional Add programs were funded in Project 4599 in FY 1998, but were shifted to Project 3834 in FY 1999.

(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 1998	FY 1999	FY 2000	FY 2001	Total Cost
(U) Previous President's Budget/FY 1999 PB	54,899	42,571	47,005	50,961	Cont
(U) Appropriated Value	98,346	60,571			
(U) Adjustments to Appropriated Value					
a. Congressional/General Reductions	-2,112	-508			
b. SBIR	-964				
c. Omnibus/Other Above Threshold Reprogrammings	-372	15,479			
d. Below Threshold Reprogrammings	-3,144				
(U) Adjustments to Budget Year Since FY 1999 PB			29,224	65,339	
(U) Current Budget Submit/FY 2000 PB	91,754	75,542	76,229	116,300	Cont

(U) Significant Program Changes: FY 2000 and FY 2001 funding adjustments continue the Discoverer II demonstration and risk reduction program. Funding will begin the development of two satellites and associated technologies to be ready for launches in FYs 2003 and 2004.

FY 1999: $1,215 identified as a source for SBIR.

FY 1999: $15,479 for Discover II is being executed under PE 0603856F, but is being reported here for continuity purposes.

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BUDGET ACTIVITY **3 - Advanced Technology Development**	PE NUMBER AND TITLE **0603401F Advanced Spacecraft Technology**

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

DATE: February 1999

BUDGET ACTIVITY: 3 - Advanced Technology Development

PE NUMBER AND TITLE: 0603401F Advanced Spacecraft Technology

PROJECT: 1026

COST *($ In Thousands)*	FY 1998 Actual	FY 1999 Estimate	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
1026 Space Structures and Controls Technology	1,520	1,773	3,700	4,390	3,953	4,134	4,220	4,308	Continuing	Continuing

(U) A. Mission Description: This project demonstrates advanced composite structures and structural control technologies for future Air Force space and missile systems. Prior to FY 1995, the Air Force relied on Ballistic Missile Defense Organization (BMDO) funding to address its needs in this technology area. As BMDO budgets have declined, so has their funding in this area, necessitating an increased Air Force investment to maintain critical spacecraft structures and controls technologies. Advanced space structure component efforts focus on the demonstration of new composite structure technologies. The goal is to significantly improve the payload mass fraction and reduce overall spacecraft fabrication time and cost. This project also pays 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, improving the focusing/imaging ability of space-based optical components such as focal plane arrays developed in Project 3784 or solar cells developed in Project 682J.

(U) FY 1998 ($ in Thousands):
- (U) $676 Developed composites for launch vehicle and spacecraft structures for applications such as the MightySat experimental spacecraft.
- (U) $260 Developed revolutionary spacecraft structural control and mechanisms technologies for applications such as advanced solar array subsystems and sensitive payload isolation systems.
- (U) $584 Developed advanced launch vehicle vibration isolation and payload isolation systems; demonstrated the first whole spacecraft isolation system on the Taurus launch vehicle.
- (U) $1,520 Total

(U) FY 1999 ($ in Thousands):
- (U) $785 Develop composites for launch vehicle and spacecraft structures for applications such as the lightweight space antenna. Develop spacecraft to demonstrate multifunctional structures technologies.
- (U) $272 Develop revolutionary spacecraft structural control and mechanisms technologies for applications such as advanced high power solar array subsystems, sensitive payload isolation systems, and miniature payload isolation systems for sensors and communications systems.
- (U) $680 Develop launch vibration isolation and primary and secondary payload isolation systems to meet specific launch vehicle requirements.
- (U) $36 Identified as a source for SBIR.
- (U) $1,773 Total

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(U) FY 2000 ($ in Thousands):

- (U) $1,101 Develop composites for launch vehicle and spacecraft structures for applications such as the lightweight space antenna. Develop spacecraft to demonstrate multifunctional structures technologies.
- (U) $288 Develop and demonstrate revolutionary spacecraft structural control and mechanisms technologies for applications such as advanced high power solar array subsystems, sensitive payload isolation systems, and miniature payload isolation systems for sensors and communications systems.
- (U) $1,256 Develop launch vibration isolation and primary and secondary payload isolation systems to meet specific launch vehicle requirements.
- (U) $1,055 Develop advanced composite launch vehicle structures such as grid stiffened shrouds for launch vehicles and lightweight thermal protection structures for reusable launch vehicles. Define technological needs for future military launch vehicles.
- (U) $3,700 Total

