

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 1999
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BUDGET ACTIVITY 3 - Advanced Technology Development	PE NUMBER AND TITLE 0603270F Electronic Combat (EC) Technology
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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	33,170	25,476	27,334	26,775	26,969	27,606	28,332	28,971	Continuing	Continuing
2432 Defensive System Fusion Technology	8,083	7,150	8,336	6,278	7,573	8,148	8,318	8,491	Continuing	Continuing
431G Radio Frequency (RF) Warning and Countermeasures	12,278	9,187	8,501	7,639	8,696	8,775	8,957	9,143	Continuing	Continuing
691X Electro-Optical/Infrared (EO/IR) Warning and Countermeasures	12,809	9,139	10,497	12,858	10,700	10,683	11,057	11,337	Continuing	Continuing
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0	0	0

(U) **A. Mission Description:** This Advanced Technology Development program develops and demonstrates technologies to support critical Air Force EC requirements. The projects are categorized by the development of components, subsystems, and technologies that have potential application to satisfy combat, space, special operations, and airlift EC requirements and to reduce acquisition and life cycle costs of EC systems. The program develops and demonstrates: radio frequency; infrared; electro-optical; warning; and command, control, and communications countermeasure technologies for air and space platforms. Technology demonstrations include flyable brassboards against validated threat simulators. In addition, the program develops and demonstrates technologies and concepts for signature reduction, advanced electronic warfare transmitters, receivers, and power management. This program ensures the Air Force maintains demonstrated technology solutions to current and next generation threat capabilities. Note: In FY 1998, Congress added \$3.75 million for Closed-Loop Infrared Countermeasures technology and \$5.0 million for Precision Location and Identification technologies, which explains the perceived decrease in FYs 1999 and out.

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(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 sensor and electronic combat system developments that have military utility and address warfighter needs.

(U) **C. Program Change Summary (\$ in Thousands):**

	<u>FY 1998</u>	<u>FY 1999</u>	<u>FY 2000</u>	<u>FY 2001</u>	<u>Total Cost</u>
(U) Previous President's Budget/FY 1999 PB	32,540	25,553	26,533	27,486	Cont
(U) Appropriated Value	34,371	25,553			
(U) Adjustments to Appropriated Value					
a. Congressional/General Reductions	-1,125	-77			
b. SBIR	-754				
c. Omnibus/Other Above Threshold Reprogrammings	-221				
d. Below Threshold Reprogrammings	899				
(U) Adjustments to Budget Year Since FY1999 PB			801	-711	
(U) Current Budget Submit/FY 2000 PB	33,170	25,476	27,334	26,775	Cont

(U) Significant Program Changes: Not Applicable.

FY 1999: \$792 identified as a source for SBIR.

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RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 1999
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BUDGET ACTIVITY 3 - Advanced Technology Development	PE NUMBER AND TITLE 0603270F Electronic Combat (EC) Technology	PROJECT 2432
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<i>COST (\$ In Thousands)</i>	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
2432 Defensive System Fusion Technology	8,083	7,150	8,336	6,278	7,573	8,148	8,318	8,491	Continuing	Continuing

(U) **A. Mission Description:** This project develops and demonstrates techniques and technologies for integrating electronic combat sensors and system fusion. It also develops the advanced algorithms and assessment techniques necessary to cope with the projected multi-spectral threat and countermeasure environments for combat aircraft as well as those technology efforts required for command and control warfare, standoff jamming, and support countermeasures for denial, disruption, and suppression of adversary air defense operations. Included in these are: 1) advanced components and techniques needed to jam enemy radar; 2) novel electronic collection methods to inform the field commander of changes in the electronic environment; and 3) advanced standoff jammer technologies.

