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DEPARTMENT OF THE AIR FORCE
FISCAL YEAR (FY) 2009 BUDGET ESTIMATES
RESEARCH, DEVELOPMENT, TEST AND EVALUATION (RDT&E)
DESCRIPTIVE SUMMARIES, VOLUME I
BUDGET ACTIVITIES 1 - 3
FEBRUARY 2008



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**Fiscal Year 2009 Program And Budget Estimates
RDT&E Descriptive Summaries, Volume I
Scientific and Technology Budget Activities 1 - 3
February 2008**

INTRODUCTION AND EXPLANATION OF CONTENTS

1. (U) GENERAL

- A. This document has been prepared to provide information on the United States Air Force (USAF) Research, Development, Test and Evaluation (RDT&E) program elements and projects in the FY 2009 President's Budget.
 - 1) All exhibits in this document have been assembled in accordance with DoD 7000.14R, Financial Management Regulation, Volume 2B, Chapter 5, Section 050402. Exception:
 - a) Exhibit R-1, RDT&E Program, which was distributed under a separate cover due to classification.
 - 2) Other comments on exhibit contents in this document:
 - a) Exhibits R-2/2a and R-3 provide narrative information for all RDT&E program elements and projects within the USAF FY 2009 RDT&E program with the exception of classified program elements. The formats and contents of this document are in accordance with the guidelines and requirements of the Congressional committees insofar as possible.
 - b) The "Other Program Funding Summary" portion of the R-2 includes, in addition to RDT&E funds, Procurement funds and quantities, Military Construction appropriation funds on specific development programs, Operations and Maintenance appropriation funds where they are essential to the development effort described, and where appropriate, Department of Energy (DOE) costs.
 - c) "Facilities Exhibits", Military Construction Project Data, (DD 1391), for improvements to and construction of government-owned facilities funded in RD&E are included in this submission.

2. (U) CLASSIFICATION

- A. All exhibits contained in Volumes I, II, and III are unclassified. Classified exhibits are not included in the submission due to the level of security classification and necessity of special security clearances.

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PROGRAM ELEMENT COMPARISON SUMMARY
INTRODUCTION AND EXPLANATION OF CONTENTS

Program Element

Remarks

BUDGET ACTIVITY 1: BASIC RESEARCH

BUDGET ACTIVITY 2: APPLIED RESEARCH

BUDGET ACTIVITY 3: ADVANCED TECHNOLOGY DEVELOPMENT (ATD)

BUDGET ACTIVITY 4: ADVANCED COMPONENT DEVELOPMENT AND PROTOTYPES (ACD&P)

BUDGET ACTIVITY 5: SYSTEM DEVELOPMENT AND DEMONSTRATION (SDD)

BUDGET ACTIVITY 6: RDT&E MANAGEMENT SUPPORT

BUDGET ACTIVITY 7: OPERATIONAL SYSTEM DEVELOPMENT

TABLE OF CONTENTS

R-1#	PE	PROGRAM ELEMENT TITLE	PAGE
#1 - Basic Research			
1	0601102F	Defense Research Sciences	1
2	0601103F	University Research Initiatives	51
3	0601108F	High Energy Laser Research Initiatives	57
#2 - Applied Research			
7	0602015F	Medical Development	63
8	0602102F	Materials	67
9	0602201F	Aerospace Vehicle Technologies	95
10	0602202F	Human Effectiveness Applied Research	113
11	0602203F	Aerospace Propulsion	135
12	0602204F	Aerospace Sensors	171
13	0602601F	Space Technology	203
14	0602602F	Conventional Munitions	223
15	0602605F	DIRECTED ENERGY TECHNOLOGY	231
16	0602702F	Command Control and Communications	245
17	0602890F	High Energy Laser Research	273
#3 - Advanced Technology Development (ATD)			
18	0603112F	Advanced Materials for Weapon Systems	279
19	0603203F	Advanced Aerospace Sensors	297
20	0603211F	Aerospace Technology Dev/Demo	317
21	0603216F	Aerospace Propulsion and Power Technology	325
22	0603231F	Crew Systems and Personnel Protection Technology	353

TABLE OF CONTENTS Continued

#3 - Advanced Technology Development (ATD) Continued

23	0603270F	Electronic Combat Technology	371
24	0603311F	Ballistic Missile Technology	383
25	0603401F	Advanced Spacecraft Technology	387
26	0603444F	MAUI SPACE SURVEILLANCE SYSTEM	411
27	0603601F	Conventional Weapons Technology	415
28	0603605F	Advanced Weapons Technology	421
29	0603680F	Manufacturing Technologies	441
30	0603789F	C3I Advanced Development	447
32	0603924F	High Energy Laser Advanced Technology Program	465

#4 - Advanced Component Development and Prototypes (ACD&P)

33	0603260F	Intelligence Advanced Development	469
34	0603287F	Physical Security Equipment	489
35	0603421F	GLOBAL POSITIONING SYSTEM	503
36	0603423F	Global Positioning System III - Operational Control Segment	509
37	0603427F	GPS Operational Control Segment Backwards Compatibility	517
38	0603430F	Advanced (EHF MILSATCOM (Space)	523
39	0603432F	Polar MILSATCOM (Space)	529
40	0603438F	Space Control Technology	535
41	0603742F	Combat Identification Technology	547
42	0603790F	NATO Cooperative R&D	561
43	0603791F	International Space Cooperative R&D	579
44	0603845F	Transformational SATCOM (TSAT)	587

TABLE OF CONTENTS Continued

#4 - Advanced Component Development and Prototypes (ACD&P) Continued

45	0603850F	Integrated Broadcast Service (DEM/VAL)	595
46	0603851F	ICBM - DEM/VAL	603
47	0603854F	Wideband MILSATCOM (Space)	629
48	0603858F	Space Radar	641
49	0603859F	Pollution Prevention	649
50	0603860F	Joint Precision Approach and Landing Systems - Dem/Val	655
51	0604015F	Next Generation Long Range Strike (NGLRS)	663
53	0604796F	Alternative Fuels	669
54	0604830F	Automated Air-to-Air Refueling	675
55	0604856F	Common Aero Vehicle	681
56	0604857F	Operationally Responsive Space	689
57	0305178F	National Polar-Orbiting Op Env Satellite	707

#5 - System Development and Demonstration (SDD)

58	0603840F	Global Broadcast Service (GBS)	715
59	0604222F	Nuclear Weapons Support	727
60	0604226F	B-1B	743
61	0604233F	Specialized Undergraduate Pilot Training	751
62	0604240F	B-2 Advanced Technology Bomber	765
63	0604261F	Personnel Recovery Systems	775
64	0604270F	EW Development	787
65	0604287F	Physical Security Equipment	807
66	0604329F	Small Diameter Bomb	813

TABLE OF CONTENTS Continued

#5 - System Development and Demonstration (SDD) Continued

67	0604421F	Counterspace Systems	829
68	0604425F	Space Situation Awareness Systems	843
69	0604429F	AIRBORNE ELECTRONIC ATTACK	859
70	0604441F	Space Based Infrared Systems (SBIRS) High EMD	865
71	0604443F	Third Generation Infrared Surveillance (3GIRS)	871
72	0604602F	Armament/Ordnance Development	879
73	0604604F	Submunitions	895
74	0604617F	Agile Combat Support	903
75	0604618F	Joint Direct Attack Munition	915
76	0604706F	Life Support Systems	923
77	0604735F	Combat Training Ranges	931
78	0604740F	Integrated Command & Control Applications	939
79	0604750F	Intelligence Equipment	949
80	0604762F	Common Low Observable Verification Sys	957
81	0604800F	Joint Strike Fighter EMD	963
82	0604853F	Evolved Expendable Launch Vehicle - EMD	971
83	0605011F	RDT&E For Aging Aircraft	977
84	0605221F	KC-X, Next Generation Aerial Refueling Aircraft	985
85	0605277F	CSAR-X	993
86	0605278F	HC/MC-130 Recap	1001
87	0207434F	Link 16 Support and Sustainment	1007
88	0207450F	E-10 Squadrons	1023

TABLE OF CONTENTS Continued

#5 - System Development and Demonstration (SDD) Continued

89	0207451F	Single Integrated Air Picture (SIAP)	1035
90	0207701F	Full Combat Mission Training	1049
91	0401138F	Joint Cargo Aircraft	1061
92	0401318F	CV-22	1069
93	0401845F	SLC3S-A (Senior Leader C3S)	1075

#6 - RDT&E Management Support

94	0604256F	Threat Simulator Development	1083
95	0604759F	Major T&E Investment	1091
96	0605101F	RAND Project Air Force	1101
98	0605712F	Initial Operational Test & Evaluation	1105
99	0605807F	Test and Evaluation Support	1115
100	0605860F	Rocket Systems Launch Program (RSLP)	1121
101	0605864F	Space Test Program	1125
102	0605976F	Facility Restoration and Modernization - T&E	1129
103	0605978F	Facility Sustainment - T&E Support	1133
105	0804731F	GENERAL SKILL TRAINING	1137
106	1001004F	International Activities	1141

#7 - Operational System Development

107	0604263F	CVLSP	1147
108	0605024F	Anti-Tamper Technology Executive Agent	1153
110	0101113F	B-52 SQUADRONS	1161
111	0101120F	ADVANCED CRUISE MISSILE	1171

TABLE OF CONTENTS Continued

#7 - Operational System Development Continued

112	0101122F	AIR LAUNCHED CRUISE MISSILE	1177
113	0101313F	STRAT WAR PLANNING SYS - USSTRATCOM	1185
116	0102326F	REGION/ SECTOR OPERATIONS CONTROL CENTER	1197
117	0102823F	STRAT AEROSPACE INTEL SYS ACTIVITIES	1205
118	0203761F	Warfighter Rapid Acquisition Program	1211
119	0205219F	MQ-9 Development and Fielding	1219
120	0207131F	A-10 SQUADRONS	1227
121	0207133F	F-16 SQUADRONS	1235
122	0207134F	F-15E SQUADRONS	1245
123	0207136F	Manned Destructive Suppression	1253
124	0207138F	F-22 SQUADRONS	1261
125	0207141F	F-117A SQUADRON	1267
126	0207161F	Tactical AIM Missiles	1273
127	0207163F	Advanced Medium Range Air-to-Air Missile	1279
128	0207170F	JHMCS	1287
129	0207247F	Air Force TENCAP	1293
131	0207253F	Compass Call	1301
132	0207268F	Aircraft Engine Component Improvement Program (CIP)	1309
133	0207277F	Chief's Innovation Program	1317
134	0207325F	Joint Air-to-Surface Standoff Missile (JASSM)	1323
135	0207410F	Air and Space Operations Center - Weapon System (AOC-WS)	1329
136	0207412F	Modular Control System	1355

TABLE OF CONTENTS Continued

#7 - Operational System Development Continued

137	0207417F	Airborne Warning and Control System (AWACS)	1363
138	0207418F	TAC AIRBORNE CONTROL SYSTEM	1375
139	0207423F	Advanced Communications Systems	1381
142	0207438F	Theater Battle Management (TBM) C4I	1397
143	0207445F	FIGHTER TACTICAL DATA LINK	1411
144	0207446F	Bomber Tactical Data Link	1419
145	0207448F	C2ISR Tactical Data Link	1427
146	0207449F	C2 Constellation	1435
147	0207581F	JOINT STARS	1449
148	0207590F	Seek Eagle	1457
150	0207601F	USAF Modeling and Simulation	1465
151	0207605F	Wargaming and Simulation Centers	1487
152	0207697F	Distributed Training and Exercises	1493
153	0208006F	Mission Planning Systems	1499
154	0208021F	Information Warfare Support	1507
162	0302015F	E-4B NATIONAL AIRBORNE OPERATIONS CENTER	1519
163	0303112F	AIR FORCE COMMUNICATIONS	1527
164	0303131F	Minimum Essential Emergency Communications Network (MEECN)	1533
165	0303140F	Information Systems Security Program	1549
166	0303141F	Global Combat Support System (GCSS)	1583
167	0303150F	WWMCCS/GLOBAL COMMAND & CONTROL SYSTEM	1589
168	0303158F	Joint Command and Control	1597

TABLE OF CONTENTS Continued

#7 - Operational System Development Continued

169	0303601F	MILSATCOM Terminals	1605
171	0304260F	Airborne SIGINT Enterprise (JMIP)	1613
174	0305099F	Communication, Navigation, Surveillance/Air Traffic Management (CNS/ATM)	1645
175	0305103F	Cyber Security Initiative	1655
176	0305110F	Satellite Control Network	1663
177	0305111F	WEATHER SERVICE	1671
178	0305114F	Air Traffic Control/Approach/Landing System (ATCALs)	1679
179	0305116F	AERIAL TARGETS	1687
182	0305128F	Security And Investigative Activities	1695
184	0305146F	Defense Joint Counter Intelligence Program	1703
186	0305160F	Defense Meteorological Satellite Program	1709
187	0305164F	NAVSTAR Global Positioning System User Equipment Space	1717
188	0305165F	NAVSTAR GPS (Space)	1725
190	0305173F	Space & Missile Test & Evaluation Center	1733
191	0305174F	SPACE WARFARE CENTER	1741
192	0305182F	Spacelift Range System	1747
193	0305193F	INTEL SPT TO INFO OPS	1755
195	0305206F	Airborne Reconnaissance Systems	1761
196	0305207F	Manned Reconnaissance System	1779
197	0305208F	Distributed Common Ground Systems	1787
198	0305219F	PREDATOR DEVELOPMENT/FIELDING	1801
199	0305220F	GLOBAL HAWK DEVELOPMENT/FIELDING	1809

TABLE OF CONTENTS Continued

#7 - Operational System Development Continued

200	0305221F	Network Centric Collaborative Targeting	1819
201	0305265F	GPS III Space Segment	1827
202	0305887F	Electronic Combat Intelligence Support	1833
203	0305906F	NCMC - TW/AA System	1841
204	0305913F	NUDET Detection System (Space)	1847
205	0305924F	National Security Space Office	1855
206	0305940F	Space Situation Awareness Operations	1861
207	0307141F	NASS, IO TECH INTEGRATION & TOOL DEV	1869
208	0308699F	Shared Early Warning System	1877
209	0401115F	C-130 AIRLIFT SQUADRONS	1883
210	0401119F	C-5 Airlift Squadrons	1895
211	0401130F	C-17 Aircraft	1907
212	0401132F	C-130J PROGRAM	1913
213	0401134F	Large Aircraft InfraRed Counter Measures (LAIRCM)	1921
214	0401218F	KC-135s	1929
215	0401219F	KC-10S	1939
216	0401221F	KC-135 Replacement Tanker	1947
217	0401314F	OPERATIONAL SUPPORT AIRLIFT	1955
218	0401839F	Airlift/Other Tactical Data Link	1961
219	0408011F	SPECIAL TACTICS/COMBAT CONTROL	1969
220	0702207F	Depot Maintenance (Non-IF)	1975
221	0702806F	ACQUISITION AND COMMAND SUPPORT	1981

TABLE OF CONTENTS Continued

#7 - Operational System Development Continued

222	0708011F	Industrial Preparedness	1987
223	0708012F	Logistic Support Activities	2001
224	0708610F	Logistics Information Technology (LOGIT)	2009
225	0708611F	Support Systems Development	2015
226	0804757F	JOINT NATIONAL TRAINING CENTER	2027
227	0808716F	OTHER PERSONNEL ACTIVITIES	2033
228	0901202F	JOINT PERSONNEL RECOVERY AGENCY (JPRA)	2039
229	0901212F	SERVICE-WIDE SUPPORT	2045
230	0901218F	Civilian Compensation Program	2053
231	0901220F	PERSONNEL ADMINISTRATION	2059
232	0901538F	Financial Management Information Systems (FMIS)	2069

ALPHABETICAL LISTING

PROGRAM ELEMENT TITLE	PE	PAGE
A-10 SQUADRONS	0207131F	1227
ACQUISITION AND COMMAND SUPPORT	0702806F	1981
Advanced (EHF MILSATCOM (Space)	0603430F	523
Advanced Aerospace Sensors	0603203F	297
Advanced Communications Systems	0207423F	1381
ADVANCED CRUISE MISSILE	0101120F	1171
Advanced Materials for Weapon Systems	0603112F	279
Advanced Medium Range Air-to-Air Missile	0207163F	1279
Advanced Spacecraft Technology	0603401F	387
Advanced Weapons Technology	0603605F	421
AERIAL TARGETS	0305116F	1687
Air and Space Operations Center - Weapon System (AOC-WS)	0207410F	1329
Aerospace Propulsion	0602203F	135
Aerospace Propulsion and Power Technology	0603216F	325
Aerospace Sensors	0602204F	171
Aerospace Technology Dev/Demo	0603211F	317
Aerospace Vehicle Technologies	0602201F	95
Agile Combat Support	0604617F	903
AIR FORCE COMMUNICATIONS	0303112F	1527
Air Force TENCAP	0207247F	1293
AIR LAUNCHED CRUISE MISSILE	0101122F	1177
Air Traffic Control/Approach/Landing System (ATCALs)	0305114F	1679

AIRBORNE ELECTRONIC ATTACK	0604429F	859
Airborne Reconnaissance Systems	0305206F	1761
Airborne SIGINT Enterprise (JMIP)	0304260F	1613
Airborne Warning and Control System (AWACS)	0207417F	1363
Aircraft Engine Component Improvement Program (CIP)	0207268F	1309
Airlift/Other Tactical Data Link	0401839F	1961
Alternative Fuels	0604796F	669
Third Generation Infrared Surveillance (3GIRS)	0604443F	871
Anti-Tamper Technology Executive Agent	0605024F	1153
Armament/Ordnance Development	0604602F	879
Automated Air-to-Air Refueling	0604830F	675
B-1B	0604226F	743
B-2 Advanced Technology Bomber	0604240F	765
B-52 SQUADRONS	0101113F	1161
Ballistic Missile Technology	0603311F	383
Bomber Tactical Data Link	0207446F	1419
C-130 AIRLIFT SQUADRONS	0401115F	1883
C-130J PROGRAM	0401132F	1913
C-17 Aircraft	0401130F	1907
C2 Constellation	0207449F	1435
C2ISR Tactical Data Link	0207448F	1427
C3I Advanced Development	0603789F	447
C-5 Airlift Squadrons	0401119F	1895
Chief's Innovation Program	0207277F	1317

Civilian Compensation Program	0901218F	2053
Combat Identification Technology	0603742F	547
Combat Training Ranges	0604735F	931
Command Control and Communications	0602702F	245
Common Aero Vehicle	0604856F	681
Common Low Observable Verification Sys	0604762F	957
Compass Call	0207253F	1301
Conventional Munitions	0602602F	223
Conventional Weapons Technology	0603601F	415
Counterspace Systems	0604421F	829
Crew Systems and Personnel Protection Technology	0603231F	353
HC/MC-130 Recap	0605278F	1001
CSAR-X	0605277F	993
CV-22	0401318F	1069
CVLSP	0604263F	1147
Cyber Security Initiative	0305103F	1655
Defense Joint Counter Intelligence Program	0305146F	1703
Defense Meteorological Satellite Program	0305160F	1709
Defense Research Sciences	0601102F	1
Depot Maintenance (Non-IF)	0702207F	1975
DIRECTED ENERGY TECHNOLOGY	0602605F	231
Distributed Common Ground Systems	0305208F	1787
E-4B NATIONAL AIRBORNE OPERATIONS CENTER	0302015F	1519
Electronic Combat Intelligence Support	0305887F	1833

Electronic Combat Technology	0603270F	371
Evolved Expendable Launch Vehicle - EMD	0604853F	971
EW Development	0604270F	787
F-117A SQUADRON	0207141F	1267
F-15E SQUADRONS	0207134F	1245
F-16 SQUADRONS	0207133F	1235
F-22 SQUADRONS	0207138F	1261
Facility Restoration and Modernization - T&E	0605976F	1129
Facility Sustainment - T&E Support	0605978F	1133
FIGHTER TACTICAL DATA LINK	0207445F	1411
Financial Management Information Systems (FMIS)	0901538F	2069
Full Combat Mission Training	0207701F	1049
GENERAL SKILL TRAINING	0804731F	1137
Communication, Navigation, Surveillance/Air Traffic Management (CNS/ATM)	0305099F	1645
Global Broadcast Service (GBS)	0603840F	715
Global Combat Support System (GCSS)	0303141F	1583
GLOBAL HAWK DEVELOPMENT/FIELDING	0305220F	1809
GLOBAL POSITIONING SYSTEM	0603421F	503
Global Positioning System III - Operational Control Segment	0603423F	509
GPS III Space Segment	0305265F	1827
GPS Operational Control Segment Backwards Compatibility	0603427F	517
High Energy Laser Advanced Technology Program	0603924F	465
High Energy Laser Research	0602890F	273
High Energy Laser Research Initiatives	0601108F	57

Human Effectiveness Applied Research	0602202F	113
ICBM - DEM/VAL	0603851F	603
Industrial Preparedness	0708011F	1987
Information Systems Security Program	0303140F	1549
Information Warfare Support	0208021F	1507
Initial Operational Test & Evaluation	0605712F	1105
Integrated Broadcast Service (DEM/VAL)	0603850F	595
Integrated Command & Control Applications	0604740F	939
INTEL SPT TO INFO OPS	0305193F	1755
Intelligence Advanced Development	0603260F	469
Intelligence Equipment	0604750F	949
International Activities	1001004F	1141
International Space Cooperative R&D	0603791F	579
JHMCS	0207170F	1287
Joint Air-to-Surface Standoff Missile (JASSM)	0207325F	1323
Joint Cargo Aircraft	0401138F	1061
Joint Command and Control	0303158F	1597
Joint Direct Attack Munition	0604618F	915
JOINT NATIONAL TRAINING CENTER	0804757F	2027
JOINT PERSONNEL RECOVERY AGENCY (JPRA)	0901202F	2039
Joint Precision Approach and Landing Systems - Dem/Val	0603860F	655
JOINT STARS	0207581F	1449
Joint Strike Fighter EMD	0604800F	963
KC-10S	0401219F	1939

KC-135 Replacement Tanker	0401221F	1947
KC-135s	0401218F	1929
KC-X, Next Generation Aerial Refueling Aircraft	0605221F	985
Large Aircraft InfraRed Counter Measures (LAIRCM)	0401134F	1921
Life Support Systems	0604706F	923
Link 16 Support and Sustainment	0207434F	1007
Logistic Support Activities	0708012F	2001
Logistics Information Technology (LOGIT)	0708610F	2009
Major T&E Investment	0604759F	1091
Manned Destructive Suppression	0207136F	1253
Manned Reconnaissance System	0305207F	1779
Manufacturing Technologies	0603680F	441
Materials	0602102F	67
MAUI SPACE SURVEILLANCE SYSTEM	0603444F	411
E-10 Squadrons	0207450F	1023
Medical Development	0602015F	63
MILSATCOM Terminals	0303601F	1605
Minimum Essential Emergency Communications Network (MEECN)	0303131F	1533
Mission Planning Systems	0208006F	1499
Modular Control System	0207412F	1355
MQ-9 Development and Fielding	0205219F	1219
NASS, IO TECH INTEGRATION & TOOL DEV	0307141F	1869
National Polar-Orbiting Op Env Satellite	0305178F	707
National Security Space Office	0305924F	1855