(U) FY 2001 ($ in Thousands):

- (U) $1,249 Develop composites for launch vehicle and spacecraft structures for applications such as the lightweight space antenna. Develop spacecraft to demonstrate multifunctional structures technologies.
- (U) $239 Develop and demonstrate revolutionary spacecraft structural control and mechanisms technologies for applications such as advanced high power solar array subsystems, sensitive payload isolation systems, and miniature payload isolation systems for sensors and communications systems.
- (U) $1,584 Develop launch vibration isolation and primary and secondary payload isolation systems to meet specific launch vehicle requirements.
- (U) $1,318 Develop advanced composite launch vehicle structures such as lightweight thermal protection structures for reusable launch vehicles and lightweight acoustically damped launch vehicle structures. Define technological needs for future military launch vehicles.
- (U) $4,390 Total

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	PROJECT 1026

(U) B. Project Change Summary - Description of Significant Changes: In FY 2000, efforts currently in PE 0603302F, Project 0003 (Launch Vehicle Technology), move into this project.

(U) C. Other Program Funding Summary:

(U) Related Activities:

- (U) PE 0602102F, Materials.
- (U) PE 0602601F, Phillips Laboratory.
- (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: Not Applicable.

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DATE: February 1999

BUDGET ACTIVITY: 3 - Advanced Technology Development

PE NUMBER AND TITLE: 0603401F Advanced Spacecraft Technology

PROJECT: 2181

COST *($ In Thousands)*	FY 1998 Actual	FY 1999 Estimate	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
2181 Space Electronics and Software Technology	11,223	12,864	13,295	13,104	14,387	12,206	12,500	12,871	Continuing	Continuing

(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 are to be more interchangeable, interoperable, and standardized. In the near-term, this project's work concentrates on converting (i.e., hardening) commercial data and signal processor technologies for use in Air Force space systems. Advanced electronic packaging technologies that reduce weight and volume are being developed for military space applications. Space data processor technologies like the Advanced Technology Insertion Module (ATIM 32-bit) technology are developed and demonstrated. The Advanced Spaceborne Computer Module (ASCM), ATIM's 16-bit predecessor, is currently baselined into 65 DoD, National Aeronautics and Space Administration (NASA), and commercial programs. Also developed and demonstrated are space signal processor technologies like the Hardened Ada Signal Processor (HASP) program. 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. Additionally, this project demonstrates very low-power electronics allowing dramatic size, weight, and power reductions for future Air Force space applications. Low-cost, easily modifiable software and hardware architectures for enhanced satellite ground control and intelligent, autonomous satellite operations to support the space surveillance mission are also developed. The Multi-mission Advanced Ground Intelligent Control (MAGIC) program in this project developed a low-cost, flexible architecture for satellite control and mission operations. In the long-term, this project area focuses on developing fully autonomous constellations of intelligent satellites capable of performing all mission related functions without operator intervention.

(U) FY 1998 ($ in Thousands):

- (U) $8,603 Developed and demonstrated affordable, space-qualifiable, radiation hardened, low-power, high performance microelectronic devices such as data processors and digital signal processors.
- (U) $1,453 Developed space-qualifiable, high density advanced packaging technology for micro-electro-mechanical systems (MEMS) and microelectronics. Developed MEMS components and applications.
- (U) $1,167 Developed reusable, standardized satellite operations software for applications such as intelligent satellite ground control workstations and an autonomous satellite operations software testbed.
- (U) $11,223 Total

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(U) FY 1999 ($ in Thousands):

- (U) $8,389 Develop and demonstrate affordable, space-qualifiable, radiation hardened, low-power, high performance microelectronic devices such as advanced data processors, and integrated and next generation digital signal processors.
- (U) $1,148 Develop space-qualifiable, high density advanced packaging technology for digital, analog, and mixed-signal electronic devices. Develop micro-electro-mechanical systems (MEMS) components and MEMS-based space system applications.
- (U) $2,182 Develop enhanced, standardized satellite operations software for application in satellite health and status verification and an autonomous satellite operations software testbed.
- (U) $885 Develop modeling and simulation applications for space-based surveillance and distributed satellite system payloads.
- (U) $260 Identified as a source for SBIR.
- (U) $12,864 Total

FY 2000 ($ in Thousands):