(U) FY 1998 (\$ in Thousands):

- (U) \$5,180 Developed low-cost technologies to demonstrate data fusion (e.g., threat, targeting, command and control, etc.) from off-board and on-board sensors to enhance situation awareness in both new and existing aerospace platforms, including hardware-in-the-loop demonstration of optimized sensor fusion technology suitable for tactical aircraft.
- (U) \$2,379 Developed and investigated command and control (C2) warfare electronic attack (EA) techniques to suppress and counter adversary C2 networks. This included critical design of hardware/software designs for jamming modern digital C2 network links and preliminary technique designs to counter advanced navigation systems.
- (U) \$524 Developed and evaluated advanced defensive techniques based on fusion of multiple information sources such as defensive sensors, offensive sensors, off-board broadcast information, off-board data links, and cooperative off-board sensors. This included completion of a preliminary design of a combat information system that integrates defensive avionics functions.
- (U) \$8,083 Total

(U) FY 1999 (\$ in Thousands):

- (U) \$1,335 Develop low-cost technologies to demonstrate data fusion (e.g., threat, targeting, command and control, etc.) from off-board and on-board sensors to enhance situation awareness in both new and existing aerospace platforms, including code optimization and completing preliminary design trade offs for candidate techniques and algorithms using commercial technology architectures.
- (U) \$5,593 Develop and investigate C2 warfare EA techniques to suppress and counter adversary C2 networks. This includes completing critical hardware/software designs and fabricating components for denying modern digital C2 network links, fabricating EA demonstration model hardware, and preparing to test designs against advanced telemetry links.
- (U) \$222 Identified as a source for SBIR.
- (U) \$7,150 Total