NATO Cooperative R&D	0603790F	561
NAVSTAR Global Positioning System User Equipment Space	0305164F	1717
NAVSTAR GPS (Space)	0305165F	1725
NCMC - TW/AA System	0305906F	1841
Network Centric Collaborative Targeting	0305221F	1819
Next Generation Long Range Strike (NGLRS)	0604015F	663
Nuclear Weapons Support	0604222F	727
NUDET Detection System (Space)	0305913F	1847
Operationally Responsive Space	0604857F	689
OPERATIONAL SUPPORT AIRLIFT	0401314F	1955
OTHER PERSONNEL ACTIVITIES	0808716F	2033
PERSONNEL ADMINISTRATION	0901220F	2059
Personnel Recovery Systems	0604261F	775
Physical Security Equipment	0604287F	807
Physical Security Equipment	0603287F	489
Polar MILSATCOM (Space)	0603432F	529
Pollution Prevention	0603859F	649
PREDATOR DEVELOPMENT/FIELDING	0305219F	1801
RAND Project Air Force	0605101F	1101
RDT&E For Aging Aircraft	0605011F	977
REGION/ SECTOR OPERATIONS CONTROL CENTER	0102326F	1197
Rocket Systems Launch Program (RSLP)	0605860F	1121
Satellite Control Network	0305110F	1663
Security And Investigative Activities	0305128F	1695

Seek Eagle	0207590F	1457
SERVICE-WIDE SUPPORT	0901212F	2045
Shared Early Warning System	0308699F	1877
Single Integrated Air Picture (SIAP)	0207451F	1035
SLC3S-A (Senior Leader C3S)	0401845F	1075
Small Diameter Bomb	0604329F	813
Space Based Infrared Systems (SBIRS) High EMD	0604441F	865
Space Control Technology	0603438F	535
Space Situation Awareness Operations	0305940F	1861
Space Situation Awareness Systems	0604425F	843
Space Technology	0602601F	203
Space & Missile Test & Evaluation Center	0305173F	1733
Space Test Program	0605864F	1125
SPACE WARFARE CENTER	0305174F	1741
Space Radar	0603858F	641
Spacelift Range System	0305182F	1747
SPECIAL TACTICS/COMBAT CONTROL	0408011F	1969
Specialized Undergraduate Pilot Training	0604233F	751
STRAT AEROSPACE INTEL SYS ACTIVITIES	0102823F	1205
STRAT WAR PLANNING SYS - USSTRATCOM	0101313F	1185
Submunitions	0604604F	895
Support Systems Development	0708611F	2015
TAC AIRBORNE CONTROL SYSTEM	0207418F	1375
Tactical AIM Missiles	0207161F	1273

Test and Evaluation Support	0605807F	1115
Theater Battle Management (TBM) C4I	0207438F	1397
Threat Simulator Development	0604256F	1083
Transformational SATCOM (TSAT)	0603845F	587
University Research Initiatives	0601103F	51
USAF Modeling and Simulation	0207601F	1465
Warfighter Rapid Acquisition Program	0203761F	1211
Wargaming and Simulation Centers	0207605F	1487
Distributed Training and Exercises	0207697F	1493
WEATHER SERVICE	0305111F	1671
Wideband MILSATCOM (Space)	0603854F	629
WWMCCS/GLOBAL COMMAND & CONTROL SYSTEM	0303150F	1589

UNCLASSIFIED
DEPARTMENT OF DEFENSE
FY 2009 RDT&E PROGRAM

23 JAN 2008

SUMMARY
(\$ IN THOUSANDS)

APPROPRIATION -----	FY 2007 -----	FY 2008 -----	FY 2009 -----
Research, Development, Test & Eval, AF	24,491,745	26,069,228	28,066,617
Tanker Replacement Transfer Fund, AF		150,000	
Total Research, Development, Test & Evaluation	24,491,745	26,219,228	28,066,617

UNCLASSIFIED
DEPARTMENT OF DEFENSE
FY 2009 RDT&E PROGRAM

23 JAN 2008

SUMMARY
(\$ IN THOUSANDS)

Summary Recap of Budget Activities -----	FY 2007 -----	FY 2008 -----	FY 2009 -----
Basic Research	395,300	571,095	452,300
Applied Research	1,115,280	1,169,833	1,044,495
Advanced Technology Development	1,030,162	663,931	578,263
Advanced Component Development & Prototypes	2,479,567	2,692,835	2,440,136
System Development & Demonstration	4,559,857	4,245,953	4,953,574
RDT&E Management Support	1,405,050	1,049,026	1,084,345
Operational Systems Development	13,506,529	15,826,555	17,513,504
Total Research, Development, Test & Evaluation	24,491,745	26,219,228	28,066,617
Summary Recap of FYDP Programs -----			
Strategic Forces	209,259	135,620	120,289
General Purpose Forces	4,013,382	3,514,541	4,358,254
Intelligence and Communications	9,277,447	11,653,705	12,794,513
Mobility Forces	680,872	1,039,049	678,316
Research and Development	10,035,375	9,573,424	9,806,908
Central Supply and Maintenance	209,939	222,286	233,783
Training Medical and Other	3,369	3,222	3,330
Administration and Associated Activities	58,315	73,365	67,314
Support of Other Nations	3,787	4,016	3,910
Total Research, Development, Test & Evaluation	24,491,745	26,219,228	28,066,617

UNCLASSIFIED
DEPARTMENT OF THE AIR FORCE
FY 2009 RDT&E PROGRAM

SUMMARY
(\$ IN THOUSANDS)

23 JAN 2008

Summary Recap of Budget Activities -----	FY 2007 -----	FY 2008 -----	FY 2009 -----
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Administration and Associated Activities	58,315	73,365	67,314
Support of Other Nations	3,787	4,016	3,910
Total Research, Development, Test & Eval, AF	24,491,745	26,069,228	28,066,617

UNCLASSIFIED

DEPARTMENT OF THE AIR FORCE
FY 2009 RDT&E PROGRAM

EXHIBIT R-1

APPROPRIATION: 3600F Research, Development, Test & Eval, AF

Date: 23 JAN 2008

Line No	Program Element Number	Item	Act	Thousands of Dollars			S E C
				FY 2007	FY 2008	FY 2009	
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1	0601102F	Defense Research Sciences	01	271,481	288,601	309,926	U
2	0601103F	University Research Initiatives	01	111,803	119,938	125,949	U
3	0601108F	High Energy Laser Research Initiatives	01	12,016	12,556	13,425	U
4	0301555F	Classified Programs	01				
5	0301556F	Special Program	01				
6	0305172F	Combined Advanced Applications	01				
	Basic Research			-----	-----	-----	
				395,300	421,095	452,300	
7	0602015F	Medical Development	02		4,670		U
8	0602102F	Materials	02	151,438	179,516	117,143	U
9	0602201F	Aerospace Vehicle Technologies	02	115,423	139,855	122,870	U
10	0602202F	Human Effectiveness Applied Research	02	106,435	92,068	82,091	U
11	0602203F	Aerospace Propulsion	02	220,143	217,172	218,049	U
12	0602204F	Aerospace Sensors	02	130,517	121,242	109,048	U
13	0602601F	Space Technology	02	101,316	128,397	117,519	U
14	0602602F	Conventional Munitions	02	60,150	58,632	55,963	U
15	0602605F	Directed Energy Technology	02	48,487	56,915	62,871	U
16	0602702F	Command Control and Communications	02	125,791	121,417	109,492	U
17	0602890F	High Energy Laser Research	02	55,580	49,949	49,449	U
	Applied Research			-----	-----	-----	
				1,115,280	1,169,833	1,044,495	
18	0603112F	Advanced Materials for Weapon Systems	03	83,546	54,871	41,926	U
19	0603203F	Advanced Aerospace Sensors	03	56,634	62,332	56,916	U
20	0603211F	Aerospace Technology Dev/Demo	03	45,443	66,884	44,918	U

UNCLASSIFIED

DEPARTMENT OF THE AIR FORCE
FY 2009 RDT&E PROGRAM

EXHIBIT R-1

APPROPRIATION: 3600F Research, Development, Test & Eval, AF

Date: 23 JAN 2008

Line No	Program Element Number	Item	Act	Thousands of Dollars			S E C
				FY 2007	FY 2008	FY 2009	
21	0603216F	Aerospace Propulsion and Power Technology	03	150,123	142,543	170,856	U
22	0603231F	Crew Systems and Personnel Protection Technology	03	39,503	38,406	26,630	U
23	0603270F	Electronic Combat Technology	03	27,599	26,762	21,056	U
24	0603311F	Ballistic Missile Technology	03	9,128			U
25	0603401F	Advanced Spacecraft Technology	03	105,422	100,600	80,958	U
26	0603444F	Maui Space Surveillance System (MSSS)	03	49,502	42,160	4,838	U
27	0603601F	Conventional Weapons Technology	03	38,602	18,379	11,813	U
28	0603605F	Advanced Weapons Technology	03	74,683	74,383	44,507	U
29	0603680F	Manufacturing Technology Program	03			39,729	U
30	0603789F	C3I Advanced Development	03	47,352	32,821	30,103	U
31	0603801F	Special Programs	03	299,029			U
32	0603924F	High Energy Laser Advanced Technology Program	03	3,596	3,790	4,013	U
		Advanced Technology Development		1,030,162	663,931	578,263	
33	0603260F	Intelligence Advanced Development	04	4,757	5,892	4,988	U
34	0603287F	Physical Security Equipment	04	1,248	2,847	477	U
35	0603421F	NAVSTAR Global Positioning System III	04	291,556	482,845		U
36	0603423F	Global Positioning System III - Operational Control Segment	04			2,975	U
37	0603427F	GPS Operational Control Segment - Backwards Compatibility	04			304,360	U
38	0603430F	Advanced EHF MILSATCOM (SPACE)	04	617,294	599,353	388,041	U
39	0603432F	Polar MILSATCOM (SPACE)	04	33,983	177,535	237,749	U

UNCLASSIFIED

DEPARTMENT OF THE AIR FORCE
FY 2009 RDT&E PROGRAM

EXHIBIT R-1

APPROPRIATION: 3600F Research, Development, Test & Eval, AF

Date: 23 JAN 2008

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				FY 2007	FY 2008	FY 2009	
40	0603438F	Space Control Technology	04	23,605	66,182	76,845	U
41	0603742F	Combat Identification Technology	04	23,389	25,875	29,400	U
42	0603790F	NATO Research and Development	04	4,003	4,253	4,334	U
43	0603791F	International Space Cooperative R&D	04	574	610	627	U
44	0603845F	Transformational SATCOM (TSAT)	04	700,429	804,739	842,974	U
45	0603850F	Integrated Broadcast Service	04	24,471	21,058	21,105	U
46	0603851F	Intercontinental Ballistic Missile	04	56,286	31,121	65,629	U
47	0603854F	Wideband Global SATCOM RDT&E (Space)	04	43,998	19,091	12,422	U
48	0603858F	Space Radar	04	183,201			U
49	0603859F	Pollution Prevention	04	6,829	10,968	2,877	U
50	0603860F	Joint Precision Approach and Landing Systems	04	9,524	7,451	7,479	U
51	0604015F	Next Generation Bomber	04	37,476			U
53	0604796F	Alternative Fuels	04			28,464	U
54	0604830F	Automated Air-to-Air Refueling	04			9,889	U
55	0604856F	Common Aero Vehicle (CAV)	04	31,523	3,974		U
56	0604857F	Operationally Responsive Space	04	42,131	96,516	110,032	U
57	0305178F	National Polar-Orbiting Operational Environmental Satellite System (NPOESS)	04	343,290	332,525	289,469	U
		Advanced Component Development & Prototypes		2,479,567	2,692,835	2,440,136	
58	0603840F	Global Broadcast Service (GBS)	05	23,157	29,098	18,790	U
59	0604222F	Nuclear Weapons Support	05	14,839	20,191	20,166	U
60	0604226F	B-1B	05	153,757	152,164	128,871	U

UNCLASSIFIED

DEPARTMENT OF THE AIR FORCE
FY 2009 RDT&E PROGRAM

EXHIBIT R-1

APPROPRIATION: 3600F Research, Development, Test & Eval, AF

Date: 23 JAN 2008

Line No --	Program Element Number -----	Item -----	Act ---	Thousands of Dollars			S E C -
				FY 2007 -----	FY 2008 -----	FY 2009 -----	
61	0604233F	Specialized Undergraduate Flight Training	05	4,112	14,927	7,462	U
62	0604240F	B-2 Advanced Technology Bomber	05	214,649	295,945	351,417	U
63	0604261F	Personnel Recovery Systems	05	103,337	104,289		U
64	0604270F	Electronic Warfare Development	05	95,949	102,601	54,995	U
65	0604287F	Physical Security Equipment	05	90	34	52	U
66	0604329F	Small Diameter Bomb (SDB)	05	122,276	144,279	125,067	U
67	0604421F	Counterspace Systems	05	44,596	63,819	74,918	U
68	0604425F	Space Situation Awareness Systems	05	166,696	196,363	210,501	U
69	0604429F	Airborne Electronic Attack	05	12,033	23,826	34,279	U
70	0604441F	Space Based Infrared System (SBIRS) High EMD	05	677,926	583,317	529,771	U
71	0604443F	Third Generation Infrared Surveillance (3GIRS)	05	67,552	75,410	149,064	U
72	0604602F	Armament/Ordnance Development	05	13,039	3,165	2,095	U
73	0604604F	Submunitions	05	8,304	1,976	1,730	U
74	0604617F	Agile Combat Support	05	9,715	12,146	5,790	U
75	0604618F	Joint Direct Attack Munition	05	20,959			U
76	0604706F	Life Support Systems	05	11,273	13,563	10,998	U
77	0604735F	Combat Training Ranges	05	16,325	17,546	28,047	U
78	0604740F	Integrated Command & Control Applications (IC2A)	05	26,507	26,593	177	U
79	0604750F	Intelligence Equipment	05	4,907	5,037	1,488	U
80	0604762F	Common Low Observables Verification System (CLOVerS)	05	4,361			U
81	0604800F	Joint Strike Fighter (JSF)	05	2,074,021	1,991,537	1,524,016	U

UNCLASSIFIED

DEPARTMENT OF THE AIR FORCE
FY 2009 RDT&E PROGRAM

EXHIBIT R-1

APPROPRIATION: 3600F Research, Development, Test & Eval, AF

Date: 23 JAN 2008

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				FY 2007	FY 2008	FY 2009	
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82	0604853F	Evolved Expendable Launch Vehicle Program (SPACE)	05	19,083		33,719	U
83	0605011F	RDT&E for Aging Aircraft	05	36,144	20,491	13,828	U
84	0605221F	Next Generation Aerial Refueling Aircraft	05			831,759	U
85	0605277F	CSAR-X RDT&E	05			305,062	U
86	0605278F	HC/MC-130 Recap RDT&E	05			11,692	U
87	0207434F	Link-16 Support and Sustainment	05	156,169	194,652	186,213	U
88	0207450F	E-10 Squadrons	05	351,924	39,032	42,215	U
89	0207451F	Single Integrated Air Picture (SIAP)	05	37,874	4,857	66,909	U
90	0207701F	Full Combat Mission Training	05	34,046	71,643	135,152	U
91	0401138F	Joint Cargo Aircraft (JCA)	05	9,781	20,869	26,777	U
92	0401318F	CV-22	05	12,756	16,583	18,562	U
93	0401845F	Airborne Senior Leader C3 (SLC3S)	05	11,700		1,992	U
		System Development & Demonstration		4,559,857	4,245,953	4,953,574	
94	0604256F	Threat Simulator Development	06	37,411	39,639	34,568	U
95	0604759F	Major T&E Investment	06	63,417	63,855	61,818	U
96	0605101F	RAND Project Air Force	06	33,611	30,802	28,676	U
97	0605502F	Small Business Innovation Research	06	359,706			U
98	0605712F	Initial Operational Test & Evaluation	06	34,554	30,011	29,537	U
99	0605807F	Test and Evaluation Support	06	713,419	720,952	787,737	U
100	0605860F	Rocket Systems Launch Program (SPACE)	06	26,503	19,023	14,895	U
101	0605864F	Space Test Program (STP)	06	48,801	47,129	48,072	U

UNCLASSIFIED

DEPARTMENT OF THE AIR FORCE
FY 2009 RDT&E PROGRAM

EXHIBIT R-1

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				FY 2007	FY 2008	FY 2009	
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102	0605976F	Facilities Restoration and Modernization - Test and Evaluation Support	06	55,473	59,750	46,234	U
103	0605978F	Facilities Sustainment - Test and Evaluation Support	06	28,073	33,849	28,898	U
105	0804731F	General Skill Training	06	295			U
106	1001004F	International Activities	06	3,787	4,016	3,910	U
		RDT&E Management Support		1,405,050	1,049,026	1,084,345	
107	0604263F	Common Vertical Lift Support Platform	07			3,868	U
108	0605024F	Anti-Tamper Technology Executive Agency	07	7,791	10,861	20,987	U
109	0605798F	Analysis Support Group	07				
110	0101113F	B-52 Squadrons	07	88,420	42,121	38,651	U
111	0101120F	Advanced Cruise Missile	07	6,767			U
112	0101122F	Air-Launched Cruise Missile (ALCM)	07	3,620	4,642	396	U
113	0101313F	Strat War Planning System - USSTRATCOM	07	24,774	20,130	17,553	U
114	0101314F	Night Fist - USSTRATCOM	07	4,963	5,263	5,299	U
115	0101815F	Advanced Strategic Programs	07				
116	0102326F	Region/Sector Operation Control Center Modernization Program	07	14,642	23,262	23,858	U
117	0102823F	Strategic Aerospace Intelligence System Activities	07			15	U
118	0203761F	Warfighter Rapid Acquisition Process (WRAP) Rapid Transition Fund	07	29,613	14,155	20,807	U
119	0205219F	MQ-9 UAV	07		63,862	43,557	U

UNCLASSIFIED

DEPARTMENT OF THE AIR FORCE
FY 2009 RDT&E PROGRAM

EXHIBIT R-1

APPROPRIATION: 3600F Research, Development, Test & Eval, AF

Date: 23 JAN 2008

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				FY 2007 -----	FY 2008 -----	FY 2009 -----	
120	0207131F	A-10 Squadrons	07	42,491	1,951		U
121	0207133F	F-16 Squadrons	07	124,761	70,172	123,979	U
122	0207134F	F-15E Squadrons	07	134,253	114,519	184,213	U
123	0207136F	Manned Destructive Suppression	07	499		5,585	U
124	0207138F	F-22A Squadrons	07	459,464	607,515	700,305	U
125	0207141F	F-117A Squadrons	07	11,718			U
126	0207161F	Tactical AIM Missiles	07	8,596	7,876	5,748	U
127	0207163F	Advanced Medium Range Air-to-Air Missile (AMRAAM)	07	33,411	33,425	54,239	U
128	0207170F	Joint Helmet Mounted Cueing System (JHMCS)	07	3,220	5,304	3,192	U
129	0207247F	AF TENCAP	07	11,160	11,452	11,578	U
130	0207248F	Special Evaluation Program	07	557,253			U
131	0207253F	Compass Call	07	9,586	8,549	4,670	U
132	0207268F	Aircraft Engine Component Improvement Program	07	152,969	138,159	150,956	U
133	0207277F	CSAF Innovation Program	07	1,554			U
134	0207325F	Joint Air-to-Surface Standoff Missile (JASSM)	07	32,995	12,074	13,035	U
135	0207410F	Air & Space Operations Center (AOC)	07	74,841	100,173	118,834	U
136	0207412F	Control and Reporting Center (CRC)	07	9,202	24,791	60,590	U
137	0207417F	Airborne Warning and Control System (AWACS)	07	157,751	151,593	126,300	U
138	0207418F	Tactical Airborne Control Systems	07	2,262	3,366	1,530	U
139	0207423F	Advanced Communications Systems	07	38,215	33,372	29,782	U

UNCLASSIFIED

DEPARTMENT OF THE AIR FORCE
FY 2009 RDT&E PROGRAM

EXHIBIT R-1

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				FY 2007	FY 2008	FY 2009	
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140	0207424F	Evaluation and Analysis Program	07	2,518	646,380	794,036	U
141	0207433F	Advanced Program Technology	07	302,972			U
142	0207438F	Theater Battle Management (TBM) C4I	07	35,950	9,898	19,437	U
143	0207445F	Fighter Tactical Data Link	07	88,094	38,944	62,788	U
144	0207446F	Bomber Tactical Data Link	07	87,613	36,875	11,702	U
145	0207448F	C2ISR Tactical Data Link	07	4,126	1,795	1,727	U
146	0207449F	Command and Control (C2) Constellation	07	41,725	44,582	32,151	U
147	0207581F	Joint Surveillance/Target Attack Radar System (JSTARS)	07	171,628	81,978	97,641	U
148	0207590F	Seek Eagle	07	16,299	22,823	21,645	U
149	0207591F	Advanced Program Evaluation	07	584,563			U
150	0207601F	USAF Modeling and Simulation	07	22,609	22,814	28,981	U
151	0207605F	Wargaming and Simulation Centers	07	6,270	6,421	3,870	U
152	0207697F	Distributed Training and Exercises	07	5,943	7,474	7,137	U
153	0208006F	Mission Planning Systems	07	139,217	104,575	97,560	U
154	0208021F	Information Warfare Support	07	28,028	11,965	12,220	U
155	0208161F	Special Evaluation System	07		765,525	1,077,970	U
156	0301310F	National Air Intelligence Center	07				
157	0301314F	COBRA BALL	07				
158	0301315F	Missile and Space Technical Collection	07				
159	0301324F	FOREST GREEN	07				
160	0301386F	GDIP Collection Management	07				

UNCLASSIFIED

DEPARTMENT OF THE AIR FORCE
FY 2009 RDT&E PROGRAM

EXHIBIT R-1

APPROPRIATION: 3600F Research, Development, Test & Eval, AF

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				FY 2007 -----	FY 2008 -----	FY 2009 -----	
162	0302015F	E-4B National Airborne Operations Center (NAOC)	07	2,728	19,406	4,069	U
163	0303112F	Air Force Communications (AIRCOM)	07		2,009		U
164	0303131F	Minimum Essential Emergency Communications Network (MEECN)	07	64,556	88,224	70,995	U
165	0303140F	Information Systems Security Program	07	156,125	186,255	187,933	U
166	0303141F	Global Combat Support System	07	22,530	11,756	4,320	U
167	0303150F	Global Command and Control System	07	3,204	4,471	3,218	U
168	0303158F	Joint Command and Control Program (JC2)	07	5,651	5,745	3,234	U
169	0303601F	MILSATCOM Terminals	07	257,226	384,652	337,098	U
170	0304111F	Special Activities	07				
171	0304260F	Airborne SIGINT Enterprise	07	119,646	135,162	173,631	U
172	0304311F	Selected Activities	07				
173	0304348F	Advanced Geospatial Intelligence (AGI)	07				
174	0305099F	Global Air Traffic Management (GATM)	07	12,115	6,638	6,275	U
175	0305103F	Cyber Security Initiative	07			2,083	U
176	0305110F	Satellite Control Network (SPACE)	07	21,238	26,898	16,758	U
177	0305111F	Weather Service	07	41,676	40,959	47,347	U
178	0305114F	Air Traffic Control, Approach, and Landing System (ATCALS)	07	3,670	8,293	6,867	U
179	0305116F	Aerial Targets	07	4,041	7,329	34,777	U
180	0305124F	Special Applications Program	07				

UNCLASSIFIED

DEPARTMENT OF THE AIR FORCE
FY 2009 RDT&E PROGRAM

EXHIBIT R-1

APPROPRIATION: 3600F Research, Development, Test & Eval, AF

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				FY 2007	FY 2008	FY 2009	
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181	0305127F	Foreign Counterintelligence Activities	07				
182	0305128F	Security and Investigative Activities	07	493	825	786	U
183	0305142F	Applied Technology and Integration	07				
184	0305146F	Defense Joint Counterintelligence Activities	07			39	U
185	0305159F	Defense Reconnaissance Support Activities (SPACE)	07				
186	0305160F	Defense Meteorological Satellite Program (SPACE)	07	936			U
187	0305164F	NAVSTAR Global Positioning System (User Equipment) (SPACE)	07	130,254	154,581	127,513	U
188	0305165F	NAVSTAR Global Positioning System (Space and Control Segments)	07	160,555	119,089	91,277	U
189	0305172F	Combined Advanced Applications	07				
190	0305173F	Space and Missile Test and Evaluation Center	07	2,526	3,070	1,985	U
191	0305174F	Space Warfare Center	07	703	1,667	3,003	U
192	0305182F	Spacelift Range System (SPACE)	07	45,633	27,095	12,376	U
193	0305193F	Intelligence Support to Information Operations (IO)	07	1,290	5,927	1,237	U
195	0305206F	Airborne Reconnaissance Systems	07	51,842	64,441	149,752	U
196	0305207F	Manned Reconnaissance Systems	07	37,015	21,387	12,819	U
197	0305208F	Distributed Common Ground/Surface Systems	07	124,007	107,048	107,834	U
198	0305219F	MQ-1 Predator A UAV	07	77,885	33,781	24,773	U
199	0305220F	Global Hawk UAV	07	224,126	274,742	284,292	U