- (U) $8,844 Develop and demonstrate affordable, space-qualifiable, radiation hardened, low-power, high performance microelectronic devices such as advanced data processors and next generation digital signal processors.
- (U) $1,440 Develop space-qualifiable, high density advanced packaging technology for digital, analog, and mixed-signal electronic devices. Develop and demonstrate MEMS components and applications.
- (U) $2,115 Develop enhanced, standardized satellite operations software for application in autonomous satellite command and control systems and an autonomous satellite operations software testbed.
- (U) $896 Develop modeling and simulation applications for space-based surveillance, distributed satellite system payloads, and autonomous/intelligent satellite systems.
- (U) $13,295 Total

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FY 2001 ($ in Thousands):

- (U) $8,086 Develop and demonstrate affordable, space-qualifiable, radiation hardened, low-power, high performance microelectronic devices such as advanced data processors and next generation digital signal processors.
- (U) $1,317 Develop next generation high density packaging technology for digital, analog, and mixed signal devices in space environment. Develop and demonstrate MEMS components and applications.
- (U) $2,099 Develop enhanced, standardized satellite operations software for application in autonomous satellite command and control systems and an autonomous satellite operations software testbed.
- (U) $1,207 Enhance modeling and simulation applications for space-based surveillance, distributed satellite system payloads, and autonomous/intelligent satellite systems.
- (U) $395 Develop and test software architecture for the Space Hazards Analysis Workstation software.
- (U) $13,104 Total

(U) B. Project Change Summary - Description of Significant Changes: In FY 1999, the Modeling and Simulation efforts funded under Project 3834, in this PE, transition into this project.

(U) C. Other Program Funding Summary:

(U) Related Activities:

- (U) PE 0303601F, MILSTAR Satellite Communications System.
- (U) PE 0305160F, Defense Meteorological Satellite Program (DMSP).
- (U) PE 0602601F, Phillips Laboratory.
- (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: Not Applicable.

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DATE: February 1999

BUDGET ACTIVITY: 3 - Advanced Technology Development

PE NUMBER AND TITLE: 0603401F Advanced Spacecraft Technology

PROJECT: 3784

COST *($ In Thousands)*	FY 1998 Actual	FY 1999 Estimate	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
3784 Space Sensors and Satellite Communication Technology	2,410	1,745	4,702	5,913	4,080	3,426	3,473	3,544	Continuing	Continuing

(U) A. Mission Description: This project funds the development of military space-based ground surveillance technologies. The project's work 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 to meet spaceborne sensor needs for national missile defense and intelligence, surveillance, and reconnaissance missions.

(U) FY 1998 ($ in Thousands):
- (U) $1,339 Developed space-based reconnaissance/surveillance sensor technologies for reliable, large format focal plane arrays and advanced mid-wave infrared detectors.
- (U) $810 Developed technologies for Space-Based Radar (SBR) including the Transmit and Receive Antenna Module (TRAM) and a Radio Frequency (RF)/mechanical characterization laboratory for investigating structure and antenna performance.
- (U) $261 Developed SBR models and clutter database for SBR system antenna simulation.
- (U) $2,410 Total

(U) FY 1999 ($ in Thousands):
- (U) $286 Develop and demonstrate space-based reconnaissance/surveillance sensor technologies for advanced mid-wave infrared detectors and hybrid detector arrays.
- (U) $1,234 Develop technologies for SBR such as the next iteration TRAM module, antenna beamsteering algorithms for improved detection and tracking, and antenna vibration compensation schemes.
- (U) $190 Develop models for the SBR system. Model five antenna designs to simulate their performance in a wargaming environment.
- (U) $35 Identified as a source for SBIR.
- (U) $1,745 Total

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(U) FY 2000 ($ in Thousands):

- (U) $1,916 Develop space-based reconnaissance/surveillance sensor technologies such as advanced long wavelength infrared focal plane arrays, hyperspectral quantum well photodetectors, and detector and readout arrays for dual waveband infrared detection in moderate optical backgrounds.
- (U) $2,067 Develop and demonstrate technologies for Space-Based Radar (SBR) such as the Transmit and Receive Antenna Module (TRAM) II panel, integrated TRAM/multifunctional technologies, and antenna vibration compensation schemes. Extend SBR system models.
- (U) $719 Develop and refine technologies for spectral remote sensing data collection and exploitation to validate satellite precision orbit-prediction methodology and for ultra-spectral imaging concepts.
- (U) $4,702 Total