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BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
3 - Advanced Technology Development	0603270F Electronic Combat (EC) Technology	2432
<p>(U) <u>FY 2000 (\$ in Thousands):</u></p> <ul style="list-style-type: none"> - (U) \$1,894 Develop low-cost technologies to demonstrate data fusion (e.g., threat, targeting, command and control (C2), etc.) from off-board and on-board sensors to enhance situation awareness in both new and existing aerospace platforms, including ground demonstrating optimized sensor fusion algorithms in a coalition environment. - (U) \$1,500 Develop, as part of international cooperative effort, the combat information management technologies necessary to provide real-time situation awareness in a joint or coalition theater environment. - (U) \$3,514 Develop and investigate C2 warfare electronic attack (EA) techniques to suppress and counter adversary C2 networks. This includes completing a brassboard demonstration model, conducting ground/field testing against modern digital C2 network links, completing EA laboratory testing and threat exploitation, and designing experimental hardware/software to counter navigation and tracking systems. - (U) \$1,428 Conduct evaluations and risk reduction demonstrations of defensive sensors and fusion of multiple information sources for situational awareness, including conducting technology survivability trade studies for advanced fighter applications. - (U) \$8,336 Total <p>(U) <u>FY 2001 (\$ in Thousands):</u></p> <ul style="list-style-type: none"> - (U) \$904 Develop low-cost technologies to demonstrate data fusion (e.g., threat, targeting, C2, etc.) from off-board and on-board sensors to enhance situation awareness in both new and existing aerospace platforms, including flight demonstrating optimized sensor fusion algorithms on a joint coalition tactical platform as part of international cooperative effort. - (U) \$3,446 Develop and investigate C2 warfare EA techniques to suppress and counter adversary C2 networks, including transitioning an EA suite and fabricating experimental hardware/software for countering navigation and tracking systems. - (U) \$1,441 Conduct evaluations and risk reduction demonstrations of defensive sensors and fusion of multiple information sources for situational awareness, including evaluating in the laboratory receiver technology for advanced fighter applications. - (U) \$487 Develop affordable threat alert technologies for combat aircraft to increase survivability against advanced, integrated radio frequency air defense systems, including trade study analyses for techniques to defeat future threat radar guided missile systems. - (U) \$6,278 Total 		
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RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE
BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
3 - Advanced Technology Development	0603270F Electronic Combat (EC) Technology	2432
<p>(U) B. <u>Project Change Summary - Description of Significant Changes:</u> Not Applicable.</p> <p>(U) C. <u>Other Program Funding Summary:</u></p> <p>(U) <u>Related Activities:</u></p> <ul style="list-style-type: none">- (U) PE 0602204F, Aerospace Sensors.- (U) PE 0604270F, Electronic Warfare (EW) Development.- (U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication. <p>(U) D. <u>Acquisition Strategy:</u> Not Applicable.</p> <p>(U) E. <u>Schedule Profile:</u> Not Applicable.</p>		
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RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)								DATE February 1999			
BUDGET ACTIVITY 3 - Advanced Technology Development				PE NUMBER AND TITLE 0603270F Electronic Combat (EC) Technology				PROJECT 431G			
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
431G	Radio Frequency (RF) Warning and Countermeasures	12,278	9,187	8,501	7,639	8,696	8,775	8,957	9,143	Continuing	Continuing
<p>(U) A. <u>Mission Description:</u> This project develops and demonstrates advanced technologies for radio frequency (RF) electronic countermeasures (ECM) suites to enhance survivability of air and space vehicles and to provide crew situation awareness. One major area addressed covers technologies for missile/threat warning, radar frequency receivers, EC preprocessors, advanced sorting/preprocessing algorithms, and expert software for applications on existing and future EC systems. Another major technology area focuses on the development and demonstration of subsystems and components for generating on-board/off-board RF countermeasure techniques. This includes the development of novel ECM techniques as well as advanced ECM technologies such as antennas, power amplifiers, preamplifiers, etc. Note: In FY 1998, Congress added \$5.0 million for Precision Location and Identification technologies.</p> <p>(U) <u>FY 1998 (\$ in Thousands):</u></p> <ul style="list-style-type: none"> - (U) \$2,135 Developed low-cost advanced radar and RF emitter warning concepts and techniques, including demonstration of evolving jam-on-pulse RF receiver technology and development of wideband digital receiver technology based on PE 0602204F brassboard test. - (U) \$6,649 Developed aircraft self-protection technologies to counter advanced RF threats associated with current and future air defense weapon systems, including completion of design of critical flight-worthy components necessary to jam monopulse radar systems and trade studies for improving performance of current inventory RF countermeasures suites. - (U) \$3,494 Developed technology for multiaperture precision location and identification (PLAID) of ground and airborne RF emitters, including modification of PLAID algorithms for use with the antenna baselines of slow-moving, large aircraft and completion of initial design of a common radar warning receiver subcomponent to reduce risk of transitioning PLAID technology to large aircraft. - (U) \$12,278 Total <p>(U) <u>FY 1999 (\$ in Thousands):</u></p> <ul style="list-style-type: none"> - (U) \$2,554 Develop low-cost advanced radar and RF emitter warning concepts and techniques, including a preliminary design for a wideband digital receiver for affordable electronic support measures and radar warning receiver suites and completing a design for an advanced antenna that improves gain by a factor of ten at half the cost of current designs. - (U) \$6,347 Develop aircraft self-protection and support jamming technologies to counter advanced RF threats associated with current and future air defense weapon systems, including developing and demonstrating monopulse angle jamming electronic countermeasures, developing steerable high-power arrays, completing design trade offs for affordable improvements to existing ECM suites, and developing multifunction, compact, modular ECM jamming technology. - (U) \$286 Identified as a source for SBIR. - (U) \$9,187 Total 											