UNCLASSIFIED

DEPARTMENT OF THE AIR FORCE
FY 2009 RDT&E PROGRAM

EXHIBIT R-1

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200	0305221F	Network-Centric Collaborative Targeting	07	18,466	8,586	8,807	U
201	0305265F	GPS III Space Segment	07			420,342	U
202	0305887F	Intelligence Support to Information Warfare	07	5,121	5,305	5,438	U
203	0305906F	NCMC - TW/AA System	07	42,152	11,720		U
204	0305913F	NUDET Detection System (SPACE)	07	59,917	38,279	41,292	U
205	0305924F	National Security Space Office	07	17,351	10,745	10,797	U
206	0305940F	Space Situation Awareness Operations	07	29,476	23,827	16,166	U
207	0307141F	Information Operations Technology Integration & Tool Development	07	14,759	15,582	15,726	U
208	0308699F	Shared Early Warning (SEW)	07	2,896	3,127	3,152	U
209	0401115F	C-130 Airlift Squadron	07	185,554	250,020	172,560	U
210	0401119F	C-5 Airlift Squadrons (IF)	07	137,565	178,990	125,063	U
211	0401130F	C-17 Aircraft (IF)	07	170,527	180,581	236,047	U
212	0401132F	C-130J Program	07	34,765	73,753	52,354	U
213	0401134F	Large Aircraft IR Countermeasures (LAIRCM)	07	35,349	19,201	32,100	U
214	0401218F	KC-135s	07	1,092	8,710	7,133	U
215	0401219F	KC-10s	07	4,696	13,703		U
216	0401221F	KC-135 Tanker Replacement	07	68,340	113,728		U
217	0401314F	Operational Support Airlift	07		4,837		U
218	0401839F	Air Mobility Tactical Data Link	07	6,785			U
219	0408011F	Special Tactics / Combat Control	07	1,962	8,074	5,728	U
220	0702207F	Depot Maintenance (Non-IF)	07	1,411	1,501	1,531	U

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DEPARTMENT OF THE AIR FORCE
FY 2009 RDT&E PROGRAM

EXHIBIT R-1

APPROPRIATION: 3600F Research, Development, Test & Eval, AF

Date: 23 JAN 2008

Line No	Program Element Number	Item	Act	Thousands of Dollars			S E C
				FY 2007	FY 2008	FY 2009	
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221	0702806F	Acquisition and Management Support	07	26,645	22,141	34,428	U
222	0708011F	Industrial Preparedness	07	65,543	50,186		U
223	0708012F	Logistics Support Activities	07	2,132			U
224	0708610F	Logistics Information Technology (LOGIT)	07	90,557	114,599	189,679	U
225	0708611F	Support Systems Development	07	23,651	33,859	8,145	U
226	0804757F	Joint National Training Center	07	2,964	3,108	3,214	U
227	0808716F	Other Personnel Activities	07	110	114	116	U
228	0901202F	Joint Personnel Recovery Agency	07	960	5,342	5,768	U
229	0901212F	Service-Wide Support (Not Otherwise Accounted For)	07		6,454	3,016	U
230	0901218F	Civilian Compensation Program	07	13,160	8,019	8,123	U
231	0901220F	Personnel Administration	07	18,787	16,714	18,625	U
232	0901538F	Financial Management Information Systems Development	07	25,408	36,836	31,782	U
		Operational Systems Development		-----	-----	-----	
				13,506,529	15,826,555	17,513,504	
		Total Research, Development, Test & Eval, AF		-----	-----	-----	
				24,491,745	26,069,228	28,066,617	

PROGRAM ELEMENT COMPARISON SUMMARY

PROGRAM ELEMENT (By BUDGET ACTIVITY)

BUDGET ACTIVITY #1: BASIC RESEARCH (Volume 1)

BUDGET ACTIVITY #2: APPLIED RESEARCH (Volume 1)

BUDGET ACTIVITY #3: ADVANCED TECHNOLOGY DEVELOPMENT (Volume 1)

REMARKS

0603216F Aerospace Propulsion and Power Technology

In FY 09, funding is higher to support ground demonstrations and fabrication of test vehicles for flight demonstrations. The funding in this project has been increased due to emphasis on component development in support of adaptive cycle technologies alternative hydrocarbon jet fuel, and improved fuel efficiency.

0603680F Manufacturing Technologies

In FY 09, the AF Manufacturing Technologies program will transfer to PE 0603680F, Manufacturing Technologies, from PE 0708011F, Industrial Preparedness, to focus on long-term manufacturing and processes.

BUDGET ACTIVITY #4: ADVANCED COMPONENT DEVELOPMENT AND PROTOTYPE (Volume 2)

0604796F Alternative Fuels
Operationally Responsive Space

In FY 09, PE 0604796F is a new PE. Previous alternative fuels work was accomplished in the "RDT&E for Aging Aircraft" PE (0605011F).

0604857F

In FY 09, Project 64A020, AF-funded ORSSats is being established to identify the funding the Air Force is planning to use for Air Force projects to meet ORS requirements. Project 64A015 is renamed ORS Common Services from Tactical Satellites. This is to delineate the funding the Air Force is contributing to support the overall DoD ORS effort versus the funding the Air Force is using to pursue specific Air Force ORS projects.

BUDGET ACTIVITY #5: SYSTEM DEVELOPMENT AND DEMONSTRATION (SDD) (Volume 2)

0207450F E-10 Squadrons

In FY09, The Global Hawk (GH) MP-RTIP sensor development continues in the sensors project line. The E-10 program was terminated in FY08.

0207451F Single Integrated Air Picture (SIAP)

In FY09, Project 5275, Joint SIAP System Engineering and Development efforts were transferred from Army PE 0603327A - Air and Missile Defense Systems Engineering, Project S32, Joint SIAP System Engineering, into Air Force PE 0207451F in accordance with DoD designation of the Air Force as the SIAP Acquisition Executive. These funds support the research, development and testing of the Integrated Architecture Behavior Model (IABM), conduct Joint System-of-Systems Engineering for air and cruise missile defense, and operation of the SIAP Joint Program Office (SIAP JPO) and SIAP Joint Program Executive Office (SIAP JPEO).

0604261F Personnel Recovery Systems

In FY09, the CSAR-X and HC-130Recap projects separate into distinct PEs (0605277F and 0605278F, respectively) to provide more budget clarity. Procurement funding for CSAR-X remains in PE 0207224F and is reported in P-Docs. Procurement funding for HC/MC-130 Recap is included in Air Combat Command PE 0207224F and Air Force Special Operations Command PE 0207230F, as reported in P-Docs.

0604617F	Agile Combat Support
0605221F	KC-X, Next Generation Aerial Refueling Aircraft
0605277F	CSAR-X

In FY09, \$3.5M was transferred to PE 0603112F, Advanced Materials for Weapon Systems, to support technology evaluation for Airfield Damage Repair (ADR) and Rapid Parking Ramp Expansion (RPRE)

In FY09, \$239.8M in Transfer Fund. These transfer funds will be used to fund KC-X acquisition after contract award.

In FY09, CSAR-X is in this new PE to provide more budget clarity.

BUDGET ACTIVITY #6: RDT&E MANAGEMENT SUPPORT (Volume 2)

BUDGET ACTIVITY #7: OPERATIONAL SYSTEM DEVELOPMENT (Volume 3)

0401221F	KC-135 Replacement Tanker
0604263F	CVLSP
0708011F	Industrial Preparedness

In FY 09, \$239.8M in Transfer Fund. These transfer funds will be used to fund KC-X acquisition after contract award.

In FY 09, Project Number 5277, CVLSP, includes new start efforts

In FY09, the program will transfer from PE 0708011F, Industrial Preparedness, to Budget Activity 3 in PE 0603680F, Manufacturing Technologies, to better align with the Office of the Secretary of Defense's ManTech PE.

The following are Program Elements not providing RDT&E exhibits due to classification:

<u>No.</u>	<u>Title</u>
0101314F	Night Fist
0101815F	Advanced Strategic Program
0207248F	Special Evaluation Program
0207424F	Evaluation and Analysis Program
0207433F	Advanced Program Technology
0207591F	Advance Program Evaluation
0208161F	Special Evaluation System
0301310F	National Air Intelligence Center
0301314F	COBRA BALL
0301315F	Missile and Space Technical Collection
0301324F	FOREST GREEN
0301386F	GDIP Collection Management
0301555F	Classified Programs
0301556F	Special Program
0304111F	Special Activities
0304311F	Selected Activities
0304348F	Advanced Geospatial Intelligence (AGI)
0305124F	Special Applications Program
0305127F	Foreign Counterintelligence Activities
0305142F	Applied Technology and Integration
0305159F	Defense Reconnaissance Support Activities (SPACE)
0305172F	Combined Advanced Applications
0603801F	Special Programs
0605798F	Analysis Support Group

In accordance with the President's Management Agenda, Budget and Performance Integration initiative, these programs have been assessed using the Program Assessment Rating Tool (PART). Remarks regarding program performance and plans for performance improvement can be located at the Expectmore.gov website.

UNCLASSIFIED

PE NUMBER: 0601102F
 PE TITLE: Defense Research Sciences

Exhibit R-2, RDT&E Budget Item Justification	DATE February 2008
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BUDGET ACTIVITY 01 Basic Research	PE NUMBER AND TITLE 0601102F Defense Research Sciences
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Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
Total Program Element (PE) Cost	271.481	288.601	309.926	322.878	340.227	344.120	349.097	Continuing	TBD
2301 Physics	27.729	49.482	46.988	47.496	49.068	48.505	48.834	Continuing	TBD
2302 Solid Mechanics and Structures	16.463	16.926	18.028	19.936	20.378	20.348	19.797	Continuing	TBD
2303 Chemistry	33.523	33.562	38.233	38.420	39.532	39.591	39.508	Continuing	TBD
2304 Mathematics and Computing Sciences	30.165	24.135	30.586	33.430	36.027	36.373	37.994	Continuing	TBD
2305 Electronics	34.245	32.963	39.289	40.943	43.636	43.689	43.502	Continuing	TBD
2306 Materials	39.054	37.436	25.681	25.118	26.659	27.335	27.633	Continuing	TBD
2307 Fluid Mechanics	13.576	14.366	18.486	20.812	22.467	23.080	23.199	Continuing	TBD
2308 Propulsion	20.499	21.144	25.432	25.732	26.956	27.431	27.847	Continuing	TBD
2311 Information Sciences	26.008	25.257	31.640	32.512	36.241	38.062	39.045	Continuing	TBD
2312 Biological Sciences	9.682	10.332	10.473	10.601	10.444	10.230	10.120	Continuing	TBD
2313 Human Performance	12.161	11.052	15.255	18.065	19.220	19.538	21.299	Continuing	TBD
4113 External Research Programs Interface	8.376	11.946	9.835	9.813	9.599	9.938	10.319	Continuing	TBD

Note: In FY 2007, Project 2311 "Space and Information Sciences" changed its name to "Information Sciences" changed its name to "Information Sciences." In FY 2008, Space related efforts in Project 2311 and Physical Mathematics efforts in Project 2304 were moved into Project 2301 in this program element (PE) to more accurately align basic research efforts in Physics.

(U) A. Mission Description and Budget Item Justification

This program consists of extramural research activities in academia and industry along with in-house investigations performed in the Air Force Research Laboratory. This program funds fundamental broad-based scientific and engineering research in areas critical to Air Force weapon systems. Projects are coordinated through the Defense Reliance process to harmonize efforts, eliminate duplication, and ensure the most effective use of funds across the Department of Defense. All research areas are subject to long-range planning and technical review by both Air Force and tri-Service scientific planning groups. Note: In FY 2008, Congress added \$0.8 million for Chabot Space and Science Center, \$5.0 million for High Energy Laser for Detection, Inspection and Non-Destructive Testing, \$2.0 million for Nanotechnology Based Biosensors and Biothreat Detectors, \$0.7 million for UNR (University of Nevada-Reno) - Millimeter Wave-Based Fatigue Countermeasure Technology, \$1.6 million for Fully-Integrated Solar-Powered Interior Lighting Technology, \$1.0 million for Process Integrated Mechanism for Human-Computer Collaboration and Coordination, \$1.6 million for Hybrid Materials for Thermal Management in Thin Films and Bulk Composites, \$16.0 million for National Aerospace Leadership Initiative, \$2.4 million for Development and Validation of Advanced Design Technologies for Hypersonic Research, and \$1.0 million for Coal Transformation Laboratory. This program is in Budget Activity 1, Basic Research, because it funds scientific study and experimentation.

Exhibit R-2, RDT&E Budget Item Justification

DATE

February 2008

BUDGET ACTIVITY

01 Basic Research

PE NUMBER AND TITLE

0601102F Defense Research Sciences

(U) **B. Program Change Summary (\$ in Millions)**

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) Previous President's Budget	281.156	258.259	263.012
(U) Current PBR/President's Budget	271.481	288.601	309.926
(U) Total Adjustments	-9.675	30.342	
(U) Congressional Program Reductions		-0.018	
Congressional Rescissions		-1.740	
Congressional Increases		16.100	
Reprogrammings	-3.672	16.000	
SBIR/STTR Transfer	-6.003		
(U) <u>Significant Program Changes:</u>			
Not Applicable.			

C. Performance Metrics

(U) Under Development.

Exhibit R-2a, RDT&E Project Justification

DATE
February 2008

BUDGET ACTIVITY 01 Basic Research				PE NUMBER AND TITLE 0601102F Defense Research Sciences			PROJECT NUMBER AND TITLE 2301 Physics		
Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
2301 Physics	27.729	49.482	46.988	47.496	49.068	48.505	48.834	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

Note: Space Environment efforts from Project 2311 and Physical Mathematics efforts from Project 2304 moved to this Project in FY 2008 to more accurately align basic research efforts in Physics.

(U) A. Mission Description and Budget Item Justification

Physics basic research seeks to enable revolutionary advances in and expand the fundamental knowledge supporting laser technologies, sensing and imaging capabilities, communications and navigational systems, fuels and explosives, and directed energy weapons that are critical to the Air Force. The primary areas of research investigated by this project are laser and optical physics; electro-energetics (includes plasma) physics; atomic, molecular, and particle physics; space sensors and imaging physics; space environment physics; electromagnetics; and applied analysis.

(U) B. Accomplishments/Planned Program (\$ in Millions)

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) MAJOR THRUST: Investigate regulated, broad-spectrum, variable-energy lasers, laser arrays, and multi-aperture adaptive optics.	9.274	9.418	10.609
(U) In FY 2007: Investigated new laser materials and configurations to enable efficient, high power, and wide wavelength tunable lasers. Investigated arrays of micro-discharges for laser devices and pumps, as well as other intense light source applications. Explored use of directed energy beams for direct-write materials processing techniques that offer new microsystems fabrication and packaging capabilities. Studied semiconductor laser and nonlinear optical devices for improved application to infrared countermeasures.			
(U) In FY 2008: Study mechanical, optical, and laser properties of ceramic materials as a function of material and preparation parameters. Investigate novel index, gain and doping profiles for high power, high beam, quality ceramic lasing. Study means for efficiently producing and making available quasi-phase matched semiconductor crystals for tunable high energy lasing. Study fundamental and practical limitations on efficiency and high temperature operation of mid-infrared semiconductor lasers, which have shown great promise for heat seeking missile countermeasures.			
(U) In FY 2009: Investigate applications of previous research enabling large inexpensive, very bright micro-plasma array ultraviolet sources to large flexible displays, materials curing, biological agent decontamination, and infectious disease treatment. Continue and expand research on high energy, tunable, all solid state lasers. Study direct-write micro-systems, including on-board power sources. Apply 3-D laser write techniques in special glasses to inexpensive, flexible subsystems for space.			
(U) MAJOR THRUST: Explore high-energy, electro-energetic device concepts and manipulate atomic and molecular	13.097	13.162	14.353

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

01 Basic Research

PE NUMBER AND TITLE

0601102F Defense Research
Sciences

PROJECT NUMBER AND TITLE

2301 Physics

(U) **B. Accomplishments/Planned Program (\$ in Millions)**FY 2007FY 2008FY 2009

properties, atomic collision processes, and atomic, molecular, ionic, and radiation interactions to improve explosives and fuels, advance directed energy systems, enhance surveillance, provide superior communications, and improve precision navigation.

- (U) In FY 2007: Characterized the interactions of atoms and molecules in strong electromagnetic fields. Examined techniques for precision measurement of atomic and molecular properties, atomic collision processes, and fundamental interactions between atoms, molecules, ions, and radiation. Explored dynamic molecular interactions in combustion and high energy density propellants. Studied electro-energetic concepts related to non-lethal weaponry. Explored high power, high frequency electromagnetic device concepts and studies of new compact pulsed power technologies. Explored use of electron beam generated microwaves for high-bandwidth communications, advanced long-distance covert surveillance, electronic countermeasures, and directed energy weapons. Investigated ultra-high current density cathode concepts. Initiated advanced modeling and simulation of electro-energetic phenomena. Studied overlapped research areas between atomic physics and condensed matter physics. Resolved basic scientific issues blocking realization of electromagnetic launch concepts.
- (U) In FY 2008: Explore usage of ultra-cold atoms and molecules for precision inertial navigation system components and ultra-precise measurement techniques using the results of previous research into atomic collision processes and fundamental interactions between atoms, molecules, ions, and radiation. Explore the possibility of tailor-making materials using the results of research in the overlap between atomic physics and condensed matter physics. Continue exploring new concepts for high-power, high-frequency electromagnetic radiation sources. Study quantum physics effects relating to the emission of electrons from surfaces. Examine the application of Chaos Theory effects to raise fundamental limits on electrical energy storage density. Study the seamless integration of magnetohydrodynamic and particle-in-cell modeling algorithms to better capture the detailed physics of high power microwave sources.
- (U) In FY 2009: Continue studying the usage of ultra-cold atoms and molecules for precision inertial navigation system components and ultra-precise measurement techniques using the results of previous research into atomic collision processes and fundamental interactions between atoms, molecules, ions, and radiation. Continue exploring the possibility of tailor-making materials using the results of research in the overlap between atomic physics and condensed matter physics. Exploit emerging microfabrication methodologies for the realization of compact, high-frequency, high-power electromagnetic radiation sources. Continue studying quantum effects impacting electron emission from surfaces. Expand Chaos Theory studies to raise fundamental limits on electrical energy storage density. Create new simulation codes embodying both magnetohydrodynamic and particle-in-cell algorithms to realistically model high power microwave sources.

(U)

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

01 Basic Research

PE NUMBER AND TITLE

0601102F Defense Research
Sciences

PROJECT NUMBER AND TITLE

2301 Physics

(U) **B. Accomplishments/Planned Program (\$ in Millions)**

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) MAJOR THRUST: Advance technologies for space sensors, imaging, identification, and tracking methods, and effective space situational awareness.	4.608	4.680	5.871
(U) In FY 2007: Studied fundamental issues that affect remote sensing, including propagation, image formation, and image recovery processes. Identified, characterized, and modeled parameters enabling remote sensing, locating, and precision tracking of objects, particularly from space and of space objects from the ground. Studied environmental effects on sensors and sensor systems and of the effects of the medium through which the signal propagates.			
(U) In FY 2008: Develop theoretical approaches to the surveillance and identification of space objects from both the ground and from space. Continue to study propagation of electromagnetic energy, image formation, image recovery, and information content maximization from both ground-based and space-based sensors. Investigate methods to mitigate environmental effects on sensors and sensor systems. Investigate atmospheric density forecast models to improve satellite orbit determination and tracking.			
(U) In FY 2009: Continue to investigate fundamental limits affecting ground-based and space-based surveillance of space objects. Develop improved adaptive optics and post-processing techniques for improved image resolution. Study spectral, polarimetric, and temporal approaches to unresolved space object identification. Continue the study of fundamental processes in the solar-terrestrial system that affects atmospheric density to lead to physics-based methods of satellite orbit prediction and precision tracking.			
(U) MAJOR THRUST: Research space environment to improve solar plasma theories and modeling in the areas of solar phenomena, space weather, magneto/ionosphere effects, space debris, adaptive optics for improved space observation, better space-based communications, and the quantifying of risks to space systems. Note: In FY 2008, Space Environment efforts previously in Project 2311 in this PE were moved into this Project to more accurately align basic research efforts in Physics.	0.000	4.919	6.110
(U) In FY 2007: Not Applicable.			
(U) In FY 2008: Begin using newly developed radio telescope instruments to probe the near-Earth space environment, to study solar phenomena, and to develop innovative methods for remote sensing the space environment as well as for heliospheric tomography. Investigate fundamental plasma modeling theory using new grid-free, full kinetic modeling techniques, and develop novel techniques to include electromagnetism. Continue development of ground-based and space-based sensor technology for remote sensing and in situ measurement of space weather conditions. Continue to seek understanding of fundamental physics and processes controlling solar, heliospheric, magnetospheric, ionospheric, and thermospheric environments with a focus on improving forecast capabilities of the near-Earth space environment using first principles physics models. Continue developing understanding of fundamental processes of			

Exhibit R-2a, RDT&E Project Justification		DATE February 2008		
BUDGET ACTIVITY 01 Basic Research	PE NUMBER AND TITLE 0601102F Defense Research Sciences	PROJECT NUMBER AND TITLE 2301 Physics		
		<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u>				
energetic particle scattering in the near-Earth environment to support protection of space assets and to explore the solar interior as a complex system through advanced modeling techniques. Continue to analyze data from DoD surveillance satellites to improve remote sensing of interplanetary space. Maintain focused research to investigate the neutral densities and winds above 150 kilometers.				
(U) In FY 2009: Emphasize development of cost - effective micro satellites for space weather sensing. Investigate requirements of boundary conditions and initial values for driving space weather models. Exploit newly developed radio astronomy techniques for remote sensing the space environment in the continued search for understanding of fundamental physics and processes controlling solar, heliospheric, magnetospheric, ionospheric, and thermospheric environments with a focus on improving our ability to forecast near-Earth space environment using first principles physics models. Expand investigation of the fundamental plasma modeling theory using new electromagnetic, grid-free, full kinetic modeling techniques. Continue ground-based and space-based sensor technology development for remote sensing and in situ measurement of space weather conditions. Continue developing understanding of fundamental processes of energetic particle scattering in the near-Earth environment to support protection of space assets and to explore the solar interior as a complex system through advanced modeling techniques. Continue to analyze data from DoD surveillance satellites to improve remote sensing of interplanetary space. Maintain focused research to investigate the neutral densities and winds above 150 kilometers for satellite drag.				
(U) MAJOR THRUST: Research physical mathematics and applied analysis to develop accurate models of physical phenomena to enhance the fidelity of simulation. Conduct research in electromagnetics to produce conceptual descriptions of electromagnetic properties of novel materials/composites and simulate their uses in various operational settings. Note: In FY 2008, Physical Mathematics efforts previously in Project 2304 in this PE were moved into this project to more accurately align basic research efforts in Physics.		0.000	8.854	10.045
(U) In FY 2007: Not Applicable.				
(U) In FY 2008: Continue to investigate properties of coherently propagating ultra-short laser pulses through the atmosphere with an emphasis on their ability to propagate through clouds and be used for target imaging. Continue to develop algorithms to simulate nonlinear optical effects within fiber lasers and nonlinear optical media with an emphasis on designs for 199KW laser weapons. Continue to investigate the dynamics of transonic/supersonic/hypersonic platforms, with an emphasis on stores release. Model the effects of the dynamics of the upper atmosphere on the stability of high altitude platforms as well as to assure the effective uses of their optical inventory. Study the design of reconfigurable warheads through suitable timing/placement of micro-detonators, together with effects of metal particle inclusions. Continue to improve methods for recognizing and tracking targets				

UNCLASSIFIED

Exhibit R-2a, RDT&E Project Justification	DATE February 2008
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BUDGET ACTIVITY 01 Basic Research	PE NUMBER AND TITLE 0601102F Defense Research Sciences	PROJECT NUMBER AND TITLE 2301 Physics
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	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u>			
and for penetrating coverings or other dispersive media that obscure targets so that radar emitting suitable waveforms can be used to image through foliage and clouds. Pursue the design of electromagnetic sources which, with the help of novel materials, can transmit optimized waveforms for a variety of surveillance purposes.			
(U) In FY 2009: Investigate properties of coherently propagating ultra-short laser pulses through the atmosphere for their exploitation as high power microwave sources. Upgrade algorithms to simulate nonlinear optical effects within fiber lasers and nonlinear optical media so that simulation of various lasers can be realized. Initiate a modeling/simulation effort to codify the theoretical work on the dynamics of transonic/supersonic/hypersonic platforms to verify that designs and operations are near optimal. Model the effects of the dynamics of the upper atmosphere on the stability of high altitude platforms, as well as to assure the effective uses of their optical inventory. Communicate these results to the airborne laser program and to the Air Force's Air Combat Command, for the latter's high altitude platforms. Verify the design of reconfigurable warheads through suitable timing/placement of micro-detonators, as well as the effects of various metal inclusions on lethality. Continue to improve methods for recognizing and tracking targets and for penetrating coverings or other dispersive media that obscure targets. Pursue the design of electromagnetic sources which, with the help of novel materials, can transmit optimized waveforms for a variety of surveillance purposes and write numerical code which allows the user to simulate these sources.			
(U) CONGRESSIONAL ADD: Non-Lethal Stunning/Immobilizing Weapons	0.750	0.000	0.000
(U) In FY 2007: Accelerated fundamental scientific investigations in non-lethal stunning and immobilizing weapons research			
(U) In FY 2008: Not Applicable.			
(U) In FY 2009: Not Applicable.			
(U) CONGRESSIONAL ADD: Chabot Space and Science Center	0.000	0.795	0.000
(U) In FY 2007: Not Applicable.			
(U) In FY 2008: Develop new science programs for K-12 students, teachers, and the general public.			
(U) In FY 2009: Not Applicable.			
(U) CONGRESSIONAL ADD: High Energy Laser for Detection, Inspection and Non-Destructive Testing	0.000	4.970	0.000
(U) In FY 2007: Not Applicable.			
(U) In FY 2008: Conduct laser technology research to support multiple applications, including inspection of military hardware and equipment flaws, and detecting weapons hidden in cargo ships.			