(U) FY 2001 ($ in Thousands):

- (U) $2,303 Develop space-based reconnaissance/surveillance sensor technologies such as advanced long wavelength infrared focal plane arrays, hyperspectral quantum well photodetectors, and multi-waveband focal plane arrays for operation in low optical backgrounds and hyperspectral imaging applications.
- (U) $2,283 Develop and demonstrate technologies for SBR such as a larger scale TRAM panel for extended performance testing, clutter algorithms to improve target discrimination, and integrated advanced processing algorithms. Extend SBR system models.
- (U) $1,327 Develop and demonstrate technologies for spectral remote sensing using an ultra-spectral imaging sensor and an airborne remote sensing spectropolarimeter for realistic military applications.
- (U) $5,913 Total

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(U) B. Project Change Summary - Description of Significant Changes: In FY 2000, spectral sensing (hyperspectral technology) efforts currently in PE 0603605F, Project 3150, move into this project.

(U) C. Other Program Funding Summary:

(U) Related Activities:
- (U) PE 0303601F, MILSTAR Satellite Communications System.
- (U) PE 0602601F, Phillips Laboratory.
- (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:** Not Applicable.

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DATE: February 1999

BUDGET ACTIVITY: 3 - Advanced Technology Development

PE NUMBER AND TITLE: 0603401F Advanced Spacecraft Technology

PROJECT: 3834

COST *($ In Thousands)*	FY 1998 Actual	FY 1999 Estimate	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
3834 Integrated Space Technology Demonstrations	46,185	33,172	18,893	18,792	20,009	22,862	24,235	22,735	Continuing	Continuing

(U) A. Mission Description: The Integrated Space Technology Demonstration (ISTD) program is a series of demonstrations, or projects established to address the latest Air Force Space Command (AFSPC) Mission Area Plan (MAP) deficiencies. The ISTD program provides for the integration of government and commercially developed technologies onto satellites. The ISTD program also seeks to validate and demonstrate the value of these new technologies to address new space tactics, techniques, procedures, doctrine, and possibly revolutionize future acquisitions of DoD space systems. The ISTD program will enhance commercial and civil space assets in a cost-effective manner, allowing the warfighter to assess the utility of new space technologies through leveraging opportunities and, when required, through dedicated space flight demonstrations. In general, the ISTD series of space technology demonstrations will allow users to assess new space technologies, which, when integrated, will become technology options for future space systems. The highly successful Technology for Autonomous Operational Survivability (TAOS) satellite was the first of the ISTD series. TAOS was launched in March 1994 and is currently demonstrating advanced warfighter concepts and the viability of advanced computers, autonomous navigation hardware/software, laser sensors, radar sensors, and data busses in space. In FY 1995, the ISTD program office initiated a cooperative agreement with National Aeronautics and Space Administration's (NASA) to leverage the NASA Clark satellite with Air Force funding and technologies. Clark was set for launch in February 1998, but the program was terminated prior to launch due to NASA funding constraints. The Warfighter-1 program, started in August 1997, is the second in the ISTD series and leverages commercial investments. Beginning in FY 1999, the technology development work supporting the integrated demonstrations of advanced guidance, navigation, and control packages for ballistic missiles is supported by this project. The Congressionally-funded microsatellite technology development and demonstration program (designated Clementine II in FY 1998 and prior years and now known as XSS-10) is also included in this project. In FY 1999, Congress added the funds for the low-cost launch vehicle technology development program, which is conducted jointly with Ballistic Missile Defense Organization (BMDO), and the orbital transfer vehicle program to this project; these two programs were previously funded under Project 4599 in this PE.