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RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)		DATE February 1999
BUDGET ACTIVITY 3 - Advanced Technology Development	PE NUMBER AND TITLE 0603270F Electronic Combat (EC) Technology	PROJECT 431G
<p>(U) <u>FY 2000 (\$ in Thousands):</u></p> <ul style="list-style-type: none"> - (U) \$1,534 Develop low-cost advanced radar and radio frequency (RF) emitter warning concepts and techniques, including completing fabrication of a wideband digital receiver for affordable electronic support measures (ESM) and radar warning receiver suites. - (U) \$3,883 Develop wideband, multimode, multifunction apertures for electronic warfare applications, including fabricating an advanced antenna that improves gain by a factor of ten at half the cost of current designs. - (U) \$3,084 Develop aerospace platform self-protection and support jamming technologies to counter advanced RF threats associated with current and future air defense weapon systems, including developing electronic countermeasure (ECM) techniques to increase satellite survivability, laboratory testing a steerable high-power array, and demonstrating advanced monopulse angle jamming techniques. - (U) \$8,501 Total <p>(U) <u>FY 2001 (\$ in Thousands):</u></p> <ul style="list-style-type: none"> - (U) \$1,100 Develop low-cost advanced radar and RF emitter warning concepts and techniques, including evaluating a wideband digital receiver for affordable ESM and radar warning receiver suites. - (U) \$4,260 Develop wideband, multimode, multifunction apertures for electronic warfare applications, including integrating and testing multimode antennas to demonstrate much improved performance in determining angle to a threat radar. - (U) \$2,279 Develop aerospace platform self-protection and support jamming technologies to counter advanced RF threats associated with current and future air defense weapon systems, including conducting laboratory evaluations of ECM techniques to increase satellite survivability, completing demonstration of a steerable high-power array, and designing and developing a flight-worthy brassboard for monopulse angle jamming integrated electronic countermeasures. - (U) \$7,639 Total 		
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RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE
BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
3 - Advanced Technology Development	0603270F Electronic Combat (EC) Technology	431G
<p>(U) B. <u>Project Change Summary - Description of Significant Changes:</u> Not Applicable.</p> <p>(U) C. <u>Other Program Funding Summary:</u></p> <p>(U) <u>Related Activities:</u></p> <ul style="list-style-type: none">- (U) PE 0602204F, Aerospace Sensors.- (U) PE 0604270F, Electronic Warfare (EW) Development.- (U) PE 0604270N, EW Development.- (U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication. <p>(U) D. <u>Acquisition Strategy:</u> Not Applicable.</p> <p>(U) E. <u>Schedule Profile:</u> Not Applicable.</p>		
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RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)								DATE February 1999		
BUDGET ACTIVITY 3 - Advanced Technology Development					PE NUMBER AND TITLE 0603270F Electronic Combat (EC) Technology				PROJECT 691X	
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
691X Electro-Optical/Infrared (EO/IR) Warning and Countermeasures	12,809	9,139	10,497	12,858	10,700	10,683	11,057	11,337	Continuing	Continuing
<p>(U) A. <u>Mission Description:</u> This project develops and demonstrates the advanced warning and countermeasure technologies required to negate electro-optical (EO), infrared (IR), and laser threat systems. The off-board (decoys and expendables) and on-board countermeasure technologies developed will provide robust, affordable solutions for protection against IR missiles with autonomous seekers, multi-spectral threats, laser-guided weapons, and EO/IR tracking systems used to direct EO/IR/radio frequency (RF) missiles. Countermeasure capability against advanced EO, IR, and laser-guided threats are vital for operational platforms survival in wartime, peacekeeping, and supply mission environments. Note: In FY 1998, Congress added \$3.75 million for Closed-Loop Infrared Countermeasures technology.