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY 01 Basic Research	PE NUMBER AND TITLE 0601102F Defense Research Sciences	PROJECT NUMBER AND TITLE 2301 Physics
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(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) In FY 2009: Not Applicable.			
(U)			
(U) CONGRESSIONAL ADD: Nanotechnology Based Biosensors and Bio-Threat Detectors	0.000	1.988	0.000
(U) In FY 2007: Not Applicable.			
(U) In FY 2008: Research to remotely control the operation of both nanofabrication equipment and nanoscale analysis tools while performing new nano related science field. In addition, a significant number of minority engineers will be trained in nanotechnology research area.			
(U) In FY 2009: Not Applicable.			
(U)			
(U) CONGRESSIONAL ADD: UNR - Millimeter Wave-Based Fatigue Countermeasure Technology	0.000	0.696	0.000
(U) In FY 2007: Not Applicable.			
(U) In FY 2008: Develop a novel device based on millimeter wave technology that will serve as a skeletal muscle fatigue countermeasure for use in the battlefield.			
(U) In FY 2009: Not Applicable.			
(U) Total Cost	27.729	49.482	46.988

(U) <u>C. Other Program Funding Summary (\$ in Millions)</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to</u>	<u>Total Cost</u>
	<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Complete</u>	
(U) Related Activities:									
(U) PE 0602203F, Aerospace Propulsion.									
(U) PE 0602204F, Aerospace Sensors.									
(U) PE 0602500F, Multi-Disciplinary Space Technology.									
(U) PE 0602601F, Space Technology.									
(U) PE 0602605F, Directed Energy Technology.									

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

01 Basic Research

PE NUMBER AND TITLE

0601102F Defense Research
Sciences

PROJECT NUMBER AND TITLE

2301 Physics

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification

DATE
February 2008

BUDGET ACTIVITY 01 Basic Research				PE NUMBER AND TITLE 0601102F Defense Research Sciences			PROJECT NUMBER AND TITLE 2302 Solid Mechanics and Structures		
Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
2302 Solid Mechanics and Structures	16.463	16.926	18.028	19.936	20.378	20.348	19.797	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

Solid mechanics and structures basic research aims to improve load-bearing performance of air and space structures through the prediction and control of multi-scale phenomena ranging from micro-level deformation and fracture of materials to the structural dynamics of large platforms. The goals are cost-effective development and safe, reliable operation of superior Air Force weapon and defensive systems. Fundamental knowledge of "multi-functional" structures with smart materials, sensors, actuators, and control systems integrated to accomplish damage control, thermal management, vibration reduction, and reconfigurable shapes. Research topics include: the modeling of non-linear static/dynamic behavior of structures; mechanical reliability of micro-devices; design of multi-functional materials; mechanical behavior of nano-materials; and composite materials for structures.

(U) B. Accomplishments/Planned Program (\$ in Millions)

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) MAJOR THRUST: Explore the integration of advanced materials (including nano-materials) and devices into turbine engines, air vehicles, space systems, and other weapon systems, and develop new mechanics criteria for system integration.	7.773	8.027	8.578
(U) In FY 2007: Expanded research in the areas of diagnostics, prognostics, self-healing, micro-/nano-mechanics, autonomics, thermal management, atomic-scale modeling, and energy harvesting to enable safer and more durable aerospace structures with improved performance characteristics. Developed the fundamental knowledge required to design and manufacture multi-functional aerospace material systems and devices and to predict their performance and structural integrity. Developed and exploited methods that combine information technology and modeling in the design of new material systems and devices at multiple scales.			
(U) In FY 2008: Expand research in the area of multi-functional composite systems with structurally integrated antenna functions of broad bandwidth and improved structural endurance. Continue research in the areas of diagnostics, prognostics, autonomics, self-healing, thermal management, energy harvesting/storage, and micro-/nano-mechanics to enable safer and more durable aerospace structures with improved performance characteristics. Further develop the fundamental knowledge required to design and manufacture multi-functional aerospace material systems and devices and to predict their performance and structural integrity. Continue developing and exploiting methods that combine information technology and multi-scale modeling in the design of new material systems and devices.			
(U) In FY 2009: Continue research in the area of multi-functional hybrid composite systems for sensing and neutralization of exogenous threats to load-bearing capability. Continue research in the areas of diagnostics, prognostics, autonomics, self-healing, thermal management, energy harvesting/storage, electromagnetic energy radiation/transmission, and micro-/nano-mechanics to enable safer and more durable aerospace structures with			

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

01 Basic Research

PE NUMBER AND TITLE

0601102F Defense Research
Sciences

PROJECT NUMBER AND TITLE

2302 Solid Mechanics and Structures

(U) **B. Accomplishments/Planned Program (\$ in Millions)**FY 2007FY 2008FY 2009

improved performance characteristics. Further develop the fundamental knowledge required to design and manufacture multi-functional aerospace material systems and devices and to predict their performance and structural integrity. Continue developing and exploiting methods that combine information technology and multi-scale modeling in the design of new material systems.

(U)

(U) MAJOR THRUST: Analyze structural fatigue and mechanics, adaptive structures, and material properties to improve the design, robustness, and performance of air and space systems to include multi-mission unmanned aerial vehicles (UAVs).

8.690

8.899

9.450

(U) In FY 2007: Explored novel methods for constructing and modeling morphing structures that broaden system operational capabilities. Developed novel actuation devices and materials for applications such as micro-UAV aircraft and space structures. Utilized acquired knowledge of material behavior in aerospace structure to develop system lifetime prognosis methodologies. Developed structural health monitoring techniques and systems and exploration of mechanical and dynamic behavior of micro-/nano-scale structures. Investigated nonlinear phenomena, such as structural deformation and aero-elastic effects in novel structural applications.

(U) In FY 2008: Develop novel theoretical and experimental methods for constructing and modeling morphing structures that broaden system operational capabilities. Continue development of novel actuation devices and materials for a variety of Air Force applications to aircraft and space structures. Study the science issues related to the introduction into new structural concepts of the novel materials developed under the advanced materials programs. Use the knowledge acquired about the novel materials to develop new aerospace structural concepts. Develop an integrated approach to structural systems lifetime prognosis. Continue the development of structural health monitoring sensors and techniques towards an integrated vehicle-wide approach. Consolidate the exploration of mechanical and dynamic behavior of micro-/nano-scale structures. Expand the investigation of nonlinear phenomena associated with the structural deformation and aero-elastic instabilities and limit-cycle vibration to include novel structural concepts.

(U) In FY 2009: Expand the novel theoretical and experimental methods in morphing aircraft structures to achieve broader operational capabilities. Utilize novel actuation devices and materials for Air Force aircraft and space structural applications. Expand the study of the science related to the acceptance into new structures of the novel materials developed under the advanced materials programs. Use this acquired knowledge to develop new aerospace structural concepts. Continue the development of structural health monitoring sensors and techniques towards an integrated vehicle-wide approach. Consolidate an integrated approach to structural systems lifetime prognosis and reliability. Expand the understanding of mechanical and dynamic behavior of micro-/nano-scale structures to

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY
01 Basic Research

PE NUMBER AND TITLE
0601102F Defense Research
Sciences

PROJECT NUMBER AND TITLE
2302 Solid Mechanics and Structures

(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u>									
generate novel structural concepts. Continue investigation of nonlinear phenomena associated with the structural deformation and aero-elastic instabilities and limit-cycle vibration to include novel structural concepts.									
(U) Total Cost									
(U) <u>C. Other Program Funding Summary (\$ in Millions)</u>									
	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to</u>	<u>Total Cost</u>
	<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Complete</u>	
(U) Related Activities:									
(U) PE 0602102F, Materials.									
(U) PE 0602201F, Aerospace Flight Dynamics.									
(U) PE 0602202F, Human Effectiveness Applied Research.									
(U) PE 0602203F, Aerospace Propulsion.									
(U) PE 0603211F, Aerospace Structures.									
(U) <u>D. Acquisition Strategy</u>									
Not Applicable.									

<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
16.463	16.926	18.028

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY 01 Basic Research				PE NUMBER AND TITLE 0601102F Defense Research Sciences			PROJECT NUMBER AND TITLE 2303 Chemistry		
Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
2303 Chemistry	33.523	33.562	38.233	38.420	39.532	39.591	39.508	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) **A. Mission Description and Budget Item Justification**

Chemistry basic research seeks bold innovations in understanding, modeling, and controlling chemical reactions for developing new materials, improving synthesis of existing materials, controlling energy flow and storage, and regulating interactions between materials and their environments. Studies expand fundamental understanding of properties regulating the chemical dynamics and energy transfer processes that foster advances in laser weaponry and allow predictions of the infrared, optical, and radar signatures of reaction products and intermediates that advance reliable target assessment and tracking. Critical research topics include: novel synthesis and characterization of lower cost, higher performance functional and structural materials, electronics, and photonic materials; nano-structures; electromagnetics; and conventional weaponry. Focused investigations include bio-derived mechanisms for lifetime extension of materials and catalysis, and the exploration of atomic and molecular surface interactions that limit performance of electronic devices, compact power sources, and lubricant materials. Primary areas of research include molecular reaction dynamics; theoretical chemistry; polymer chemistry; biophysical mechanisms; and surface and interfacial science.

(U) **B. Accomplishments/Planned Program (\$ in Millions)**

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) MAJOR THRUST: Research and characterize molecular dynamics, reaction mechanics/interactions, and theoretical chemistry to model, predict, control, and exploit atomic and molecular energetics for advanced fuels, munitions, and countermeasure techniques.	13.653	14.423	16.510
(U) In FY 2007: Utilized theoretical chemistry to predict promising new chemicals of interests to the Air Force and to guide their efficient synthesis. Supported advance research to understand, predict, and control the reactivity and flow of energy in molecules to improve exhaust signature detection and control capabilities, to develop new high-energy, high density chemicals for propellants and propulsion systems, and to develop new high-energy chemical laser systems. Enhanced efforts to develop higher performance, less sensitive nano-scale energetic materials for applications in munitions and propellants.			
(U) In FY 2008: Develop new theoretical and computational methods to enhance capabilities to predict and simulate properties of chemicals and materials of interest to the Air Force. Continue to develop new experimental methods to advance understanding of reactivity and energy flow in molecules for applications to signatures, battlespace awareness, propellants, munitions, and laser systems. Explore ability to understand and control catalysis and plasmonic structures to enhance propulsion and energetic applications and sensitive detection of target compounds.			
(U) In FY 2009: Continue to develop new capabilities to predict molecular and macroscopic properties of chemicals of interest to the Air Force. Explore properties and potential of nano-scale energetic materials. Continue to develop new experimental methods to advance understanding of reactivity and energy flow in molecules for applications to signatures, battlespace awareness, propellants, munitions, and laser systems. Continue to develop novel applications			

Exhibit R-2a, RDT&E Project Justification		DATE February 2008		
BUDGET ACTIVITY 01 Basic Research	PE NUMBER AND TITLE 0601102F Defense Research Sciences	PROJECT NUMBER AND TITLE 2303 Chemistry		
(U) B. Accomplishments/Planned Program (\$ in Millions)		<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
of catalysis and plasmonic structures for applications to propulsion, energetics, and sensing. Explore new concepts for closed-cycle hybrid chemical lasers.				
(U) MAJOR THRUST: Enhance fundamental understanding of polymer chemical structures, reactivity, molecular engineering, processing controls, and materials technologies to develop advanced organic and matrix composites aimed at improving Air Force systems performance and life spans.		9.488	10.134	12.221
(U) In FY 2007: Utilized nanotechnology to enhance chemical and physical properties of polymers. Exploited photorefractive polymer as a medium for wavefront correction in optical communication and imaging. Explored flexible structures that can provide functions such as sensing, power generation and storage, electronics, and other functionalities for smart skin and multi-functional structures.				
(U) In FY 2008: Explore power generation and power storage for warfighters based on improved polymers for solar cells and fuel cells applications. Continue to explore photonic polymers and conductive polymers for communications and detections. Investigate 3-D displays based on photorefractive polymers. Polymers with controlled dielectric permittivity and magnetic permeability will be explored for advanced radar antenna applications. Control growth mechanisms of carbon single wall nanotubes will be investigated.				
(U) In FY 2009: Continue to exploit nanotechnology to enhance functional and mechanical properties of polymers through controlled dispersion, distribution, and placement of the nano-entities for Air Force applications. Control synthesis of new polymers with improved power generation and storage functions will be explored. Modeling, synthesis, and characterization of conjugated polymers will be conducted to understand and enhance the charge mobility of organic based semi-conducting organics and polymers.				
(U) MAJOR THRUST: Expand the fundamental chemistry and physics of surfaces and interfacial processes pertaining to corrosion protection, wear reduction, and power storage for air and space systems.		6.873	7.414	9.502
(U) In FY 2007: Explored theoretical and predictive methods for the fundamental understanding of the structure and reactivity of surfaces and how surfaces interact with their environment at the interface. Investigated phenomena at surface interfaces, including friction and wear, lubrication, corrosion and degradation, sensing, electrochemical energy storage, and electrochemically induced reaction products and kinetics. Created and characterized novel multi-functional surface structures, coatings, covers, and lubricants. Investigated novel biophysical mechanisms for catalysis and survivability in compact electronic, power, and sensing applications.				
(U) In FY 2008: Develop theoretical and predictive methods for the fundamental understanding of the structure and reactivity of surfaces and how surfaces interact with their environment at the interface. Continue to investigate				

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

01 Basic Research

PE NUMBER AND TITLE

0601102F Defense Research
Sciences

PROJECT NUMBER AND TITLE

2303 Chemistry

(U) **B. Accomplishments/Planned Program (\$ in Millions)**FY 2007FY 2008FY 2009

phenomena at surface interfaces, including friction and wear, lubrication, corrosion and degradation. Explore novel approaches to corrosion prevention, particularly multi-disciplinary efforts that combine corrosion initiation, detection, and lifetime prediction. Continue tribological investigations that focus on bridging the fundamental gap between macro and nano scale mechanisms, including heat transfer, chemical reactivity, and atmospheric effects. Continue to investigate nano-scale surface structures for power applications.

(U) In FY 2009: Continue to develop theoretical and predictive methods for the fundamental understanding of the structure and reactivity of surfaces and how surfaces interact with their environment at the interface. Continue to investigate phenomena at surface interfaces, including friction and wear, lubrication, corrosion and degradation. Explore novel approaches to corrosion prevention, particularly multi-disciplinary efforts that combine corrosion initiation, detection, and lifetime prediction. Continue tribological investigations in nanocomposite lubricants that provide function over a wide variety of extreme environments, including space.

(U) CONGRESSIONAL ADD: New Methods for Designing and Testing Aircraft Coatings.

1.559

0.000

0.000

(U) In FY 2007: Conducted research to explore environmentally friendly and longer-lasting anti-corrosion coatings for aging aircraft.

(U) In FY 2008: Not Applicable.

(U) In FY 2009: Not Applicable.

(U) CONGRESSIONAL ADD: Smart Surfaces and Interfaces

0.975

0.000

0.000

(U) In FY 2007: Conducted research to explore surfaces and interfaces that respond smartly to the surroundings.

(U) In FY 2008: Not Applicable.

(U) In FY 2009: Not Applicable.

(U) CONGRESSIONAL ADD: Fully-Integrated Solar-Powered Interior Lighting Technology.

0.975

1.591

0.000

(U) In FY 2007: Conducted research to integrate solar-energy-generating photovoltaic materials and light-emitting organic materials for self-contained lighting systems for combat locations.

(U) In FY 2008: Continue to conduct research to integrate solar-energy-generating photovoltaic materials and light-emitting organic materials for self-contained lighting systems for combat locations.

(U) In FY 2009: Not Applicable.

(U) Total Cost

33.523

33.562

38.233

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY
01 Basic Research

PE NUMBER AND TITLE
0601102F Defense Research
Sciences

PROJECT NUMBER AND TITLE
2303 Chemistry

(U) **C. Other Program Funding Summary (\$ in Millions)**

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to</u>	<u>Total Cost</u>
	<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Complete</u>	

(U) Related Activities:

(U) PE 0602102F, Materials.

(U) PE 0602203F, Aerospace
Propulsion.

(U) PE 0602500F,
Multi-Disciplinary Space
Technology.

(U) PE 0602601F, Space
Technology.

(U) PE 0602602F, Conventional
Munitions.

(U) **D. Acquisition Strategy**

Not Applicable.

Exhibit R-2a, RDT&E Project Justification

DATE
February 2008

BUDGET ACTIVITY 01 Basic Research				PE NUMBER AND TITLE 0601102F Defense Research Sciences			PROJECT NUMBER AND TITLE 2304 Mathematics and Computing Sciences			
Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total	
2304 Mathematics and Computing Sciences	30.165	24.135	30.586	33.430	36.027	36.373	37.994	Continuing	TBD	
Quantity of RDT&E Articles	0	0	0	0	0	0	0			

Note: In FY 2008, Physical Mathematics efforts in this Project moved to Project 2301 within this PE to more accurately align basic research efforts in Physics.

(U) A. Mission Description and Budget Item Justification

Mathematics and computing sciences basic research develops novel techniques for mathematical modeling and simulation, algorithm development, complex systems control, and innovative analytical and high performance computing methods for air and space systems. Basic research provides fundamental knowledge enabling improved performance and control of systems and subsystems through accurate models and computational tools, artificial intelligence, and improved programming techniques and theories. The primary areas of research investigated by this project are dynamics and control, optimization and discrete mathematics, and computational mathematics.

(U) B. Accomplishments/Planned Program (\$ in Millions)

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) MAJOR THRUST: Perform dynamics and control research to develop innovative techniques for design and analysis of control systems enhancing capabilities and performance of advanced air and space systems. Increasing level of efforts in basic research on complex networks require monetary increases in this major thrust.	9.300	11.928	15.650
(U) In FY 2007: Improved advance techniques for design and analysis of cooperative control systems in dynamic, uncertain, adversarial environments with applications to swarms of smart munitions, UAVs, and constellations of small satellites. Developed control methodologies to improve non-equilibrium behavior of complex, unsteady fluid systems with applications for combustion, materials processing, and agile autonomous flight. Improved image processing and sensor technologies for use in UAV controllers, smart munitions, and non-destructive vehicle testing. Investigated methods for design and analysis of bio-inspired sensing systems, controls, and computational systems. Developed algorithms for control of and over dynamic, large-scale networks.			
(U) In FY 2008: Investigate emerging novel approaches for cooperative control systems in dynamic, uncertain, adversarial environments with applications to swarms of smart munitions, UAVs, and constellations of small satellites. Conduct additional research for teams of micro air vehicles operating at various altitudes in complex environments to execute assigned missions with variable operator intervention. Advance control methodologies and modeling to improve non-equilibrium behavior of complex, unsteady fluid systems with applications for combustion, materials processing, and agile autonomous flight. Continue to advance image processing and sensor technologies for use in UAV controllers, smart munitions, and non-destructive vehicle testing. Advance methods for design and analysis of bio-inspired sensing systems, controls, and computational systems. Continue development of algorithms for control of and over dynamic, large-scale networks. Investigate theory and algorithms for specification, design, verification, and validation of distributed embedded systems. Research potential devices to exploit nonlinear			

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

01 Basic Research

PE NUMBER AND TITLE

0601102F Defense Research
Sciences

PROJECT NUMBER AND TITLE

2304 Mathematics and Computing
Sciences

(U) B. Accomplishments/Planned Program (\$ in Millions)	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
dynamic phenomena with a focus on detection, classification, and control systems for use in urban combat environments.			
(U) In FY 2009: Further develop the design and analysis techniques for cooperative control systems in dynamic, uncertain, adversarial environments with applications to swarms of smart munitions, UAVs, and constellations of small satellites. Continue additional research for teams of micro air vehicles operating at various altitudes in complex environments to execute assigned missions with variable operator intervention. Continue developing control methodologies to improve non-equilibrium behavior of complex, unsteady fluid systems. Continue to advance image processing and sensor technologies for use in UAV controllers, smart munitions, and non-destructive vehicle testing. Develop methods for design and analysis of bio-inspired sensing systems, controls, and computational systems. Continue development of algorithms for control of and over dynamic, large-scale networks. Develop theory and algorithms for specification, design, verification, and validation of distributed embedded systems. Design novel devices to exploit nonlinear dynamic phenomena with a focus on detection, classification, and control systems for use in urban combat environments.			
(U) MAJOR THRUST: Research physical mathematics, applied analysis, and electromagnetics. Note: In FY 2008, efforts previously in this Major Thrust were moved into Project 2301 in this PE to more accurately align basic research efforts in Physics.	9.787	0.000	0.000
(U) In FY 2007: Developed enhanced models of physical phenomena to advance the fidelity of simulations. Investigated properties of coherently propagating ultra-short laser pulses through the atmosphere. Developed algorithms to simulate nonlinear optical effects within fiber lasers and nonlinear optical media. Investigated the dynamics of transonic/supersonic/hypersonic platforms. Studied the design of reconfigurable warheads through suitable placement of micro-detonators. Improved methods for recognizing and tracking targets and for penetrating coverings or other dispersive media that obscure targets.			
(U) In FY 2008: Not Applicable.			
(U) In FY 2009: Not Applicable.			
(U) MAJOR THRUST: Conduct research in optimization, as well as computational and discrete mathematics to validate and further advance mathematical methods, algorithms, and modeling and simulation to solve problems and improve designs of advanced Air Force systems.	11.078	11.213	14.936
(U) In FY 2007: Elucidated complex problems in system diagnostics/prognostics, air mobility contingencies, target tracking, and strategic/tactical planning for battlespace information management. Developed innovative methods and			

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

01 Basic Research

PE NUMBER AND TITLE

0601102F Defense Research
Sciences

PROJECT NUMBER AND TITLE

2304 Mathematics and Computing
Sciences(U) **B. Accomplishments/Planned Program (\$ in Millions)**FY 2007FY 2008FY 2009

algorithms that will improve modeling and simulation capabilities. Integrated new multi-disciplinary design optimization strategies with high-order, time-accurate solutions for superior design of jet engines, directed energy devices, munitions and penetrators, air and space components, and system health and maintenance systems. Developed mathematical method for solving large or complex problems in logistics, air mobility contingencies, target tracking, and strategic/tactical planning for battlespace information management. Enhanced uncertainty analysis in non-linear models of aerodynamic flows and structural failure predictions.