(U) FY 1998 ($ in Thousands):

- (U) $15,311 Developed components for the Warfighter-1 Integrated Space Technology Demonstration Program, including payload and mobile ground station components and modified data exploitation algorithms.
- (U) $50 Planned the Warfighter-2 Integrated Space Technology Demonstration Program.
- (U) $824 Developed simulation applications for integrated satellite payloads for Space-Based Radar, Ultra Lightweight Imaging Technology (UltraLITE), and Hyperspectral Imaging (HSI) programs.
- (U) $30,000 Developed technologies for autonomous and manual on-orbit control of microsatellites and for autonomous microsatellite navigation and inspection. Designed and developed a microsatellite to demonstrate the "proof of principle".
- (U) $46,185 Total

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(U) FY 1999 ($ in Thousands):

– (U)	$18,462	Develop and integrate components for the Warfighter-1 Integrated Space Technology Demonstration Program, including payload and mobile ground station components and the modified data exploitation algorithms.
– (U)	$100	Define concept and develop acquisition strategy for Warfighter-2 Integrated Space Technology Demonstration Program.
– (U)	$1,235	Develop advanced precision ballistic missile navigation technologies to support range instrumentation and safety requirements, improve accuracy after reentry, and support conventional weapon delivery systems.
– (U)	$5,862	Develop technologies for autonomous and manual on-orbit control of microsatellites and for autonomous microsatellite navigation and inspection. Conduct the XSS-10 flight demonstration of a microsatellite to demonstrate the "proof of principle".
– (U)	$2,443	Develop the two-stage near-orbital demonstrator for low-cost liquid launch vehicle technologies.
– (U)	$4,398	Develop and test technologies for solar orbital transfer vehicles (SOTV) such as high performance thermionic energy converters and high temperature insulation materials. Develop preliminary design of a space experiment to validate key solar orbital transfer vehicle technologies such as thermionic energy converters, lightweight solar concentrators, and cryogenic propellant systems.
– (U)	$672	Identified as a source for SBIR.
– (U)	$33,172	Total

(U) FY 2000 ($ in Thousands):

– (U)	$11,382	Complete development of the Warfighter-1 mission data center and mobile ground station. Perform pre-operations testing, launch satellite, conduct early orbit checkout, and begin data exploitation analysis and assessment.
– (U)	$5,990	Develop Warfighter-2 Integrated Space Technology Demonstration Program system.
– (U)	$491	Develop an end-to-end performance prediction model for a generalized, user-specified hyperspectral imaging (HSI) sensor applicable to a variety of different operating environments.
– (U)	$1,030	Develop advanced precision ballistic missile navigation technologies to improve accuracy during reentry and in plasma and jamming environments, and to support application on conventional weapon delivery systems.
– (U)	$18,893	Total

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(U) FY 2001 ($ in Thousands):

– (U)	$3,822	Conduct Warfighter-1 satellite operations, including user utility demonstrations, satellite technology validation, and data exploitation analysis and assessment.
– (U)	$13,851	Continue Warfighter-2 system development. Continue design of Warfighter-2 system; begin fabrication of payload. Define user requirements and plan; coordinate and design user utility demonstrations.
– (U)	$139	Develop an end-to-end performance prediction model for a generalized, user-specified hyperspectral imaging (HSI) sensor applicable to a variety of different operating environments.
– (U)	$980	Develop advanced precision ballistic missile navigation technologies to improve accuracy during reentry and in plasma and jamming environments, and to support application on conventional weapon delivery systems.
– (U)	$18,792	Total

(U) B. Project Change Summary - Description of Significant Changes: In FY 1999, the Modeling and Simulation efforts transition from this project to Project 2181 in this PE. The low-cost launch vehicle and orbital transfer vehicle efforts, both funded by Congressional Adds, were moved to this project from Project 4599 in this PE.

(U) C. Other Program Funding Summary:

(U) Related Activities:
- (U) PE 0602601F, Phillips Laboratory.
- (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: Not Applicable.

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DATE: February 1999

BUDGET ACTIVITY: 3 - Advanced Technology Development

PE NUMBER AND TITLE: 0603401F Advanced Spacecraft Technology

PROJECT: 4400

COST *($ In Thousands)*	FY 1998 Actual	FY 1999 Estimate	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
4400 Satellite Survivability Technology	5,353	5,779	2,616	3,859	4,773	4,661	4,340	4,006	Continuing	Continuing

(U) A. Mission Description: This project funds the development and demonstration of technologies required to assure operation of U.S. space assets in potentially hostile warfighting environments. Work performed includes assessment of critical components, subsystems, and systems' threat susceptibility and vulnerability. This project also develops technologies to mitigate identified vulnerabilities. Further, technology options are developed and demonstrated to support balanced satellite protection strategies for detecting, avoiding, and operating in a hostile space environment. Efforts under this project will be closely integrated with exploratory space technologies such as those developed under PE 0602601F, Project 8809, and advanced space technologies developed under this PE in Projects 1026, 2181, 3784, and 682J. Where appropriate, end products include integrated demonstrations with technologies developed in Project 3834. Through this project, the Air Force assumes responsibility for critical spacecraft survivability technology from the Ballistic Missile Defense Organization (BMDO).