</p> <p>(U) <u>FY 1998 (\$ in Thousands):</u></p> <ul style="list-style-type: none"> - (U) \$11,270 Developed on-board, threat adaptable, laser-based infrared countermeasure (IRCM) technology and off-board (active decoy) technology to defeat current and future IR missiles in multiple scenarios. This effort included tower tests of threat-adaptable, laser-based jamming codes, fabrication and integration of brassboard demonstration hardware, hardware-in-the-loop and digital simulation experiments, field tests and demonstration of signature management technologies, development and fabrication of a two-color missile warning sensor to hand-off missile detection to the countermeasure system, and development of a miniature pointer-tracker. - (U) \$1,069 Developed laser warning and countermeasure technologies necessary to defeat advanced day/night EO/IR acquisition/tracking sensors on threat air defense systems, including completion of technique development for laser beamrider missile detection, development of non-mechanical beam-steering technologies, and completion of threat definition for concept design of IR/RF decoys for multimode threat seekers. - (U) \$470 Developed IR missile warning technologies to detect advanced, low signature threat missiles, including evaluation of uncooled IR focal plane arrays, assessment of use of commercial image processors for IR threat algorithms, and design of IR sensors and algorithms. - (U) \$12,809 Total <p>(U) <u>FY 1999 (\$ in Thousands):</u></p> <ul style="list-style-type: none"> - (U) \$5,184 Develop on-board, closed-loop, laser-based infrared countermeasure technology and off-board (active decoy) technology to defeat current and future infrared (IR) missiles in multiple scenarios, including continued tower testing of threat-adaptable, laser-based jamming codes, live fire IR demonstrations at White Sands Missile Range against brassboard demonstration hardware, and design of flight-worthy closed-loop laser IRCM hardware for flight demonstrations in a C-17 or other large aircraft. 										
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BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
3 - Advanced Technology Development	0603270F Electronic Combat (EC) Technology	691X
<ul style="list-style-type: none"> - (U) \$751 Conduct in-house experiments to analyze current and future infrared (IR) threat missiles, including developing digital threat models of threat IR missiles, and validating countermeasure techniques for conventional IR missiles, and developing a target simulator for imaging IR seekers. - (U) \$1,998 Develop aerospace laser warning and countermeasure technologies necessary to defeat advanced laser acquisition/tracking sensors on threat air defense systems, including detecting and locating both high power (dazzle/damage) and low-power (laser guided ordinance) signals, and completing threat modeling technologies to counter dual-mode missile seekers. - (U) \$922 Develop infrared (IR) missile warning technologies to detect advanced, low signature threat missiles, including developing distributed aperture algorithms and clutter rejection techniques. - (U) \$284 Identified as a source for SBIR. - (U) \$9,139 Total <p>(U) <u>FY 2000 (\$ in Thousands):</u></p> <ul style="list-style-type: none"> - (U) \$5,786 Develop on-board, closed-loop, laser infrared countermeasures (IRCM) for large aircraft to defeat current and future IR missiles in multiple scenarios, including completing live fire aerial cable car testing at White Sands Missile Range and fabricating a flight-worthy closed-loop IRCM suite for demonstration on C-17 or other large aircraft. - (U) \$1,725 Conduct in-house analysis of current and future IR threat missiles, including refining digital threat models, creating countermeasure techniques for imaging IR missiles, and integrating a target simulator for imaging IR seekers. - (U) \$942 Develop aerospace laser warning technologies for timely alert and response to advanced laser acquisition/tracking sensors, including detecting and locating both high power (dazzle/damage) and low power (laser guided ordnance) signals, and developing low-cost warning technologies for special operations aircraft. - (U) \$2,044 Develop IR missile warning technologies to detect advanced, low signature threat missiles, including evaluating distributed aperture algorithms, collecting data, and demonstrating real-time missile warning algorithms for low-cost, uncooled sensors. - (U) \$10,497 Total <p>(U) <u>FY 2001 (\$ in Thousands):</u></p> <ul style="list-style-type: none"> - (U) \$3,634 Develop on-board, closed-loop, laser IRCM for large aircraft to defeat current and future IR missiles in multiple scenarios, including integration and flight testing of closed-loop IRCM technology on a C-17 or other large aircraft. - (U) \$1,325 Conduct in-house analysis of current and future IR threat missiles, developing digital models of IR threat missiles and testing countermeasure techniques for conventional and imaging IR missiles. - (U) \$1,092 Develop aerospace laser warning technologies for timely alert and response to advanced laser acquisition/tracking sensors, including detecting and locating both high power (dazzle/damage) and low power (laser guided ordnance) signals, testing low-cost warning for special operations aircraft, and space-based laser warning sensors. 		
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RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE
BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
3 - Advanced Technology Development	0603270F Electronic Combat (EC) Technology	691X
<ul style="list-style-type: none">- (U) \$2,109 Develop infrared (IR) missile warning technologies to detect advanced, low signature threat missiles, including evaluating hyperspectral imaging technology for use in missile warning and/or as a distributed aperture sensor.- (U) \$2,766 Develop the laser countermeasure technology to defeat advanced electro-optical/infrared (EO/IR) acquisition/tracking sensors that allow threat air defense systems to track air and space platforms in day or night, including gimballess beam steering technologies.- (U) \$1,932 Develop technology to defeat imaging IR missiles, including decoys and lethal expendables.- (U) \$12,858 Total		
<p>(U) B. <u>Project Change Summary - Description of Significant Changes:</u> Not Applicable.</p>		
<p>(U) C. <u>Other Program Funding Summary:</u></p> <p>(U) <u>Related Activities:</u></p> <ul style="list-style-type: none">- (U) PE 0602204F, Aerospace Sensors.- (U) PE 0604270F, Electronic Warfare (EW) Development.- (U) PE 0604270N, EW Development.- (U) PE 0603203F, Advanced Aerospace Sensors.- (U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.		
<p>(U) D. <u>Acquisition Strategy:</u> Not Applicable.</p>		
<p>(U) E. <u>Schedule Profile:</u> Not Applicable.</p>		
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