(U) In FY 2008: Continue to develop mathematical methods for solving large and complex problems in logistics, system diagnostics/prognostics, air mobility contingencies, target tracking, and strategic/tactical planning for battlespace information management. Approaches will include both rigorous analytical tools and meta heuristic searches. Continue to develop innovative mathematical and numerical algorithms that will improve modeling and simulation capabilities in order to increase understanding, prediction, and design of large and complex phenomena of interest to the Air Force. These phenomena include aerodynamics for various flight regimes, high power microwaves, material design, and structural mechanics. Continue to develop and integrate new multi-disciplinary design optimization strategies with high-order, time-accurate solutions for superior design of jet engines, directed energy devices, munitions and penetrators, micro air vehicles, air and space components, and system health and maintenance systems. Enhance uncertainty quantification based on rigorous error analysis in non-linear models of aerodynamic flows and structural failure predictions. Develop mathematical models that are dynamically evolving that would deal with operational data that are possibly incomplete, uncertain, conflicting, or overlapping.

(U) In FY 2009: Develop rigorous mathematical methods for solving large and complex problems in logistics, system diagnostics/prognostics, air mobility contingencies, target tracking, and strategic/tactical planning for battlespace information management. Enhance the analytical tool developments in operation research, meta heuristic searches, and robust and stochastic optimization. Focus on developing innovative and accurate mathematical and numerical algorithms that will improve modeling and simulation capabilities. These phenomena include aerodynamics as applicable to a range of flight regimes such as hypersonics and micro air vehicles. Continue to develop and integrate new multi-disciplinary design optimization strategies with high-order, time-accurate solutions for superior design of jet engines, directed energy devices, munitions and penetrators, air and space components, and system health and maintenance systems. Continue to enhance uncertainty analysis in non-linear models of aerodynamic flows and structural failure predictions. Continue to develop mathematical models that are dynamically evolving that would deal with operational data that are possibly incomplete, uncertain, conflicting, or overlapping.

(U)

(U) CONGRESSIONAL ADD: Process Integrated Mechanism for Human-Computer Collaboration and Coordination

0.000

0.994

0.000

R-1 Line Item No. 1

Page-19 of 49

Project 2304

Exhibit R-2a (PE 0601102F)

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY 01 Basic Research	PE NUMBER AND TITLE 0601102F Defense Research Sciences	PROJECT NUMBER AND TITLE 2304 Mathematics and Computing Sciences
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(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) In FY 2007: Not Applicable.			
(U) In FY 2008: Develop a novel technology of a process integrated mechanism, which ties together computers and humans into a single collaborating system by virtue of a single program that rapidly moves between all the computers in the system.			
(U) In FY 2009: Not Applicable.			
(U) Total Cost	30.165	24.135	30.586

(U) <u>C. Other Program Funding Summary (\$ in Millions)</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to</u>	<u>Total Cost</u>
	<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Complete</u>	
(U) Related Activities:									
(U) PE 0602201F, Aerospace Flight Dynamics.									
(U) PE 0602203F, Aerospace Propulsion.									
(U) PE 0602500F, Multi-Disciplinary Space Technology.									
(U) PE 0602602F, Conventional Munitions.									
(U) PE 0602702F, Command, Control, and Communications.									
(U) PE 0603789F, C3I Advanced Development.									
(U) <u>D. Acquisition Strategy</u>									
Not Applicable.									

Exhibit R-2a, RDT&E Project Justification

DATE
February 2008

BUDGET ACTIVITY 01 Basic Research				PE NUMBER AND TITLE 0601102F Defense Research Sciences			PROJECT NUMBER AND TITLE 2305 Electronics		
Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
2305 Electronics	34.245	32.963	39.289	40.943	43.636	43.689	43.502	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

Electronics basic research generates and exploits fundamental knowledge and understanding of novel solid - state electronic, sensor, and optoelectronic materials and device implementation schemes vital to advance Air Force operational capabilities in surveillance, information and signal processing, communications, command and control, electronic countermeasures, stealth technologies, and directed energy weapons. Solid - state electronics research discovers and develops new materials, advances processing and fabrication sciences, and develops and implements advanced physical modeling and simulation capabilities essential to evaluate novel electronic, sensor, and optoelectronic structures and device concept implementation schemes. Research stresses high-risk, far-term, game-changing capability breakthroughs essential for future leaps in warfighter system performance, functionality, reliability, and survivability, while simultaneously reducing component and system power, size, mass, and life cycle costs.

(U) B. Accomplishments/Planned Program (\$ in Millions)

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) MAJOR THRUST: Investigate novel detector and electronic materials, device concepts, and circuit architecture and implementation schemes important to future military space platforms for increased system reliability, survivability, and functionality, while simultaneously reducing component power, size, and mass. Research is focused on high-risk, innovative, and potential-breakthrough materials, devices, and circuit concepts enabling future generation high-sensitivity multi-spectral detection, high-speed and high-throughput data processing, high-density non-volatile data storage, and advanced high-power, broad-band, highly efficient X-W band radar and communications.	7.546	7.785	9.366
(U) In FY 2007: Investigated novel materials for reconfigurable electronics produced from major review of entire program. Researched efforts on wide bandgap gallium nitride materials and devices and transitioned to major Defense Advanced Research Projects Agency (DARPA) program. Linked university nanosatellite projects to key DoD and commercial space interests, and more aggressively sought space launches for the best nanosatellite projects.			
(U) In FY 2008: Investigate novel reconfigurable multi-functional electronic materials that show potential for dynamically tailoring their physical properties via application of one or more 'stimuli', such as electric and/or magnetic fields, optical signals, heat, mechanical stress, chemical processes, etc., with the end objective of precisely tuning their physical properties in response to dynamically changing electronic and/or optoelectronic device, circuit, or system requirements, such as that driven by natural or radiation induced degradation and/or changing mission requirements. Investigate innovative multi-spectral and multi-phenomenology-based detector concepts/approaches utilizing breakthroughs in material electronic bandgap and defect-band tuning concepts, absorption phenomenology-based detection mechanisms, novel material and device functionality, novel hetero-material interfacing and interconnect schemes, and biologically-based detection processes.			

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

01 Basic Research

PE NUMBER AND TITLE

0601102F Defense Research
Sciences

PROJECT NUMBER AND TITLE

2305 Electronics

(U) **B. Accomplishments/Planned Program (\$ in Millions)**FY 2007FY 2008FY 2009

- (U) In FY 2009: Continue investigating novel innovative reconfigurable multi-functional electronic materials, material bandgap and defect-band tuning concepts, phenomenology-based detection mechanisms, novel hetero-material interfacing and interconnect schemes, and novel nanoscience and biologically-based detection processes. Investigate 'smart' reconfigurable materials whose properties can be dynamically tailored via self-programming or system software in response to changing behavior or mission needs. Focus on novel 'programmable pathways' to enable tailoring novel hybrid material systems such as metamorphic and heterogeneous systems.
- (U) MAJOR THRUST: Investigate quantum and optoelectronic materials and devices, memory, and information processing, as well as nano-science for wide-field spectral sensors and critical, high-speed communication systems in order to achieve communications and spectral dominance of the battlespace to include surveillance, target tracking, and target signature identification.
- (U) In FY 2007: Investigated nonlinear optical and laser materials, devices, and fabrication processes for radiation protection, cloaking and tracking, and target signature identification. Explored nanoelectronics, nanophotonics, and other advanced optoelectronic and electronic materials and devices for lower power consumption, high-efficiency lasers wavelength-diverse, high sensitivity detectors. Examined advanced optical memory technologies for enhanced data storage. Investigated technologies for robust monolithic and miniature terahertz frequency spectrum devices and quantum cascade lasers. Investigated communication network technologies, room temperature ferromagnetic materials, and the interaction of system electronics and sensors with atmospheric and space environments.
- (U) In FY 2008: Continue to investigate nonlinear optical and laser materials, devices, and fabrication processes for radiation protection, cloaking and tracking, and target signature identification. Continue to explore nanoelectronics, nanophotonics, spintronics and other advanced optoelectronic and electronic materials and devices for lower power consumption, high-efficiency wavelength-diverse lasers, high sensitivity detectors. Further the examination of advanced optical memory technologies for enhanced data storage, including negative index of refraction metastructures. Investigate technologies for robust monolithic and miniature terahertz frequency spectrum devices and quantum cascade lasers. Continue to investigate communication network technologies, room temperature ferromagnetic materials, and the interaction of system electronics and sensors with atmospheric and space environments.
- (U) In FY 2009: Further investigate nonlinear optical and laser materials, devices, and fabrication processes for radiation protection, cloaking and tracking, and target signature identification. Continue to explore nanoelectronics, nanophotonics, spintronics, multi-functional materials, and other advanced optoelectronic, magnetic, and electronic materials and devices for lower power consumption, high-efficiency wavelength-diverse lasers, high sensitivity

14.450

14.245

15.827

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

01 Basic Research

PE NUMBER AND TITLE

0601102F Defense Research
Sciences

PROJECT NUMBER AND TITLE

2305 Electronics

(U) **B. Accomplishments/Planned Program (\$ in Millions)**FY 2007FY 2008FY 2009

detectors. Further the examination of advanced optical memory technologies for enhanced data storage, including negative index of refraction metastructures and photonic crystals. Investigate technologies for robust monolithic and miniature terahertz frequency spectrum devices and quantum cascade lasers, as well as plasmonics. Continue to investigate communication network technologies, room temperature ferromagnetic materials, and the interaction of system electronics and sensors with atmospheric and space environments.

(U)

(U) MAJOR THRUST: Exploit advances in nanotechnology to support multi-spectral detection technology and chip-scale optical networks.

5.091

5.258

6.839

(U) In FY 2007: Developed techniques to control growth of self-assembled quantum structures and connections to these structures for multi-spectral image processing. Developed nanoelectronics and nanophotonics for guided wave and free space optoelectronic device technology and methods for their integration to enable chip-scale optical networks that will overcome future interconnect problems. Explored nanophotonic concepts for information processing components and systems.

(U) In FY 2008: Further develop and refine techniques to control growth of self-assembled quantum structures and connections to these structures for multi-spectral image processing. Test functionalities of structural materials and improve growth methods. Continue developing nanoelectronics and nanophotonics for guided wave and free space optoelectronic device technology and methods for their integration to enable chip-scale optical networks that will overcome future interconnect problems. Continue exploring nanophotonic concepts for information processing components and systems.

(U) In FY 2009: Exploit controlled growth of self-assembled quantum structures and connections to these structures for multi-spectral image processing. Continue testing functionalities of structural materials and improve growth methods. Continue developing and improving knowledge of nanoelectronics and nanophotonics for guided wave and free space optoelectronic device technology and methods for their integration to enable chip-scale optical networks that will overcome future interconnect problems. Continue exploring nanophotonic concepts for information processing components and systems.

(U)

(U) MAJOR THRUST: Investigate quantum electronic solids phenomena to explore superconducting, magnetic, negative index, and nanoscopic materials to produce superconducting tapes for compact power generators and magnets, and for advanced sensors, communications, lightweight antennas, signal processing, and ultra-dense memory.

5.500

5.675

7.257

(U) In FY 2007: Exploited methodologies to fabricate new high current, high-temperature superconducting materials for

Exhibit R-2a, RDT&E Project Justification	DATE February 2008
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BUDGET ACTIVITY 01 Basic Research	PE NUMBER AND TITLE 0601102F Defense Research Sciences	PROJECT NUMBER AND TITLE 2305 Electronics
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	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u> enhanced power generation and storage devices. Searched for high-temperature superconductors. Developed high-temperature magnetic materials for power devices, switches, and bearings in aircraft electrical systems. Searched for 3-D negative index materials in the infrared and visible regions, and used those materials to make circuit elements with smaller size and increased functionality.			
(U) In FY 2008: Recent success in increasing current-carrying properties of high-temperature superconducting short sections of tape will be exploited to increase those properties in longer lengths and attempts will be made to reduce eddy-current losses. Microwave properties of high-temperature superconductors will receive added emphasis because of recent progress in reducing losses at high frequencies. The goal is to provide thin-film superconducting material that can provide improved radar systems and compact communications systems. The search for practical even higher-temperature superconductors will continue. Efforts to create true 3-D negative index material at frequencies from microwave to infrared and visible will be augmented. The search for higher-temperature, high-energy-product magnetic materials will continue using innovative nanomaterial technology. Using carbon nanotubes and other nanomaterials, new compact architectures will be created to further miniaturize devices for signal processing, memory storage, and sensing.			
(U) In FY 2009: Using improved planar thin-film Josephson-junction technology, a low-noise, wide-bandwidth amplifier will be constructed and tested. Attempts to fabricate high-temperature, high-performance magnetic materials will be given greater emphasis in providing support for the More Electric Airplane and other advanced systems. Studies to reduce eddy-current losses and to prevent quenching in superconducting tapes will be augmented as the tape technology reaches desired goals. Progress in seeking practical negative index materials over a broad range of frequencies will continue. Nanoelectronic circuitry based on nanomaterials and new concepts also will receive added emphasis in attempting to promote miniaturization, greater functionality, and lower losses. Searches for new higher-temperature (and practical) superconductors will continue.			
(U) CONGRESSIONAL ADD: Nanophotonic Components.	1.658	0.000	0.000
(U) In FY 2007: Conducted basic research in nano-materials and nano-manufacturing for military photonic applications.			
(U) In FY 2008: Not Applicable.			
(U) In FY 2009: Not Applicable.			
(U) Total Cost	34.245	32.963	39.289

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY
01 Basic Research

PE NUMBER AND TITLE
0601102F Defense Research
Sciences

PROJECT NUMBER AND TITLE
2305 Electronics

(U) **C. Other Program Funding Summary (\$ in Millions)**

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to</u>	<u>Total Cost</u>
	<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Complete</u>	

(U) Related Activities:

(U) PE 0602204F, Aerospace
Sensors.

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

(U) PE 0603203F, Advanced
Aerospace Sensors.

(U) PE 0603789F, C3I Advanced
Development.

(U) **D. Acquisition Strategy**

Not Applicable.

Exhibit R-2a, RDT&E Project Justification

DATE
February 2008

BUDGET ACTIVITY 01 Basic Research				PE NUMBER AND TITLE 0601102F Defense Research Sciences			PROJECT NUMBER AND TITLE 2306 Materials		
Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
2306 Materials	39.054	37.436	25.681	25.118	26.659	27.335	27.633	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

- (U) **A. Mission Description and Budget Item Justification**
 Materials basic research enhances the performance, cost, and reliability of structural materials to eliminate reliability issues related to high-temperature strength, toughness, fatigue, and environmental conditions. This research expands fundamental knowledge of material properties that leads to the development of novel materials for airframe, turbine engine, and spacecraft structures. The goals of this project are to develop improved materials for air and space vehicles that provide increased structural efficiency and reliability, increase the operating temperature of engine materials, and further increase thrust-to-weight ratio of engines. A primary research focus is on refractory alloys, intermetallics, polymer composites, metal and ceramic matrix composites, advanced ceramics, and new material processing methods. The primary areas investigated by this project are ceramics, non-metallic hybrid composites, and metallic materials.
- | | | | |
|---|----------------|----------------|----------------|
| (U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u> | <u>FY 2007</u> | <u>FY 2008</u> | <u>FY 2009</u> |
| (U) MAJOR THRUST: Perform non-metallic, ceramic, and hybrid materials research to identify and to design new materials and composites with very-high (>1400F) and ultra-high (>2500F) temperature applications. Create inorganic matrix composites, functional materials (including adhesives/epoxies), and hybrid carbon materials to increase the strength, application, and life span of air and space structural materials. | 9.266 | 9.481 | 12.351 |
- (U) In FY 2007: Optimized the thermal and mechanical stability of oxide ceramic composites for aircraft and engine applications. Exploited new approaches to designing multi-functional structural ceramics materials to enable structurally enhanced smart systems for application in extreme environments. Investigated high-temperature resistant and joining methodologies for lightweight ceramic materials. Examined innovative concepts for developing higher temperature and more damage-tolerant organic, inorganic, and polymer matrix composites. Developed nanomaterials and nanocomposites that will enable reduced system weight and/or size, increased operational lifetime, and multi-functional performance of load-bearing aerospace structures.
- (U) In FY 2008: Continue to optimize the design of multi-functional structural ceramics materials to enable structurally enhanced smart systems for application in extreme environments. Exploit new approaches in improving the thermal and mechanical stability of oxide ceramic composites for aircraft and engine applications. Further develop high-temperature resistant and joining methodologies for lightweight ceramic materials. Continue to develop innovative concepts for developing higher temperature and more damage-tolerant organic, inorganic, and polymer matrix composites. Continue to develop the fundamental knowledge base to exploit the use of nanomaterials and nanocomposites in aerospace structures.
- (U) In FY 2009: Continue optimizing the design of multi-functional structural ceramics materials to enable structurally enhanced smart systems for application in extreme environments. Expand the development of new approaches in

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

01 Basic Research

PE NUMBER AND TITLE

0601102F Defense Research
Sciences

PROJECT NUMBER AND TITLE

2306 Materials

(U) B. Accomplishments/Planned Program (\$ in Millions)	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
<p>improving the thermal and mechanical stability of oxide ceramic composites for aircraft and engine applications. Continue to further develop high-temperature resistant and joining methodologies for lightweight ceramic materials. Expand the development of innovative concepts for developing higher temperature and more damage-tolerant organic, inorganic, and polymer matrix composites. Continue to expand the development of the fundamental knowledge base to exploit the use of nanomaterials and nanocomposites in aerospace structures.</p>			
(U) MAJOR THRUST: Research metallic materials and identify relationships between structures (including microstructures), processing, properties, and performance so as to develop affordable and durable metallic systems for advanced engines and aerospace structural applications.	10.288	10.460	13.330
(U) In FY 2007: Investigated lightweight structural materials, refractory metals, intermetallic alloys, amorphous alloys and their composites, and micro-laminated materials for sustainable use in aerospace applications. Developed and verified physics-based, quantitative, predictive models that relate processing, chemistry, and structure with properties and performance of metallic materials.			
(U) In FY 2008: Continue investigating metallic materials for sustainable use in structural applications and advanced engines. Investigate nano-laminates and nano-composites for aerospace armor and small air vehicle structures. Explore the interaction between chemistry and mechanics in surfaces and interfaces of these nanoscale structures. Explore the processing and development of multifunctional structural metals for power systems and space applications. Capitalize on advances in multi-scale modeling to study the response of aerospace alloys exposed to corrosive environments and cyclical loading. Develop an informatics process exploiting disparate sources of materials' properties data derived from modeling and experimentation. Explore the fundamental science of friction and thermal effects during friction stir processing.			
(U) In FY 2009: Further investigate nano-laminates and nano-composites for aerospace armor and small air vehicle structures. Explore the interaction between chemistry and mechanics in the surfaces and interfaces of these nanoscale structures. Further explore the processing and development of multifunctional structural metals for power systems and space applications. Further develop and verify multi-scale models to study the response of aerospace alloys exposed to corrosive environments and cyclical loading. Continue development of an informatics process to exploit disparate sources of materials' properties data derived from modeling and experimentation. Continue research on the fundamental science of friction and thermal effects during friction stir processing. Investigate affordable and environmentally sustainable methods to process aerospace alloys.			
(U) CONGRESSIONAL ADD: National Aerospace Leadership Initiative.	19.500	15.904	0.000

R-1 Line Item No. 1

Page-27 of 49

Project 2306

Exhibit R-2a (PE 0601102F)

Exhibit R-2a, RDT&E Project Justification

DATE
February 2008

BUDGET ACTIVITY 01 Basic Research	PE NUMBER AND TITLE 0601102F Defense Research Sciences	PROJECT NUMBER AND TITLE 2306 Materials
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(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) In FY 2007: Supported aerospace R&D, fortified U.S.-based manufacturing supply chain, and strengthen aerospace equipment manufacturers' R&D.			
(U) In FY 2008: Continue to support aerospace R&D, fortif U.S.-based manufacturing supply chain, and strengthened aerospace equipment manufacturers' R&D.			
(U) In FY 2009: Not Applicable.			
(U) CONGRESSIONAL ADD: Hybrid Materials for Thermal Management in Thin Films and Bulk Composites.	0.000	1.591	0.000
(U) In FY 2007: Not Applicable.			
(U) In FY 2008: Conduct research to develop advanced aeronautical structural members, sheathing, and coatings having longer service life.			
(U) In FY 2009: Not Applicable.			
(U) Total Cost	39.054	37.436	25.681

(U) <u>C. Other Program Funding Summary (\$ in Millions)</u>	<u>FY 2007</u> <u>Actual</u>	<u>FY 2008</u> <u>Estimate</u>	<u>FY 2009</u> <u>Estimate</u>	<u>FY 2010</u> <u>Estimate</u>	<u>FY 2011</u> <u>Estimate</u>	<u>FY 2012</u> <u>Estimate</u>	<u>FY 2013</u> <u>Estimate</u>	<u>Cost to</u> <u>Complete</u>	<u>Total Cost</u>
(U) Related Activities:									
(U) PE 0602102F, Materials.									
(U) PE 0602201F, Aerospace Flight Dynamics.									
(U) PE 0602203F, Aerospace Propulsion.									
(U) PE 0602500F, Multi-Disciplinary Space Technology.									
(U) PE 0602601F, Space Technology.									
(U) PE 0603211F, Aerospace Structures.									
(U) PE 0708011F, Industrial Preparedness.									

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

01 Basic Research

PE NUMBER AND TITLE

0601102F Defense Research
Sciences

PROJECT NUMBER AND TITLE

2306 Materials

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification

DATE
February 2008

BUDGET ACTIVITY 01 Basic Research				PE NUMBER AND TITLE 0601102F Defense Research Sciences			PROJECT NUMBER AND TITLE 2307 Fluid Mechanics		
Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
2307 Fluid Mechanics	13.576	14.366	18.486	20.812	22.467	23.080	23.199	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

Fluid mechanics basic research advances fundamental knowledge, tools, data, concepts, and methods for improving the efficiency, effectiveness, and reliability of air and space vehicles. The goals are to improve theoretical models for aerodynamic prediction and design, as well as to originate flow control concepts and predictive methods used to expand current flight performance boundaries through enhanced understanding of key fluid flow (primarily high-speed air) phenomena. Basic research emphasis is on turbulence prediction and control, unsteady and separated flows, subsonic/supersonic/hypersonic flows, and internal fluid dynamics. The primary approach is to perform fundamental experimental investigations and to formulate advanced computational methods for the simulation and study of complex flows, prediction of real gas effects in high-speed flight, and control and prediction of turbulence in flight vehicles and propulsion systems. Primary areas of research investigated by this project are unsteady aerodynamics, supersonic and hypersonic aerodynamics, turbulence, and rotating and internal flows characteristic of turbomachinery flows.