(U) FY 1998 ($ in Thousands):

- (U) $180 Completed state-of-the-art technology assessment of hostile/stressing environmental impact on subsystem performance parameters.
- (U) $184 Refined multi-threat sensor performance modeling tool to include natural radiation environments.
- (U) $185 Initiated countermeasure analysis task to examine countermeasure payoffs with respect to weight and power improvements.
- (U) $4,804 Initiated next phase of miniaturization of the Miniaturized Satellite Threat Reporting System (MSTRS) to further reduce the weight and power of the on-board threat warning package.
- (U) $5,353 Total

(U) FY 1999 ($ in Thousands):

- (U) $150 Expand the capability of the multi-threat assessment tool by adding selected directed energy effects.
- (U) $150 Complete countermeasure analysis task, examining weight and power improvements.
- (U) $476 Complete fabrication and begin testing of the radio frequency (RF) threat warning/attack reporting (TW/AR) receiver.
- (U) $4,886 Complete radar warning receiver miniaturization for power and weight savings for the Miniaturized Satellite Threat Reporting System (MSTRS). Begin preparation for the MSTRS prototype hardware space flight. Begin integration of the radar warning receiver with the prototype laser detection system.
- (U) $117 Identified as a source for SBIR.
- (U) $5,779 Total

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(U) FY 2000 ($ in Thousands):
- (U) $1,270 Use the multi-threat assessment tool to assess electo-optical sensor response for various candidate laser countermeasures. Begin fixed wavelength countermeasure development.
- (U) $560 Fabricate and test laser threat warning/attack reporting (TW/AR) receiver brassboard.
- (U) $786 Integrate and test radio frequency (RF) TW/AR receiver on the host space experiment platform.
- (U) $2,616 Total

(U) FY 2001($ in Thousands):
- (U) $1,983 Complete development and test of fixed wavelength laser countermeasure.
- (U) $1,091 Optimize sensor suite for combined RF/laser threat warning/TW/AR receiver.
- (U) $785 Complete payload/spacecraft integration for RF TW/AR receiver space experiment.
- (U) $3,859 Total

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

(U) C. Other Program Funding Summary:

(U) Related Activities:
- (U) PE 0602102F, Materials.
- (U) PE 0602601F, Phillips Laboratory.
- (U) PE 0603410F, Space Systems Environmental Interactions 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: Not Applicable.

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BUDGET ACTIVITY: 3 - Advanced Technology Development

PE NUMBER AND TITLE: 0603401F Advanced Spacecraft Technology

PROJECT: 4599

COST *($ In Thousands)*	FY 1998 Actual	FY 1999 Estimate	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
4599 Reusable Launch Vehicle Technology	21,780	0	0	0	0	0	0	0	TBD	TBD

(U) A. Mission Description: This project currently funds the development of technologies for reusable, long-life space vehicles, advanced and innovative low-cost launch vehicles, and orbital transfer vehicles. The Military Spaceplane technology project (previously designated the Reusable Launch Vehicle (RLV) program) directly complements and leverages off of the National Aeronautics and Space Administration (NASA)-led RLV program, with the goal of developing responsive, reusable space access systems such as the Space Maneuver Vehicle (SMV). The Space Launch Modernization Plan (SLMP) chartered the DoD to be the lead in Expendable Launch Vehicle (ELV) systems and technologies. The technologies being developed in this project are in support of this charter. The development of the low- cost expendable launch technology is being conducted jointly with Ballistic Missile Defense Organization (BMDO).

(U) FY 1998 ($ in Thousands):

- (U) $3,882 Developed low-cost launch vehicle technologies and conducted suborbital flight tests using a testbed vehicle.
- (U) $830 Developed scaleable preburner liquid propellant injector technology.
- (U) $7,068 Developed technologies for upper stages that can operate as orbit transfer vehicles.
- (U) $4,500 Developed technologies for reusable, long-life space vehicles such as the Space Maneuver Vehicle (SMV). Conducted flight experiments to demonstrate an advanced concept upperstage engine and to collect X40A SMV vehicle performance data in a critical operational regime.
- (U) $5,500 Enhanced the capabilities of the NASA Pathfinder vehicle to improve the military utility of the vehicle; demonstrated these Air Force-unique mission capabilities.
- (U) $21,780 Total

(U) FY 1999: Not Applicable.