(U) B. Accomplishments/Planned Program (\$ in Millions)

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) MAJOR THRUST: Investigate and characterize complex phenomena in supersonic, hypersonic, boundary layers, and turbulent flows to enable and optimize the design of air and space vehicles and flight control systems.	5.285	5.492	8.744
(U) In FY 2007: Characterized and modeled critical phenomena required to predict and control unsteady, vortex-dominated flows and to develop rapid maneuver controls on UAVs. Validated current models and explored higher-fidelity models for unsteady aerodynamics of complex, hypersonic flows to include boundary layer effects, shock-dominated flows (engine inlets), and nonequilibrium effects. Developed control strategy models for mitigating excessive heat transfer and unsteadiness in hypersonic flows and for abating the effects of highly separated flows.			
(U) In FY 2008: Characterize and model fundamental phenomena of 3-D high-speed boundary layers to facilitate prediction and control of laminar-turbulent transition and the onset of severe heating rates in high-speed systems. Extend applicability and capability to handle complex flows of high-fidelity, unsteady numerical models for shock-dominated flows, and nonequilibrium effects. Continue development of control strategy models for mitigating excessive heat transfer and unsteadiness in hypersonic flows and for abating the effects of highly separated flows.			
(U) In FY 2009: Extend efforts to characterize and model fundamental phenomena of high-speed boundary laminar-turbulent transition to include interactions between multiple instability modes. Validate high-fidelity, unsteady numerical simulation methodologies for shock-dominated flows and nonequilibrium effects. Extend strategies for control of excessive heat transfer, unsteadiness, and separation in hypersonic flows to reduce severe local loads on systems. Explore interactions between severe phenomena in aerothermodynamic environment and high-temperature vehicle materials with the goal of reducing thermal protection system complexity and increasing			

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

01 Basic Research

PE NUMBER AND TITLE

0601102F Defense Research
Sciences

PROJECT NUMBER AND TITLE

2307 Fluid Mechanics

(U) B. Accomplishments/Planned Program (\$ in Millions)	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
performance to improve reusability, sustainability, efficiency, and turn time of hypersonic and space-access vehicles.			
(U)			
(U) MAJOR THRUST: Expand fundamental knowledge of unsteady flows in integrated theoretical, experimental, and computational efforts. Study complex rotating and internal flow phenomena related to turbomachinery and jet engine applications with an emphasis on flow control approaches.	6.342	6.489	9.742
(U) In FY 2007: Evaluated advanced flow control coupling mechanisms in complex, turbulent flows, including transient phenomena and time accurate simulation techniques. Evaluated reduced order, closed-loop flow control mechanisms on unsteady flow of complex geometries and jet engines. Developed large eddy simulation techniques to include heat transfer and fluid flow coupling in preliminary simulations of film cooling flows. Evaluated hybrid computational techniques for accurately modeling turbulent flows. Evaluated coupling between aerodynamic and structural mistuning mechanisms in multiple blade row interactions tied to high cycle fatigue failures. Developed predictive tools for unsteady flow control approaches using sensors and actuators for harsh environments.			
(U) In FY 2008: Further develop reduced order, closed-loop flow control mechanisms on unsteady flows of complex geometries and jet engines. Investigate new applications of flow control techniques to improve jet engine integration and efficiency for a wider range of flight operating conditions. Develop tools for predicting and controlling unsteady, vortex-dominated flows on unmanned aerial vehicles (UAVs). Explore and develop innovative techniques for improving convective heat transfer at all flow scales to enhance thermal management of subsonic and supersonic flight systems.			
(U) In FY 2009: Continue to develop reduced order, closed-loop flow control mechanisms on unsteady flows of complex geometries and jet engines and identify specific applications to transition technology. Characterize and model promising applications of flow control techniques to improve jet engine integration and efficiency for a wider range of flight operating conditions. Validate tools for predicting and controlling unsteady, vortex-dominated flows on UAVs. Continue to develop innovative techniques for improving convective heat transfer at all flow scales to enhance thermal management of subsonic and supersonic flight systems.			
(U)			
(U) CONGRESSIONAL ADD: Development and Validation of Advanced Design Technologies for Hypersonic Research (National Hypersonic Research Center)	1.949	2.385	0.000
(U) In FY 2007: Conducted research on experimental and numerical simulation to characterize and develop predictive numerical methods for physical phenomena associated with hypersonics.			
(U) In FY 2008: Continue research on experimental and numerical simulation to characterize and develop predictive numerical methods for physical phenomena associated with hypersonics.			

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY 01 Basic Research	PE NUMBER AND TITLE 0601102F Defense Research Sciences	PROJECT NUMBER AND TITLE 2307 Fluid Mechanics
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(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) In FY 2009: Not Applicable.			
(U)			
(U) Total Cost	13.576	14.366	18.486

(U) <u>C. Other Program Funding Summary (\$ in Millions)</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to</u>	<u>Total Cost</u>
	<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Complete</u>	
(U) Related Activities:									
(U) PE 0602102F, Materials.									
(U) PE 0602201F, Aerospace Flight Dynamics.									
(U) PE 0602203F, Aerospace Propulsion.									
(U) PE 0603211F, Aerospace Structures.									
(U) <u>D. Acquisition Strategy</u>									
Not Applicable.									

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY 01 Basic Research				PE NUMBER AND TITLE 0601102F Defense Research Sciences			PROJECT NUMBER AND TITLE 2308 Propulsion		
Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
2308 Propulsion	20.499	21.144	25.432	25.732	26.956	27.431	27.847	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

Propulsion basic research expounds fundamental knowledge to enable and enhance efficient utilization of energy in airbreathing engines, chemical and non-chemical rockets, and combined cycle propulsion systems for future rapid global reach and on-demand space access. Basic Research thrusts include airbreathing propulsion, space power and propulsion, high altitude signature characterization and contamination, propulsion diagnostics, thermal management of space-based power and propulsion, and the synthesis of new chemical propellants. These thrusts can be grouped into reacting flows and non-chemical energetics. Study of reacting flows involves the complex coupling between energy release through chemical reaction and the flow processes that transport chemical reactants, products, and energy. Non-chemical energetics research includes both plasma and beamed-energy propulsion for orbit-raising space missions and ultra-high energy techniques for space-based energy utilization. Primary areas of research investigated by this project are space power, propulsion, combustion, and diagnostics.

(U) B. Accomplishments/Planned Program (\$ in Millions)

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) MAJOR THRUST: Research and model space propulsion and power in the areas of chemistry, electronics, miniaturization, and contamination/signature.	8.786	9.054	11.695
(U) In FY 2007: Conducted research on plasma-based, charged droplet based, and beamed-energy thrusters. Investigated pulsed detonation rocket engines and other new engine concepts. Examined methods to predict and suppress combustion instabilities. Investigated high altitude plumes signature and contamination. Investigated magnetohydrodynamic (MHD) flow control to optimize scramjet flow path performance. Investigated lightweight superconducting magnet capability for MHD flow control of advanced engines.			
(U) In FY 2008: Conduct studies of small satellite, microsatellite, and nanosatellite propulsion and investigate plasma dynamics in these thrusters. Evaluate methods to predict and suppress combustion instabilities under supercritical conditions, and develop research models that can be incorporated into the design codes. Develop novel diagnostic techniques for characterization of combustion instabilities in high pressure, harsh, optically thick environments. Continue to investigate high altitude plumes signature and contamination. Investigate alternate launch systems using electromagnetic forces as a rail-gun or coil-gun. Conduct research to enable revolutionary designs of satellite systems that can achieve the simultaneous objectives of increasing payload and/or time in orbit and increasing mission flexibility and scope.			
(U) In FY 2009: Continue studies of small satellite, microsatellite, and nanosatellite propulsion and investigate plasma dynamics in these thrusters. Continue to investigate high altitude plumes signature and contamination. Continue investigating alternate launch systems using electromagnetic forces. Conduct fundamental component and system level research that leads to the introduction of novel multi-use technologies and concepts in order to achieve			

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

01 Basic Research

PE NUMBER AND TITLE

0601102F Defense Research
Sciences

PROJECT NUMBER AND TITLE

2308 Propulsion

(U) B. Accomplishments/Planned Program (\$ in Millions)	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
multi-functional satellite architectures and the development of highly efficient power generation/recovery systems (e.g., micro electro-mechanical turbines and nano-structured thermoelectric units) deeply integrated with thermal management or spacecraft structure. Enhance novel diagnostic techniques for characterization of combustion instabilities in high pressure, harsh, optically thick environments.			
(U) MAJOR THRUST: Explore combustion, propulsion, and diagnostics in subsonics, supersonics, and hypersonics. Investigate multi-phase, turbulent reacting flows to improve the performance of propulsion systems, including gas turbines, ramjets, scramjets, pulsed detonation engines, and rockets. Starting in FY 2008, conduct basic research in support of a higher Air Force priority Energy Conservation -Assured Fuels Initiative to identify and develop technologies that enable the use of domestic fuel sources for military energy needs.	8.886	11.096	13.737
(U) In FY 2007: Improved laser diagnostic measurement capabilities in the characterization of turbulent reacting flows. Investigated molecular transport effects causing and enhancing thermal destabilization of hydrocarbon fuels under supercritical thermodynamic conditions. Incorporated prediction methodologies, which are both quantitatively accurate and computationally tractable, into turbulent combustion models. Enhanced scientific bases for how plasmas are used to improve aerodynamic characteristics and propulsive efficiencies. Investigated fuels and propellants that are more energetic, environmentally benign, and less sensitive to accidental detonations. Formulated strategies for using alternate hydrocarbon fuels based on the incorporation of detailed chemistry models into large eddy simulations.			
(U) In FY 2008: Continue improving laser diagnostic measurement capabilities, investigations of molecular transport effects causing and enhancing thermal destabilization of hydrocarbon fuels under supercritical thermodynamic conditions, and prediction methodologies, which are both quantitatively accurate and computationally tractable, for turbulent combustion models. Further enhance scientific bases for how plasmas are used to improve aerodynamic characteristics and propulsive efficiencies. Expand strategies for using alternate hydrocarbon fuels based on the incorporation of detailed chemistry and transport models through surrogate fuel representations. Conduct research to provide fuel-flexible energy conversion technology in support of the Energy Conservation-Assured Fuels Initiative.			
(U) In FY 2009: Continue improving laser diagnostic measurement capabilities, investigations of molecular transport effects causing and enhancing thermal destabilization of hydrocarbon fuels under supercritical thermodynamic conditions, and prediction methodologies, which are both quantitatively accurate and computationally tractable, for turbulent combustion models. Continue exploring the scientific bases for how plasmas are used to improve aerodynamic characteristics and propulsive efficiencies. Exploit strategies for using alternate hydrocarbon fuels by inserting reduced fuel representations into comprehensive combustion models such as large eddy simulations. In			

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY 01 Basic Research	PE NUMBER AND TITLE 0601102F Defense Research Sciences	PROJECT NUMBER AND TITLE 2308 Propulsion
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(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
support of the Energy Conservation-Assured Fuels Initiative, identify surrogate fuels that will represent the behavior of current and future alternative fuels through chemically simplified chemical compounds that retain the energy conversion characteristics of the base fuels.			
(U) CONGRESSIONAL ADD: Coal-Based Jet Fuels.	2.827	0.000	0.000
(U) In FY 2007: Conducted research to produce coal-based jet fuels. Assess military utility and suitability of this fuel.			
(U) In FY 2008: Not Applicable.			
(U) In FY 2009: Not Applicable.			
(U) CONGRESSIONAL ADD: Coal Transformation Laboratory.	0.000	0.994	0.000
(U) In FY 2007: Not Applicable.			
(U) In FY 2008: Conducted research to produce domestic sources of biofuels and coal-based fuels.			
(U) In FY 2009: Not Applicable.			
(U) Total Cost	20.499	21.144	25.432

(U) <u>C. Other Program Funding Summary (\$ in Millions)</u>	<u>FY 2007</u> <u>Actual</u>	<u>FY 2008</u> <u>Estimate</u>	<u>FY 2009</u> <u>Estimate</u>	<u>FY 2010</u> <u>Estimate</u>	<u>FY 2011</u> <u>Estimate</u>	<u>FY 2012</u> <u>Estimate</u>	<u>FY 2013</u> <u>Estimate</u>	<u>Cost to</u> <u>Complete</u>	<u>Total Cost</u>
(U) Related Activities:									
(U) PE 0602102F, Materials.									
(U) PE 0602203F, Aerospace Propulsion.									
(U) PE 0602500F, Multi-Disciplinary Space Technology.									
(U) PE 0602601F, Space Technology.									
(U) PE 0603211F, Aerospace Structures.									
(U) <u>D. Acquisition Strategy</u>									
Not Applicable.									

Exhibit R-2a, RDT&E Project Justification

DATE
February 2008

BUDGET ACTIVITY 01 Basic Research				PE NUMBER AND TITLE 0601102F Defense Research Sciences			PROJECT NUMBER AND TITLE 2311 Information Sciences		
Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
2311 Information Sciences	26.008	25.257	31.640	32.512	36.241	38.062	39.045	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

Note: In FY 2007, this project is renamed from "Space and Information Sciences" to "Information Sciences." In FY 2008, Space Environment efforts were moved to Project 2301 in this PE to more accurately align basic research efforts in Physics.

(U) A. Mission Description and Budget Item Justification

Information sciences basic research generates fundamental knowledge and understanding to support critical Air Force capabilities in information superiority, precision targeting (or strike), and improved battlespace awareness. Areas of research focus are (1) access to disparate data and information, (2) information fusion and distribution, and (3) conversion of information into knowledge to support decision making. The data, fusion engines, and command and control functions reside on interlocking systems connected by networks leading to a system of systems architecture. Areas of research underpinning these team-focused, network-enabled systems are those in networks and communications, software, information management, and human-system interactions. Complementing these overall focus areas, research is occurring in the following areas: information operations network, software, and system architectures; information fusion; information forensics; communications and signals and control of large systems.

(U) B. Accomplishments/Planned Program (\$ in Millions)

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) MAJOR THRUST: Research space environment to improve solar plasma theories and modeling in the areas of solar phenomena, space weather, magneto/ionosphere effects, space debris, adaptive optics for improved space observation, better space-based communications, and the quantifying of risks to space systems. Note: In FY 2008, efforts previously in this Major Thrust were moved into Project 2301 in this PE to more accurately align basic research efforts in Physics.	8.893	0.000	0.000
(U) In FY 2007: Expanded development of ground-based optical telescope technologies (i.e., adaptive optics, photon detection, spectral resolution, nanotechnology, and advanced signal-processing algorithms) to include radio telescopes. Developed space-based sensor technology. Explored the solar interior as a complex system through advanced modeling techniques. Explored advanced modeling algorithms to take advantage of increased computer power and speed, and to seek improved plasma models to enhance understanding of basic plasma theory. Developed understanding of fundamental processes of energetic particle scattering in the near-Earth environment to support protection of space assets. Investigated solar processes and energetic events, the solar wind, and fundamental processes in the magnetosphere, ionosphere, and thermosphere. Searched for understanding of fundamental processes controlling space plasma to improve ability to forecast near-Earth space environment. Analyzed data from DoD surveillance and the Communications/Navigation Outage Forecasting System-Solar Mass Ejection Imager (C/NOFS-SMEI) satellites to improve remote sensing of interplanetary space. Initiated research to investigate the neutral winds above 150 kilometers. Employed all-sky imaging to study of ionospheric plasma phenomena and			

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

01 Basic Research

PE NUMBER AND TITLE

0601102F Defense Research
Sciences

PROJECT NUMBER AND TITLE

2311 Information Sciences

(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
develop techniques to quantify these observations.			
(U) In FY 2008: Not Applicable.			
(U) In FY 2009: Not Applicable.			
(U)			
(U) MAJOR THRUST: Explore basic mechanisms to realize gains in innovative transformational communications technologies, thereby enabling the Air Force to enhance its dominance communications using the space medium.	0.993	0.994	1.000
(U) In FY 2007: Investigated innovative methods for optical communications such as partial coherence, polarization modulation, and liquid crystal spatial modification techniques. Explored the basic mechanisms of dual polarization antennas for space applications.			
(U) In FY 2008: Refine the details of the investigation that partially coherent laser beams are less disturbed by passage through turbulent atmospheres than their classically coherent counterparts. Pursue the design of solid state lasers which can emit such partially coherent beams. Continue to investigate the possibility that the long distance stability of polarization states can be exploited to communicate digitized messages.			
(U) In FY 2009: Continue to study and refine results of selected solid state partially coherent laser designs together with the propagation of partially coherent laser beams through surrogate turbulent media. Monitor the polarization states to verify the predicted long distance stability.			
(U)			
(U) MAJOR THRUST: Investigate signal communications, surveillance, and targeting for increased awareness and improved command and control for the battlefield commander. Efforts include research in linear operator theory, generalized functions and probability, harmonic methods, and asymptotic expansions.	4.667	5.378	7.055
(U) In FY 2007: Explored data fusion science to enable rapid data conversion across multiple bands into graphical and conceptualized information. Studied methodologies for evaluating the performance of new wireless mobile, networked communications systems. Studied and assessed technical alternatives for feasibility of super-resolution millimeter and search and rescue imagery. Investigated the hybrid radio-frequency/free-space optical paradigm and refined the parameters of other innovative technologies to attain ultra-fast, reliable information exchange. Developed ultra-wide band transmission technology for hyperspectral and other diverse data.			
(U) In FY 2008: Focus on integrating results in distributed navigation, geo-location, and interactive telemetry to improve the collecting and interpreting of battlespace information, with emphasis placed on dealing with diverse, changing warfare scenarios. Continue to study methodologies for evaluating the performance of new wireless mobile, networked communications systems. Continue study and assessment of technical alternatives for feasibility of super-resolution millimeter and search and rescue imagery. Continue to investigate the hybrid			

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

01 Basic Research

PE NUMBER AND TITLE

0601102F Defense Research
Sciences

PROJECT NUMBER AND TITLE

2311 Information Sciences

(U) **B. Accomplishments/Planned Program (\$ in Millions)**FY 2007FY 2008FY 2009

radio-frequency/free-space optical paradigm and refine the parameters of other innovative technologies to attain ultra-fast, reliable information exchange.

- (U) In FY 2009: Study navigation approaches such as "optical flow field" to improve understanding of the foundation for over-arching methodologies that integrate sensing data collected by distributed, inter-communicating networks of sensor resources. Continue to develop ultra-wide band transmission technology for hyper-spectral and other diverse data. Continue to study methodologies for evaluating the performance of new wireless mobile, networked communications systems. Continue study and assessment of technical alternatives for feasibility of super-resolution millimeter and search and rescue imagery.

(U)

- (U) MAJOR THRUST: Conduct research in complex systems and algorithms for highly flexible, reliable, secure, and rich information systems supporting battlefield commanders using artificial intelligence, information warfare techniques, intelligent agents, knowledge bases, distributed systems, machine learning, uncertainty reasoning, and information fusion.

11.455

18.885

23.585

- (U) In FY 2007: Developed information operations science techniques to exploit information intensive systems and networks. Developed information fusion science to provide deep, adaptive, expert decision support. Exploited quantum and bio-computing techniques and algorithms to allow enhanced tracking, recognition, and characterization to improve situational awareness, command and control, and security. Investigated first principles of software system architectures including characteristic property metrics and begin development of automatic software architecture analysis tools.

- (U) In FY 2008: Significantly increase investigation of first principles of software system, network, and information system architectures including characteristic properties and metrics, and begin development of automatic software architecture analysis tools. Add research on brilliant software agents and other techniques for information operations, knowledge mining, and to improve situational awareness and command and control. Continue evolving information operations science techniques to exploit information intensive systems and networks. Further develop information fusion science to provide deep, adaptive, expert decision support.

- (U) In FY 2009: Continue to increase emphasis on investigating first principles of software system architectures including characteristic properties and metrics, and begin development of automatic software architecture analysis tools. Continue research on brilliant software agents and other techniques for information operations, knowledge mining, and to improve situational awareness and command and control. Continue to develop information operations science techniques to exploit information intensive systems and networks. Continue developing information fusion science to provide deep, adaptive, expert decision support.

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY 01 Basic Research	PE NUMBER AND TITLE 0601102F Defense Research Sciences	PROJECT NUMBER AND TITLE 2311 Information Sciences
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(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U)	0.000	0.000	0.000
(U) Total Cost	26.008	25.257	31.640

(U) <u>C. Other Program Funding Summary (\$ in Millions)</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to</u>	<u>Total Cost</u>
	<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Complete</u>	
(U) Related Activities:									
(U) PE 0602500F, Multi-Disciplinary Space Technology.									
(U) PE 0602601F, Space Technology.									
(U) PE 0602702F, Command, Control, and Communications.									
(U) PE 0603410F, Space System Environmental Interactions Technology.									
(U) PE 0603500F, Multi-Disciplinary Advanced Development Space Technology.									
(U) <u>D. Acquisition Strategy</u>									
Not Applicable.									

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY		PE NUMBER AND TITLE					PROJECT NUMBER AND TITLE			
01 Basic Research		0601102F Defense Research Sciences					2312 Biological Sciences			
Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total	
2312 Biological Sciences	9.682	10.332	10.473	10.601	10.444	10.230	10.120	Continuing	TBD	
Quantity of RDT&E Articles	0	0	0	0	0	0	0			

(U) **A. Mission Description and Budget Item Justification**

Biological basic science research provides the fundamental knowledge necessary to understand and enable technologies associated with selected biological responses induced by chemical and physical agents, electromagnetic sensors based on biomimicry, biomolecular materials, biochromatics, and luminescence. The goal is to exploit biological properties to control and manipulate operational environments. Research topics are focused on the interactions of chemicals and physical agents (lasers and microwaves) with human tissues and associated effects to enable safety assessment strategies, hazard-free development and use of future air and space materials and directed energy systems, and innovation of biotechnologies to enhance the physiological performance and protection of Air Force personnel. Research in biomimetic sensors strives to mimic the biological detection systems of organisms at the molecular level in developing novel man-made sensors. Basic research in biocatalysis characterizes and bioengineers cellular enzymes to biosynthesize renewable hydrogen fuel from sunlight and water. Research in biomaterials focuses on the mimicking of natural materials, using organisms as biomaterial factories of new materials, genetically altering existing organisms for new materials capabilities, or taking existing biomaterials/organisms and using them as novel materials like viral gradients or processing them further to make a useful material as in biomineralization. Research in biointerfacial science is focused on new biosensors and bionanotechnology, and specifically addresses the fundamental science at either the biotic-biotic or the biotic-abiotic interface. Research in biophysical mechanisms will look to discover and understand basic biological mechanisms that could be used to either harden or repair bio-based devices or utilize complex, impure biofuels for compact power.

(U) **B. Accomplishments/Planned Program (\$ in Millions)**

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) MAJOR THRUST: Characterize, understand, predict, control, and engineer biomolecular responses induced in organisms by chemical and physical agents of Air Force significance, such as alternate synthetic jet fuels, nano-energetic materials, and directed energy. Identify, characterize, and engineer novel enzymatic properties that enable photosynthetic microbes to use light energy for the renewable generation of hydrogen fuel from water. Explore biomolecular profiles and hormetic mechanisms involved in the positive stimulatory (rather than the negative inhibitory) biological responses induced by low-doses of toxic agents and investigate the implications of such low-dose positive stimulation in inducing a protective state in tissue that is resistant to subsequent high-dose toxicity.	5.534	5.836	5.906
(U) In FY 2007: Validated biokinetics models used to predict the fuel constituent levels in tissues following dermal and pulmonary exposures to fuel mixtures. Applied methodologies for profiling and modeling the biomolecular responses induced by the interactions of directed energy and nano-energetic materials with biological systems. Utilized biocatalysis techniques and genetic engineering principles to elicit the water-based generation of fuel-cell hydrogen by photosynthetic microbes. Investigated the biomolecular profiles for underlying mechanisms associated with positive stimulatory or "hormetic" responses of biological systems exposed to very low-levels of known toxic			

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

01 Basic Research

PE NUMBER AND TITLE

0601102F Defense Research
Sciences

PROJECT NUMBER AND TITLE

2312 Biological Sciences

(U) **B. Accomplishments/Planned Program (\$ in Millions)**FY 2007FY 2008FY 2009

substances and hazardous radiation.