(U) FY2000: Not Applicable.

(U) FY 2001: Not Applicable.

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	PROJECT 4599

B. Project Change Summary - Description of Significant Changes: In FY 1999, the low-cost launch vehicle and orbital transfer vehicle efforts, both funded by Congressional Adds, were moved to Project 3834 in this PE.

(U) C. Other Program Funding Summary:

(U) Related Activities:
- (U) PE 0602102F, Materials.
- (U) PE 0602269F, Hypersonic Technology Program.
- (U) PE 0602601F, Phillips Laboratory.
- (U) PE 0603302F, Space and Missile Launch Technology.
- (U) PE 0603853F, Evolved Expendable Launch Vehicle Program.
- (U) UPN 242, National Aeronautics and Space Administration (NASA) Reusable Launch Vehicle Program.
- (U) This project has been coordinated through the Reliance process and with NASA to harmonize efforts and eliminate duplication.

(U) D. Acquisition Strategy: Not Applicable.

(U) E. Schedule Profile: Not Applicable.

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BUDGET ACTIVITY: 3 - Advanced Technology Development

PE NUMBER AND TITLE: 0603401F Advanced Spacecraft Technology

PROJECT: 4782

COST *($ In Thousands)*	FY 1998 Actual	FY 1999 Estimate	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
4782 Discoverer II	0	15,479	28,670	67,216	48,501	21,522	9,668	0	0	191,056

(U) A. Mission Description and Budget Item Justification: Discoverer II (D II) is a space-based radar/ground moving target indicator (SBR/GMTI) risk reduction demonstration. Air Force participation in this effort begins with FY 1999 RDT&E funds appropriated in PE 0603856F and defined in the FY 1999 President's Budget PE 0603856F Descriptive Summary as, "Conduct joint demonstrations, operations, and space activities in support of the Air Force/National Reconnaissance Office (AF/NRO) Integration Planning Group (ANIPG)." Discoverer II is a two-satellite technical demonstration recommended by the Defense Science Board which develops and demonstrates the technologies that would be inherent to an SBR/GMTI tactical surveillance architecture. The cost goal of the program is to enable an affordable acquisition of an operational SBR architecture for worldwide surveillance and targeting by mitigating the technical risks in the D II demonstration. NRO is an investment partner in this project and submits their budget request under the "Discoverer II MTI Demo." 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, NRO, and DARPA oversees D II. The Air Force has the Senior Acquisition Executive responsibilities and DARPA has program management responsibilities.

(U) FY 1998 ($ in Thousands): Not Applicable.

(U) FY 1999 ($ in Thousands):

- (U) $7,696 Support jointly funded effort to conduct design trades and analyses leading to candidate objective system and demonstration system designs by awarding approximately four System Integration contracts. Core activities will focus on cost/performance trades and completion of an Integrated Master Plan/Schedule. An initial Interim Evaluation Review will be conducted.
- (U) $7,033 Support jointly funded risk reduction efforts in key risk areas to include antenna design and fabrication, and exploitation software. Complete Thinned Transmitter/Receiver (T/R) Module Electronically Scanned Array Design.
- (U) $750 Conduct mission utility analysis and conops studies.
- (U) $15,479 Total

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(U) FY 2000 ($ in Thousands):

- (U) $12,500 Support 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.
- (U) $4,005 Support jointly funded risk reduction efforts in key risk areas to include antenna design and fabrication, advanced signal processing, and exploitation software. Conduct mission utility analyses and conops studies.
- (U) $12,165 Support jointly funded effort to begin detailed design and long lead procurement for selected demonstration system.
- (U) $28,670 Total

(U) FY 2001 ($ in Thousands):

- (U) $31,469 Support jointly funded development of detailed demonstration design culminating in Critical Design Review.
- (U) $22,574 Support jointly funded construction and component testing of spacecraft bus and payload.
- (U) $9,966 Support jointly funded software testing, integration, test, and data reduction.
- (U) $3,207 Support jointly funded risk reduction efforts in key risk areas to include antenna design and fabrication, advanced signal processing, and exploitation software. Conduct mission utility analyses and conops studies.
- (U) $67,216 Total

B. Project Change Summary - Description of Significant Changes: Discoverer II funding has been moved from PE 0603856F to Project 4782 in this PE for FY 1999 and beyond.

(U) C. Other Program Funding Summary:

(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) D. Acquisition Strategy: All major contracts awarded within this program will be awarded following full and open competition.

(U) E. Schedule Profile: Not Applicable

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BUDGET ACTIVITY: 3 - Advanced Technology Development

PE NUMBER AND TITLE: 0603401F Advanced Spacecraft Technology

PROJECT: 682J

COST (*$ In Thousands*)	FY 1998 Actual	FY 1999 Estimate	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
682J Space Power and Thermal Management Technology	3,283	4,730	4,353	3,026	5,160	6,041	6,440	7,037	Continuing	Continuing

(U) A. Mission Description: This project develops and demonstrates compact, low-cost, spacecraft and ballistic missile power generation, storage, distribution, and thermal management technologies, including cryogenic cooling technologies. Power generation work focuses on lightweight, low-cost, low volume, and survivable solar cell arrays. Energy storage work focuses on lightweight nickel hydrogen (NiH_2) and sodium sulfur (NaS) spacecraft batteries and flywheel energy storage systems for extended (five-ten year) satellite missions. Power distribution efforts focus on producing lightweight, high efficiency, standardized power busses for use on future Air Force space programs. This project also funds the development and demonstration of the non-nuclear technologies associated with space nuclear power systems such as power conversion, conditioning, and power system thermal management. In addition, investigations into alternative technologies to increase space vehicle power subsystem performance, lifetime, survivability, and safety while reducing costs/risks are conducted. In FY 1995, the Air Force assumed responsibility for the Ballistic Missile Defense Organization's (BMDO) goal to develop spacecraft thermal management technologies. Examples of this are cryogenic coolers necessary to maintain passive (e.g., infrared focal plane array) sensors in low-light backgrounds through this project.

(U) FY 1998 ($ in Thousands):

- (U) $2,401 Developed and demonstrated space conventional power generation technologies such as advanced multijunction solar cells and solar-to-electric converter solar cells.
- (U) $322 Developed and performance tested space conventional energy storage technologies such as the Sodium Sulfur Battery Cell Flight Experiment flown on shuttle flight STS-87.
- (U) $560 Developed advanced cryocooler technology for application to a 10K cryocooler capable of meeting the load, weight, and power requirements for space-based infrared concepts.
- (U) $3,283 Total

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(U) FY 1999 ($ in Thousands):

- (U) $1,772 Develop and evaluate performance of space conventional power generation technologies such as advanced multijunction solar cells, thin film solar cells, and a solar-to-electric converter power system for space operation.
- (U) $1,768 Develop space conventional energy storage technologies such as the lightweight flywheel integrated power and attitude control system.
- (U) $951 Develop advanced cryocooler technology for application to a 10K cryocooler capable of meeting the load, weight, and power requirements for space-based infrared concepts.
- (U) $144 Develop spacecraft thermal management systems such as advanced capillary pumped loop systems.
- (U) $95 Identified as a source for SBIR.
- (U) $4,730 Total

(U) FY 2000 ($ in Thousands):

- (U) $1,707 Develop and evaluate 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.
- (U) $1,392 Develop space conventional energy storage technologies such as the lightweight flywheel integrated power and attitude control system.
- (U) $910 Complete development of the advanced cryocooler technology for application to a 10K demonstration.
- (U) $344 Complete development of an advanced capillary pumped loop system. Develop thermal management systems such as thermal control systems using high density electronics technologies.
- (U) $4,353 Total

(U) FY 2001($ in Thousands):

- (U) $1,758 Develop and test space conventional power generation technologies such as next generation thin film solar cells, integrated power cells, and high power radiation resistant solar cell modules.
- (U) $1,123 Develop space conventional energy storage technologies such as the lightweight flywheel integrated power and attitude control system and advanced energy storage systems for geosynchronous orbit spacecraft applications.
- (U) $145 Develop spacecraft thermal management systems such as thermal control systems using high density electronics technologies.
- (U) $3,026 Total

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	PROJECT 682J

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

(U) C. Other Program Funding Summary:

(U) Related Activities:
- (U) PE 0602203F, Aerospace Propulsion.
- (U) PE 0602601F, Phillips Laboratory.
- (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: Not Applicable.

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