(U) In FY 2008: Refine whole animal biokinetic models predicting tissue disposition of fuel components based on iterative experimental input derived from laboratory animal exposures and analyses. Begin to apply newly developed methodologies to acquire in vitro and in vivo data from biological systems exposed to nano-scale structures possessing varying physical and chemical properties. By using recently improved methodologies, begin the molecular profiling and characterization of biological systems responding to high and low doses of directed energy generated from laser and microwave sources. Continue bio-prospecting for hydrogen-generating microbes and begin bio-engineering and directed-evolution experiments aimed at enhancing the photosynthetic flow of electrons and protons to the hydrogen-generating enzyme. Continue to utilize state-of-the-art tools and techniques to explore, collect, and analyze data with regard to low-dose chemical and radiation exposure effects and the molecular pathways and profiles mediating the responses to the exposures.

(U) In FY 2009: Begin to integrate individual computational models characterizing multi-component fuel deposition in lung and absorption through skin into animal biokinetic models for predicting whole animal disposition of single fuel components. Continue to collect data from biological systems exposed to nano-materials and begin to develop a data base of responses for future predictive modeling studies based on physico-chemical properties of various nanostructures. Continue collecting directed energy dose-response data and begin bioinformatics analyses to identify unique biomolecular profiles responding to specific levels of radiant exposure. Continue bio-prospecting, bio-engineering, and directed-evolution approaches to the generation of hydrogen fuel by photosynthetic microbes and begin metabolic engineering research to identify and eliminate pathways that drain unnecessary energy equivalents away from the hydrogen-generating apparatus. Continue utilizing state-of-the-art tools and techniques to explore, collect, and analyze data with regard to low-dose chemical and radiation exposure effects and the molecular pathways and profiles mediating the responses to the exposures.

(U)

(U) MAJOR THRUST: Explore biomimetics, biomaterials, and biointerfacial sciences to enable development of novel sensors, engineering processes, and mechanisms, and the synthesis of novel materials, as well as to research new sensor modalities, explore surface-mediated process, and delve into extreme environmental conditions. Research in biophysical mechanisms will look to discover and understand basic biological mechanisms that could be used to either harden or repair bio-based devices or can utilize complex, impure biofuels for compact power.

4.148

4.496

4.567

(U) In FY 2007: Investigated, evaluated, modeled, and mimicked biological processes and designs for future applications in near-ambient temperature sensing devices, and added predator avoidance and new prey detection schemes as future technology areas. Probed and manipulated biochromophores and biophotoluminescent

Exhibit R-2a, RDT&E Project Justification	DATE February 2008
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BUDGET ACTIVITY 01 Basic Research	PE NUMBER AND TITLE 0601102F Defense Research Sciences	PROJECT NUMBER AND TITLE 2312 Biological Sciences
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	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u>			
characteristics in microbial and protein-based biosystems for applications to military sensor systems. Exploited biomaterial and biointerfacial sciences to control cellular systems to synthesize novel materials, evaluate biosensors, and elucidate bionanotechnology applications. Researched surface mediated cellular differentiation as a new sensor modality. Expanded into extremophile research to access biosynthetic pathways not achievable with room temperature organisms.			
(U) In FY 2008: Initiate work on manipulating materials to mimic the desirable properties found in skin for maintenance, self-healing, and repair. Continue to investigate predator avoidance and new prey detection schemes as future technology areas. Further probe and manipulate biochromophores and biophotoluminescent characteristics in microbial and protein-based biosystems for applications to military sensor systems. Continue to exploit biomaterial and biointerfacial sciences to control cellular systems to synthesize novel materials, evaluate biosensors, and elucidate bionanotechnology applications. Research surface mediated cellular differentiation as a new sensor modality. Continue investigations in extremophile research to access biosynthetic pathways and materials not achievable with room temperature organisms. Continue work in biophysical mechanisms to discover and understand the basic underlying biological mechanism that could be used to either harden or repair bio-based devices or can utilize complex, impure biofuels for compact power.			
(U) In FY 2009: Continue work on manipulating materials to mimic the desirable properties found in skin for maintenance, self-healing and repair. Expand investigating predator avoidance and new prey detection schemes as future technology areas. Further probe and manipulate biochromophores and biophotoluminescent characteristics in microbial and protein-based biosystems for applications to military sensor systems. Continue to exploit biomaterial and biointerfacial sciences to control cellular systems to synthesize novel materials, evaluate biosensors, and elucidate bionanotechnology applications. Research surface mediated cellular differentiation as a new sensor modality. Continue investigations in extremophile research to access biosynthetic pathways and materials not achievable with room temperature organisms. Continue work in biophysical mechanisms to discover and understand the basic underlying biological mechanism that could be used to either harden or repair bio-based devices or can utilize complex, impure biofuels for compact power.			
(U) Total Cost	9.682	10.332	10.473

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to</u>	<u>Total Cost</u>
	<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Complete</u>	
(U) Related Activities:									
(U) PE 0602202F, Human									

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

01 Basic Research

PE NUMBER AND TITLE

**0601102F Defense Research
Sciences**

PROJECT NUMBER AND TITLE

2312 Biological Sciences**(U) C. Other Program Funding Summary (\$ in Millions)**

Effectiveness Applied Research.

(U) PE 0602204F, Aerospace

Sensors.

(U) PE 0602602F, Conventional

Munitions.

(U) PE 0602702F, Command,

Control, and Communication.

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification

DATE
February 2008

BUDGET ACTIVITY 01 Basic Research				PE NUMBER AND TITLE 0601102F Defense Research Sciences			PROJECT NUMBER AND TITLE 2313 Human Performance		
Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
2313 Human Performance	12.161	11.052	15.255	18.065	19.220	19.538	21.299	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) **A. Mission Description and Budget Item Justification**
 Human performance basic research seeks the fundamental knowledge needed to understand, measure, and optimize human capabilities critical to Air Force operations. Within this project, the special areas of scientific interest include Sensory Systems, Cognition and Decision, Homeostatic and Circadian Regulation of Human Performance, and Socio-Cultural Modeling. In all areas, experimental efforts are coordinated with mathematical or computational modeling. Air Force sensory research emphasizes human auditory capabilities, including 3D spatial hearing, multi-talker communication, speech intelligibility, and informational masking. Cognitive research emphasizes decision optimization in complex, dynamic tasks, including coordinated decision-making performed by networked, multi-person teams. Also aligned with Air Force cognitive research are efforts to determine how best to promote robust, reliable decision-making through information-processing algorithms for fusion, automation, and intelligent signal processing. Modeling efforts include cultural factors that may affect behavior in adversarial decision-making. The Air Force reliance on sustained human performance during trans-meridian operations and night operations motivates basic research efforts to predict and mitigate cognitive impairments from extended wake and much higher than normal workload periods.

(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) MAJOR THRUST: Probe human sensory systems and perceptions critical for warfighter performance (auditory and visual processes, multi-sensory integration, and sensory biomimetics) to enhance human-machine interaction in Air Force weapon systems. Research biophysical and neural mechanisms to determine human cognitive performance under conditions of sleep loss, sustained operations, and non-standard sleep/wake duty cycles.	5.244	5.367	6.468
(U) In FY 2007: Conducted empirical research with mathematical and computational modeling in spatial audition, speech perception, and hearing protection. Exploited multi-sensory integration methods and novel biological sensing mechanisms. Probed biophysical mechanisms responsible for fatigue. Evaluated models of sleep/wake dynamics to predict specific consequences in the performance of an individual warfighter. Investigated the effects of ultrashort laser pulse on the eye (laser flash blindness).			
(U) In FY 2008: Continue empirical research with mathematical and computational modeling in spatial audition, speech perception, and hearing protection. Prepare new understanding of speech recognition and acoustic noise for transition to hearing protection technologies. Exploit multi-sensory integration methods and novel biological sensing mechanisms. Continue to probe biophysical mechanisms responsible for fatigue, including models of sleep/wake dynamics. Shift emphasis from acute to chronic sleep deprivation in order to predict specific consequences in the performance of individual warfighters. Refine models showing effects of ultrashort laser pulse on the eye (laser flash blindness).			
(U) In FY 2009: Engage new research methods to characterize requirements for optimal speech communication,			

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

01 Basic Research

PE NUMBER AND TITLE

0601102F Defense Research
Sciences

PROJECT NUMBER AND TITLE

2313 Human Performance

(U) **B. Accomplishments/Planned Program (\$ in Millions)**FY 2007FY 2008FY 2009

including modulation representation and filtering. Develop data, models, and algorithms to minimize informational masking in speech signals and in spatial audio displays. To inform the design of new hearing protection systems, develop and test theoretical models for bone- and tissue-conducted cochlear excitation in high-noise environments. To improve the ability to understand and forecast cognitive impairments during continuous high workload conditions, employ new genomic and brain-monitoring methods to identify biomarkers for individual susceptibility. Devise new, physiologically accurate quantitative models to elucidate mechanisms of sleep/wake timing, homeostatic recovery, and re-entrainment to circadian phase shifts (e.g., "jet lag").

(U)

(U) MAJOR THRUST: Evaluate cognition and perception research to measure and analyze dimensions of human performance in complex, multi-interaction command and control tasks. Investigate behavioral and physiological theories of cognitive workload, alertness, and vulnerability to sleep loss. Discover dynamic models of attitudes and beliefs that drive adaptive decision-making of interacting non-cooperative groups.

5.162

5.685

8.787

(U) In FY 2007: Developed quantitative models of individual and team information processing and decision-making including applications to systems to improve the speed and accuracy of networked teams. Employed progress on modeling individual and team training for the development of training systems optimized for specific individuals, teams, and applications. Assessed mechanisms for continuous learning and automated, diagnostic mentoring of individuals. Developed models of symbolic spatial-imaginal processing. Explored measures to avert/mitigate human error and optimize decision making under conditions of uncertainty and information overload.

(U) In FY 2008: Continue to refine quantitative models of individual and team information processing and decision-making for application to systems for improving speed and accuracy of decisions networked teams. Employ progress on modeling individual and team training for the development of training systems optimized for specific individuals, teams, and applications. Assess mechanisms for continuous learning and automated, diagnostic mentoring of individuals to enable human and machine collaboration. Continue exploring measures to avert/mitigate human error and optimize decision making under conditions of uncertainty and information overload. Increase cognitive process modeling to include socio-cultural influences in competitive or non-cooperative environments for successful Airmen response to and prediction of adversary actions.

(U) In FY 2009: Specific research objectives include the development of mathematical and computational models to characterize important aspects of human cognitive performance in situations applicable to Air Force operational environments. The goal is to optimize human information-processing, problem-solving, and decision making, both for individual war fighters and for networked, collaborative teams. Research will probe human inference and reasoning under uncertainty, algorithms for information integration and fusion, and new approaches to ensure robust

Exhibit R-2a, RDT&E Project Justification	DATE February 2008
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BUDGET ACTIVITY 01 Basic Research	PE NUMBER AND TITLE 0601102F Defense Research Sciences	PROJECT NUMBER AND TITLE 2313 Human Performance
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(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
decision-making under continuous, extended duty and under rapidly changing, adversarial conditions. Continue to refine agent-based modeling and game theory, to include socio-cultural influences in competitive or non-cooperative environments for successful response to and prediction of adversary actions. New efforts will promote cross-disciplinary contributions from brain science, operations research, network theory, and computer science.			
(U) CONGRESSIONAL ADD: Virtual Teleoperations for Unmanned Aerial Vehicles.	1.755	0.000	0.000
(U) In FY 2007: Conducted research on virtual reality technology to allow a single operator to simultaneously monitor and control multiple unmanned aerial vehicles remotely.			
(U) In FY 2008: Not Applicable.			
(U) In FY 2009: Not Applicable.			
(U) Total Cost	12.161	11.052	15.255

(U) <u>C. Other Program Funding Summary (\$ in Millions)</u>		<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to</u>	<u>Total Cost</u>
		<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Complete</u>	
(U) Related Activities:										
(U) PE 0602202F, Human Effectiveness Applied Research.										
(U) PE 0602702F, Command, Control, and Communication.										
(U) <u>D. Acquisition Strategy</u>										
Not Applicable.										

Exhibit R-2a, RDT&E Project Justification

DATE
February 2008

BUDGET ACTIVITY 01 Basic Research				PE NUMBER AND TITLE 0601102F Defense Research Sciences			PROJECT NUMBER AND TITLE 4113 External Research Programs Interface		
Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
4113 External Research Programs Interface	8.376	11.946	9.835	9.813	9.599	9.938	10.319	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

The primary elements in this project are to facilitate interactions between the international and domestic research communities and Air Force researchers and to support and develop scientists and engineers with an awareness of Air Force basic research priorities. These professional interactions and collaborations stimulate scientific and engineering education beneficial to the Air Force, increase the awareness of Air Force basic research priorities to the research community as a whole, and attract talented scientists and engineers to address Air Force needs. International interactions facilitate future interoperability of coalition systems and foster relationships with future coalition partners. This project also seeks to enhance educational interactions with historically black colleges and universities, Hispanic serving institutions, and other minority institutions.

(U) B. Accomplishments/Planned Program (\$ in Millions)

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) MAJOR THRUST: Foster international science and technology cooperation by supporting the Air Force's international strategy mission. Identify and obtain unique foreign research capabilities through the international technology liaison missions of the European Office of Aerospace Research and Development and the Asian Office of Aerospace Research and Development.	4.354	4.766	5.435
(U) In FY 2007: Provided centralized cooperation expertise and supported international technology liaison missions in order to identify and maintain awareness of foreign science and technology developments. Capitalized on foreign investments by influencing and acquiring world-class scientific research. Established and maintained access to technical briefs and publications on unique foreign research and research capabilities. Supported international visits of high-level DoD delegations and provided primary interface to coordinate international participation among DoD organizations. Assisted in Air Force fiscal commitments to NATO-affiliated research institutes.			
(U) In FY 2008: Continue to provide centralized cooperation expertise and support international technology liaison missions in order to identify and maintain awareness of foreign science and technology developments. Continue to capitalize on foreign investments by influencing and acquiring world-class scientific research. Continue to seek and maintain access to technical briefs and publications on unique foreign research and research capabilities. Continue to support international visits of high-level DoD delegations and provide primary interface to coordinate international participation among DoD organizations. Continue to assist in Air Force fiscal commitments to NATO-affiliated research institutes.			
(U) In FY 2009: Continue to provide centralized cooperation expertise and support international technology liaison missions in order to identify and maintain awareness of foreign science and technology developments. Continue to capitalize on foreign investments by influencing and acquiring world-class scientific research. Continue to seek and			

Exhibit R-2a, RDT&E Project Justification	DATE February 2008
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BUDGET ACTIVITY 01 Basic Research	PE NUMBER AND TITLE 0601102F Defense Research Sciences	PROJECT NUMBER AND TITLE 4113 External Research Programs Interface
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	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u>			
maintain access to technical briefs and publications on unique foreign research and research capabilities. Continue to support international visits of high-level DoD delegations and provide primary interface to coordinate international participation among DoD organizations. Continue to assist in Air Force fiscal commitments to NATO-affiliated research institutes.			
(U) MAJOR THRUST: Strengthen science, mathematics, and engineering research and educational infrastructure in the U.S., thereby strengthening Air Force technical capabilities. Assure the Air Force of continuing availability of superior technical talent and forge Air Force Research Laboratory relationships with premiere scientists.	4.022	7.180	4.400
(U) In FY 2007: Supported science, mathematics, and engineering research and educational outreach programs at U.S. colleges and universities, including historically black colleges and universities, Hispanic serving institutions, and other minority institutions. Increased awareness of Air Force research needs throughout civilian scientific community, while simultaneously identifying/recruiting the best scientific talent to participate in critical Air Force research.			
(U) In FY 2008: Continue to support science, mathematics, and engineering research and educational outreach programs at U.S. colleges and universities, including historically black colleges and universities, Hispanic serving institutions, and other minority institutions. Increase awareness of Air Force research needs throughout civilian scientific community, while simultaneously identifying/recruiting the best scientific talent to participate in critical Air Force research.			
(U) In FY 2009: Continue to support science, mathematics, and engineering research and educational outreach programs at U.S. colleges and universities, including historically black colleges and universities, Hispanic serving institutions, and other minority institutions. Increase awareness of Air Force research needs throughout civilian scientific community, while simultaneously identifying/recruiting the best scientific talent to participate in critical Air Force research. Note: \$3.0M erroneously placed in this effort for Science Board support moved out of this program in FY 2009 and out.			
(U) Total Cost	8.376	11.946	9.835

		<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to Complete</u>	<u>Total Cost</u>
		<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>		
(U) Related Activities:										
(U) PE 0601103D, University Research Initiative.										

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

01 Basic Research

PE NUMBER AND TITLE

**0601102F Defense Research
Sciences**

PROJECT NUMBER AND TITLE

**4113 External Research Programs
Interface****(U) C. Other Program Funding Summary (\$ in Millions)**

- (U) PE 0602102F, Materials.
- (U) PE 0602201F, Aerospace Flight Dynamics.
- (U) PE 0602202F, Human Effectiveness Applied Research.
- (U) PE 0602203F, Aerospace Propulsion.
- (U) PE 0602204F, Aerospace Avionics.
- (U) PE 0602269F, Hypersonic Technology Program.
- (U) PE 0602500F, Multi-Disciplinary Space Technology.
- (U) PE 0602601F, Space Technology.
- (U) PE 0602602F, Conventional Munitions.
- (U) PE 0602702F, Command, Control and Communication.
- (U) D. Acquisition Strategy**
Not Applicable.

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PE NUMBER: 0601103F
 PE TITLE: University Research Initiatives

Exhibit R-2, RDT&E Budget Item Justification	DATE February 2008
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BUDGET ACTIVITY 01 Basic Research	PE NUMBER AND TITLE 0601103F University Research Initiatives
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Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
Total Program Element (PE) Cost	111.803	119.938	125.949	130.938	135.960	140.507	146.001	Continuing	TBD
5094 University Research Initiatives	111.803	119.938	125.949	130.938	135.960	140.507	146.001	Continuing	TBD

(U) A. Mission Description and Budget Item Justification

This program supports defense-related basic research in a wide range of scientific and engineering disciplines pertinent to maintaining U.S. military technology superiority; enhances and promotes the education of U.S. scientists and engineers in disciplines critical to maintaining, advancing, and enabling future U.S. defense technologies; and assists universities in establishing superior instrumentation capabilities needed to improve the quality of defense-related research and education. A fundamental component of this program is the recognition that future technologies and technology exploitations require highly coordinated and concerted multi- and interdisciplinary efforts. Note: In FY 2008, Congress added \$2.4M for Battlespace Reducing Military Decision Cycles, \$1M for Frank R. Seaver Science and Engineering Complex, \$1M for High Temperature Hydrogen and the Space Education Consortium (SEC), \$2.4M for Secure Grid Research, and \$8M for University Research Initiatives. This program is in Budget Activity 1, Basic Science, because it funds scientific study and experimentation.

(U) B. Program Change Summary (\$ in Millions)

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) Previous President's Budget	115.035	104.304	101.850
(U) Current PBR/President's Budget	111.803	119.938	125.949
(U) Total Adjustments	-3.232	15.634	
(U) Congressional Program Reductions			
Congressional Rescissions		-0.766	
Congressional Increases		16.400	
Reprogrammings			
SBIR/STTR Transfer	-3.232		

(U) Significant Program Changes:

Not Applicable.

C. Performance Metrics

(U) Under Development.

Exhibit R-2a, RDT&E Project Justification

DATE
February 2008

BUDGET ACTIVITY 01 Basic Research				PE NUMBER AND TITLE 0601103F University Research Initiatives			PROJECT NUMBER AND TITLE 5094 University Research Initiatives			
Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total	
5094 University Research Initiatives	111.803	119.938	125.949	130.938	135.960	140.507	146.001	Continuing	TBD	
Quantity of RDT&E Articles	0	0	0	0	0	0	0			

- (U) **A. Mission Description and Budget Item Justification**
 This program supports defense-related basic research in a wide range of scientific and engineering disciplines pertinent to maintaining U.S. military technology superiority; enhances and promotes the education of U.S. scientists and engineers in disciplines critical to maintaining, advancing, and enabling future U.S. defense technologies; and assists universities in establishing superior instrumentation capabilities needed to improve the quality of defense-related research and education. A fundamental component of this program is the recognition that future technologies and technology exploitations require highly coordinated and concerted multi- and interdisciplinary efforts. Note: In FY 2008, Congress added \$2.4M for Battlespace Reducing Military Decision Cycles, \$1M for Frank R. Seaver Science and Engineering Complex, \$1M for High Temperature Hydrogen and the Space Education Consortium (SEC), \$2.4M for Secure Grid Research, and \$8M for University Research Initiatives. This program is in Budget Activity 1, Basic Science, because it funds scientific study and experimentation.
- | | | | |
|---|----------------|----------------|----------------|
| (U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u> | <u>FY 2007</u> | <u>FY 2008</u> | <u>FY 2009</u> |
| (U) MAJOR THRUST: Promote fundamental, multi- and interdisciplinary science and engineering research projects. Topics will be selected in scientific research areas related to transformational and high priority technologies, such as nanotechnology, sensor networks, intelligence information fusion, smart materials and structures, efficient energy and power conversion, high energy materials for propulsion and control, and enhancing human performance. | 54.657 | 55.682 | 71.312 |
| (U) In FY 2007: Funded competitive research awards at U.S. universities to focus on underpinning Air Force-related technologies usually not achievable through typical single investigator awards. Supported and recognized superior academic researchers in the early stages of their career through the Presidential Early Career Award for Scientists and Engineers (PECASE). Continued funding of multi-disciplinary programs begun in prior years. | | | |
| (U) In FY 2008: Continue funding competitive research awards at U.S. universities to focus on underpinning Air Force-related technologies usually not achievable through typical single investigator awards. Continue to support and recognize superior academic researchers in the early stages of their career through PECASE. Continue funding of multi-disciplinary programs begun in prior years. | | | |
| (U) In FY 2009: Continue funding competitive research awards at U.S. universities to focus on underpinning Air Force-related technologies usually not achievable through typical single investigator awards. Support and recognize superior academic research through the PECASE. Continue funding of multi-disciplinary programs begun in prior years. | | | |
| (U) MAJOR THRUST: Support post-graduate, graduate, and undergraduate education in science and engineering disciplines at U.S. universities. National Defense Science and Engineering Graduate Program (NDSEG) Fellowships | 36.317 | 36.325 | 41.058 |

UNCLASSIFIED

Exhibit R-2a, RDT&E Project Justification		DATE February 2008
BUDGET ACTIVITY 01 Basic Research	PE NUMBER AND TITLE 0601103F University Research Initiatives	PROJECT NUMBER AND TITLE 5094 University Research Initiatives

(U) B. Accomplishments/Planned Program (\$ in Millions)	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
are awarded to train U.S citizens in science and engineering disciplines of military importance under a joint tri-Service and Office of the Director of Defense Research and Engineering competition.			
(U) In FY 2007: Awarded highly competitive NDSEG fellowships. Supported competitive awards for graduate and undergraduate research experiences including those established under the Awards to Stimulate and Support Undergraduate Research Education program. Continued to fund for awards made under prior year Department of Defense programs.			
(U) In FY 2008: Continue to award highly competitive NDSEG fellowships. Continue to support competitive awards for graduate and undergraduate research experiences including those established under the Awards to Stimulate and Support Undergraduate Research Education program. Continue funding for awards made under prior year Department of Defense programs.			
(U) In FY 2009: Continue to award highly competitive NDSEG fellowships. Continue to support competitive awards for graduate and undergraduate research experiences including those established under the Awards to Stimulate and Support Undergraduate Research Education program. Continue funding for awards made under prior year Department of Defense programs.			
(U) MAJOR THRUST: Enhance the scientific and engineering research through advanced education infrastructure and instrumentation at U.S. universities.	13.180	11.636	13.579
(U) In FY 2007: Conducted the competition for U.S. universities to acquire state-of-the-art, high technology instrumentation and infrastructure to enhance research and educational capabilities under the Defense University Research Instrumentation Program.			
(U) In FY 2008: Continue to conduct the competition for U.S. universities to acquire state-of-the-art, high technology instrumentation and infrastructure to enhance research and educational capabilities under the Defense University Research Instrumentation Program.			
(U) In FY 2009: Continue to conduct the competition for U.S. universities to acquire state-of-the-art, high technology instrumentation and infrastructure to enhance research and educational capabilities under the Defense University Research Instrumentation Program.			
(U) CONGRESSIONAL ADD: High Assurance Software Engineering.	1.743	0.000	0.000
(U) In FY 2007: Conducted research on the security issues in information technology architectures and components.			
(U) In FY 2008: Not Applicable.			
(U) In FY 2009: Not Applicable.			

UNCLASSIFIED

Exhibit R-2a, RDT&E Project Justification			DATE February 2008		
BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE			
01 Basic Research	0601103F University Research Initiatives	5094 University Research Initiatives			
(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u>		<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	
(U) CONGRESSIONAL ADD: Single Chip Multi-Modal Nansensors.		3.873	0.000	0.000	
(U) In FY 2007: Conducted research to develop single chip sensors for the detection of chemical and biological agents.					
(U) In FY 2008: Not Applicable.					
(U) In FY 2009: Not Applicable.					
(U) CONGRESSIONAL ADD: Partnership in Innovative Preparation for Educators and Students.		1.065	1.589	0.000	
(U) In FY 2007: Conducted multi-disciplinary research associated with information network for educators and students.					
(U) In FY 2008: Continue to conduct multi-disciplinary research associated with information network for educators and students.					
(U) In FY 2009: Not Applicable.					
(U) CONGRESSIONAL ADD: High Temperature Hydrogen Energy Production.		0.968	0.993	0.000	
(U) In FY 2007: Conducted research to develop methods for hydrogen production.					
(U) In FY 2008: Continue to conduct research to develop methods for hydrogen production.					
(U) In FY 2009: Not Applicable.					
(U) CONGRESSIONAL ADD: Battle Space Reducing Military Decision Cycle		0.000	2.385	0.000	
(U) In FY 2007: Not Applicable.					
(U) In FY 2008: Develop decision making tool that can result in rapid and effective analyses of battlefield situational elements and recommendation for response.					
(U) In FY 2009: Not Applicable.					
(U) CONGRESSIONAL ADD: Frank R. Seaver Science and Engineering Complex		0.000	0.993	0.000	
(U) In FY 2007: Not Applicable.					
(U) In FY 2008: Support the Frank R. Seaver Science and Engineering Complex in conducting basic research in science and engineering disciplines.					
(U) In FY 2009: Not Applicable.					
(U) CONGRESSIONAL ADD: Secure Grid Research		0.000	2.385	0.000	
(U) In FY 2007: Not Applicable.					
(U) In FY 2008: Conduct research on the security issues in information technology architectures and components.					
(U) In FY 2009: Not Applicable.					
(U) CONGRESSIONAL ADD: Univeristy Research Initiatives		0.000	7.950	0.000	
(U) In FY 2007: Not Applicable.					
(U) In FY 2008: Conduct university research and support post-graduate, and undergraduate education in science and engineering disciplines.		0.000	0.000	0.000	

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

01 Basic Research

PE NUMBER AND TITLE

0601103F University Research Initiatives

PROJECT NUMBER AND TITLE

5094 University Research Initiatives

(U) **B. Accomplishments/Planned Program (\$ in Millions)**

(U) In FY 2009: Not Applicable

(U) Total Cost

FY 2007

FY 2008

FY 2009

111.803

119.938

125.949

(U) **C. Other Program Funding Summary (\$ in Millions)**

FY 2007

FY 2008

FY 2009

FY 2010

FY 2011

FY 2012

FY 2013

Cost to

Total Cost

Actual

Estimate

Estimate

Estimate

Estimate

Estimate

Estimate

Complete

(U) Related Activities:

(U) PE 0601102F, Defense Research Sciences.

This project has been coordinated through the Reliance 21 process to harmonize efforts and eliminate duplication.

(U) **D. Acquisition Strategy**

Not Applicable.

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PE NUMBER: 0601108F
 PE TITLE: High Energy Laser Research Initiatives

Exhibit R-2, RDT&E Budget Item Justification	DATE February 2008
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BUDGET ACTIVITY 01 Basic Research	PE NUMBER AND TITLE 0601108F High Energy Laser Research Initiatives
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Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
Total Program Element (PE) Cost	12.016	12.556	13.425	13.030	13.488	14.621	14.506	Continuing	TBD
5097 High Energy Laser Research Initiatives	12.016	12.556	13.425	13.030	13.488	14.621	14.506	Continuing	TBD

(U) **A. Mission Description and Budget Item Justification**
 This program funds basic research aimed at developing fundamental scientific knowledge to support future Department of Defense (DoD) high energy laser (HEL) systems. The HEL Joint Technology Office (JTO) sends these funds to multi-disciplinary research institutes (MRIs) for projects on laser and beam control technologies. In addition, funding is spent on educational grants which are designed to stimulate interest in HELs. These educational grants are used for educational tools, scholarships, and summer intern employees in military laboratories. These funds are also used for modeling and simulation projects for the research of physics-based models of HEL systems. This program is in Budget Activity 1, Basic Research, because it funds scientific study and experimentation. Through this program, the DoD invests in research directed toward increasing knowledge and understanding in those fields of science and engineering related to long-term national security needs.

(U) **B. Program Change Summary (\$ in Millions)**

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) Previous President's Budget	12.356	12.636	13.735
(U) Current PBR/President's Budget	12.016	12.556	13.425
(U) Total Adjustments	-0.340	-0.080	
(U) Congressional Program Reductions			
Congressional Rescissions		-0.080	
Congressional Increases			
Reprogrammings			
SBIR/STTR Transfer	-0.340		
(U) <u>Significant Program Changes:</u>			
Not Applicable.			

C. Performance Metrics
 Under Development.

Exhibit R-2a, RDT&E Project Justification

DATE
February 2008

BUDGET ACTIVITY 01 Basic Research				PE NUMBER AND TITLE 0601108F High Energy Laser Research Initiatives			PROJECT NUMBER AND TITLE 5097 High Energy Laser Research Initiatives		
Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
5097 High Energy Laser Research Initiatives	12.016	12.556	13.425	13.030	13.488	14.621	14.506	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

- (U) **A. Mission Description and Budget Item Justification**
 This program funds basic research aimed at developing fundamental scientific knowledge to support future Department of Defense (DoD) high energy laser (HEL) systems. The HEL Joint Technology Office (JTO) sends these funds to multi-disciplinary research institutes (MRIs) for projects on laser and beam control technologies. In addition, funding is spent on educational grants which are designed to stimulate interest in HELs. These educational grants are used for educational tools, scholarships, and summer intern employees in military laboratories. These funds are also used for modeling and simulation projects for the research of physics-based models of HEL systems. This program is in Budget Activity 1, Basic Research, because it funds scientific study and experimentation. Through this program, the DoD invests in research directed toward increasing knowledge and understanding in those fields of science and engineering related to long-term national security needs.
- | | | | |
|--|----------------|----------------|----------------|
| (U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u> | <u>FY 2007</u> | <u>FY 2008</u> | <u>FY 2009</u> |
| (U) MAJOR THRUST: Improve the fundamental understanding of high-power laser sources, to include solid-state, free electron, and gas laser technologies. | 7.110 | 7.498 | 7.993 |
| (U) In FY 2007: Completed research projects on closed-cycle chemical, free electron, and solid state laser initiatives. Conducted fiber laser research focused on single aperture scaling single-mode fibers, and organization of multiple fibers. Conducted fundamental research on optically-pumped atomic and molecular gas lasers. Conducted a MRI call for innovative research related to gas, free electron, and solid state laser topics, awarded nine efforts. | | | |
| (U) In FY 2008: Conduct fiber laser research focused on single aperture scaling of single-mode fibers and combining multiple fibers. Conduct fundamental research on optically-pumped atomic and molecular gas lasers. Initiate research on selected topics in gas, free electron, and solid state laser technologies. | | | |
| (U) In FY 2009: Conduct fiber laser research focused on single aperture scaling of single-mode fibers and combining multiple fibers. Conduct fundamental research on optically-pumped atomic and molecular gas lasers. Conduct research on selected topics in gas, free electron, and solid state laser technologies. | | | |
| (U) MAJOR THRUST: Improve the fundamental understanding of beam control technologies as they relate to high power laser applications. Conduct research in atmospheric characterization and beam control component technology. | 2.493 | 2.559 | 2.882 |
| (U) in FY 2007: Improved negative thermal expansion optical coating materials to match zero expansion substrates and measured thermal and strain responses of these coatings. Completed research on improving theoretical and computational atmospheric propagation effects, advanced wavefront sensing, and thermal blooming effects. | | | |

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Exhibit R-2a, RDT&E Project Justification		DATE February 2008		
BUDGET ACTIVITY 01 Basic Research	PE NUMBER AND TITLE 0601108F High Energy Laser Research Initiatives	PROJECT NUMBER AND TITLE 5097 High Energy Laser Research Initiatives		
	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	
(U) B. Accomplishments/Planned Program (\$ in Millions) Conducted an MRI call for innovative research related to improved beam control technology and techniques, awarded four efforts.				
(U) In FY 2008: Complete negative thermal expansion research. Initiate research on selected topics for improved beam control technologies and techniques.				
(U) In FY 2009: Conduct research on selected topics for improved beam control technologies and techniques.				
(U) MAJOR THRUST: Evaluate high-fidelity engineering models for incorporation into the HEL toolkit.	1.765	1.794	1.800	
(U) In FY 2007: Merged developed models into a common architecture through verification and validation techniques. Conducted mission-level HEL engagement scenarios and wargame HEL concepts.				
(U) In FY 2008: Continue to develop models and merge them into a common architecture through verification and validation techniques. Conduct mission-level HEL engagement scenarios and wargame HEL concepts.				
(U) In FY 2009: Continue to develop models and merge them into a common architecture through verification and validation techniques. Conduct mission-level HEL engagement scenarios and wargame HEL concepts.				
(U) MAJOR THRUST: Fund educational grants intended to simulate interest in HEL technologies among students.	0.648	0.705	0.750	
(U) In FY 2007: Provided scholarships and internships in areas directly supporting HEL research. Provided grants to service academies to stimulate HEL studies among military cadets. Provided support to K-12 school programs to stimulate science and math studies, with an emphasis on lasers and optics. Funded publication of journals and continuing education for professionals in the HEL field.				
(U) In FY 2008: Provide scholarships and internships in areas directly supporting HEL research. Provide grants to Service Academies to stimulate HEL studies among military cadets. Provide support to K-12 school programs to stimulate science and math studies, with an emphasis on lasers and optics. Fund publication of journals and continuing education for professionals in the HEL field.				
(U) In FY 2009: Provide scholarships and internships in areas directly supporting HEL researches. Provide grants to Service Academies to stimulate HEL studies among military cadets. Provide support to K-12 school programs to stimulate science and math studies, with an emphasis on lasers and optics. Fund publication of journals and continuing education for professionals in the HEL field.				
(U) Total Cost	12.016	12.556	13.425	

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY
01 Basic Research

PE NUMBER AND TITLE
0601108F High Energy Laser
Research Initiatives

PROJECT NUMBER AND TITLE
5097 High Energy Laser Research
Initiatives

(U) C. Other Program Funding Summary (\$ in Millions)

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to</u>	<u>Total Cost</u>
	<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Complete</u>	
(U) PE 0602890F, High Energy Laser Research.									
(U) PE 0603444F, Maui Space Surveillance System.									
(U) PE 0603605F, Advanced Weapons Technology.									
(U) PE 0603924F, High Energy Laser Advanced Technology Program.									
(U) PE 0602605F, Directed Energy Technology.									
(U) PE 0602120A, Sensors and Electronic Survivability.									
(U) PE 0602307A, Advanced Weapons Technology.									
(U) PE 0602624A, Weapons and Munitions Technology.									
(U) PE 0603004A, Weapons and Munitions Advanced Technology.									
(U) PE 0602114N, Power Projection Applied Research.									
(U) PE 0602702E, Tactical Technology.									
(U) PE 0603175C, Ballistic Missile Defense Technology.									
(U) PE 0603883C, Ballistic Missile Defense Boost Phase Segment.									
(U) PE 0602651M, Joint Non-Lethal									

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

01 Basic Research

PE NUMBER AND TITLE

**0601108F High Energy Laser
Research Initiatives**

PROJECT NUMBER AND TITLE

**5097 High Energy Laser Research
Initiatives****(U) C. Other Program Funding Summary (\$ in Millions)**

Weapons Applied Research.

(U) PE 0603651M, Joint Non-Lethal

Weapons Technology

Development.

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

(U) D. Acquisition Strategy

Not Applicable.

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PE NUMBER: 0602015F
 PE TITLE: Medical Development

Exhibit R-2, RDT&E Budget Item Justification	DATE February 2008
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BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602015F Medical Development
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Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
Total Program Element (PE) Cost	0.000	4.670	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5244 Diabetes Research	0.000	4.670	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Note: Funds for the FY 2008 Congressionally-directed Tricorder Detector in the amount of \$1.2 million, National Center for Integrated Civilian-Military Domestic Disaster Medical Response (Yale New Haven Health System) in the amount of \$2.0 million, and Comprehensive Clinical Phenotyping and Genetic Mapping for the Discovery of Autism Susceptibility Gene in the amount of \$1.5 million, are in the process of being moved to the Defense Health Program, from PE 0602015F, Medical Development, for execution.

(U) A. Mission Description and Budget Item Justification

Funds for the FY 2008 Congressionally-directed Tricorder Detector in the amount of \$1.2 million, National Center for Integrated Civilian-Military Domestic Disaster Medical Response (Yale New Haven Health System) in the amount of \$2.0 million, and Comprehensive Clinical Phenotyping and Genetic Mapping for the Discovery of Autism Susceptibility Gene in the amount of \$1.5 million, are in the process of being moved to the Defense Health Program, from PE 0602015F, Medical Development, for execution. This program is in Budget Activity 2, Applied Research, since it develops and determines the technical feasibility and military utility of evolutionary and revolutionary technologies.

(U) B. Program Change Summary (\$ in Millions)

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) Previous President's Budget	23.810	0.000	0.000
(U) Current PBR/President's Budget	0.000	4.670	0.000
(U) Total Adjustments	-23.810	4.670	
(U) Congressional Program Reductions			
Congressional Rescissions		-0.030	
Congressional Increases		4.700	
Reprogrammings	-23.810		
SBIR/STTR Transfer			

(U) Significant Program Changes:

Not Applicable.

C. Performance Metrics

Under Development.

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Exhibit R-2a, RDT&E Project Justification

DATE
February 2008

BUDGET ACTIVITY 02 Applied Research				PE NUMBER AND TITLE 0602015F Medical Development			PROJECT NUMBER AND TITLE 5244 Diabetes Research		
Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
5244 Diabetes Research	0.000	4.670	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

Note: Funds for the FY 2008 Congressionally-directed Tricorder Detector in the amount of \$1.2 million, National Center for Integrated Civilian-Military Domestic Disaster Medical Response (Yale New Haven Health System) in the amount of \$2.0 million, and Comprehensive Clinical Phenotyping and Genetic Mapping for the Discovery of Autism Susceptability Gene in the amount of \$1.5 million, are in the process of being moved to the Defense Health Program, from PE 0602015F, Medical Development, for execution.

(U) A. Mission Description and Budget Item Justification

Funds for the FY 2008 Congressionally-directed Tricorder Detector in the amount of \$1.2 million, National Center for Integrated Civilian-Military Domestic Disaster Medical Response (Yale New Haven Health System) in the amount of \$2.0 million, and Comprehensive Clinical Phenotyping and Genetic Mapping for the Discovery of Autism Susceptability Gene in the amount of \$1.5 million, are in the process of being moved to the Defense Health Program, from PE 0602015F, Medical Development, for execution. This program is in Budget Activity 2, Applied Research, since it develops and determines the technical feasibility and military utility of evolutionary and revolutionary technologies.

(U) B. Accomplishments/Planned Program (\$ in Millions)

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) CONGRESSIONAL ADD: Tricorder Detector.	0.000	1.192	0.000
(U) In FY 2007: Not Applicable.			
(U) In FY 2008: Conduct Congressionally-directed effort for Tricorder Detector.			
(U) In FY 2009: Not Applicable.			
(U) CONGRESSIONAL ADD: National Center for Integrated Civilian-Military Domestic Disaster Medical Response (Yale New Haven Health System).	0.000	1.988	0.000
(U) In FY 2007: Not Applicable.			
(U) In FY 2008: Conduct Congressionally-directed effort for National Center for Integrated Civilian-Military Domestic Disaster Medical Response (Yale New Haven Health System).			
(U) In FY 2009: Not Applicable.			
(U) CONGRESSIONAL ADD: Comprehensive Clinical Phenotyping and Genetic Mapping for the Discovery of Autism Susceptability Gene.	0.000	1.490	0.000
(U) In FY 2007: Not Applicable.			
(U) In FY 2008: Conduct Congressionally-directed effort for Comprehensive Clinical Phenotyping and Genetic Mapping for the Discovery of Autism Susceptability Gene.			
(U) In FY 2009: Not Applicable.			
(U) Total Cost	0.000	4.670	0.000

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY
02 Applied Research

PE NUMBER AND TITLE
0602015F Medical Development

PROJECT NUMBER AND TITLE
5244 Diabetes Research

(U) C. Other Program Funding Summary (\$ in Millions)

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to</u>	<u>Total Cost</u>
	<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Complete</u>	

(U) Related Activities:
Not Applicable.

(U) D. Acquisition Strategy
Not Applicable.

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PE NUMBER: 0602102F

PE TITLE: Materials

Exhibit R-2, RDT&E Budget Item Justification

DATE

February 2008

BUDGET ACTIVITY

02 Applied Research

PE NUMBER AND TITLE

0602102F Materials

Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
Total Program Element (PE) Cost	151.438	179.516	117.143	127.504	126.999	130.567	126.415	Continuing	TBD
01SP Space Materials Development	25.728	37.558	29.042	34.161	33.801	32.654	33.337	Continuing	TBD
4347 Materials for Structures, Propulsion, and Subsystems	70.723	73.257	44.313	52.955	54.892	56.284	55.495	Continuing	TBD
4348 Materials for Electronics, Optics, and Survivability	26.687	29.751	21.480	19.990	17.982	20.032	15.807	Continuing	TBD
4349 Materials Technology for Sustainment	21.550	27.642	18.662	17.692	17.590	18.698	18.771	Continuing	TBD
4915 Deployed Air Base Technology	6.750	11.308	3.646	2.706	2.734	2.899	3.005	Continuing	TBD

Note: FY 2008 funding totals do not include \$3.7 million FY 2008 GWOT requirements still pending Congressional consideration.

(U) A. Mission Description and Budget Item Justification

This program develops advanced materials, processing, and inspection technologies to reduce life cycle costs and improve performance, affordability, supportability, reliability, and survivability of current and future Air Force systems and operations. The program has five projects that develop: (1) the materials and processing technology base for spacecraft and launch systems; (2) structural, propulsion, and sub-systems materials and processes technologies; (3) electronic, optical, and survivability materials and processes technologies; (4) sustainment materials, processes technologies, and advanced non-destructive inspection methodologies; and (5) air base operations technologies including deployable base infrastructure, force protection, and fire fighting capabilities. Note: In FY 2008 Congress added \$1.6 million for Chrome Free Environmentally Friendly Corrosion Protection for Aircraft, \$1.6 million for Free Electron Laser Capabilities for Aerospace Microfabrication, \$4.8 million for Intelligent Carbon nanotube Based Computer Devices for Space Applications, \$1.0 million for Aircraft Active Corrosion Protective Compounds, \$2.8 million for Accelerated Insertion of Advanced Materials and Certification for Military Aircraft Structure Material, \$1.6 million for Blast Resistant Concrete Products, \$1.6 million for Large Area, APVT Materials Development for High Power Devices, \$1.6 million for Plasma-Sphere Array for Flexible Electronics, \$3.0 million for Advanced Carbon Fiber Research and Testing Initiative, \$2.5 million for Institute for Science and Engineering Simulation (ISES) / Aircraft Fatigue Modeling and Simulation, \$1.6 million for Science for Sustainment Initiative to Improve Mission, \$3.2 million for Oregon Nanoscience and Microtechnologies Institute (ONAMI) Safer Nanomaterials and Nanomanufacturing, \$1.6 million for Pennsylvania Nanomaterials Commercialization Center, \$1.6 million for High Temperature Aerogel Materials for Global Strike Vehicles, \$0.8 million for Polymer Nanocomposites for Energy Storage and Pulsed Power, \$1.6 million for Carbon Nano-Materials for Advanced Aerospace Applications, AQW Rice University, \$2.4 million for University of Houston Consortium for Nanomaterials for Aerospace Commerce and Technology (CONTACT), \$1.6 million for Gallium Nitride (GaN) RF Power Technology, \$1.0 million for Life Shield Blast Resistant Panels, \$1.6 million for Advanced Aerospace Carbon Foam Heat Exchangers, \$0.96 million for Advanced Engineered Non-Linear Optical Materials for Critical Wavelengths, \$6.0 million for Air Force Minority Leaders Program, \$1.2 million for Durable Hybrid Coatings for Aircraft Systems, \$1.6 million for Fire and Blast Resistant Materials for Force Protection, \$1.6 million for Nanocomposites for Lightning Protection of Composite Airframe Structures, \$5.0 million for Nanotechnology Research, \$2.9 million for Polymer Stress and Sensor Damage Sensors for Composites, and \$1.0 million for Innovative Polymeric Materials for Three-Dimensional (3-D) Microdevice Construction. Congress also reduced Affordable structural and non-structural materials for space by \$1.5 million for program growth. This program is in Budget

Exhibit R-2, RDT&E Budget Item Justification

DATE

February 2008

BUDGET ACTIVITY

02 Applied Research

PE NUMBER AND TITLE

0602102F Materials

Activity 2, Applied Research, since it develops and determines the technical feasibility and military utility of evolutionary and revolutionary technologies.

(U) **B. Program Change Summary (\$ in Millions)**

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) Previous President's Budget	153.293	122.794	110.412
(U) Current PBR/President's Budget	151.438	179.516	117.143
(U) Total Adjustments	-1.855	56.722	
(U) Congressional Program Reductions		-1.500	
Congressional Rescissions		-1.138	
Congressional Increases		58.360	
Reprogrammings	0.859	1.000	
SBIR/STTR Transfer	-2.714		
(U) <u>Significant Program Changes:</u>			
Not Applicable.			

C. Performance Metrics
Under Development.

Exhibit R-2a, RDT&E Project Justification

DATE
February 2008

BUDGET ACTIVITY 02 Applied Research				PE NUMBER AND TITLE 0602102F Materials			PROJECT NUMBER AND TITLE 01SP Space Materials Development		
Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
01SP Space Materials Development	25.728	37.558	29.042	34.161	33.801	32.654	33.337	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

Note: In FY 2007, Project 01SP, Space Materials Development, efforts transfer from PE 0602500F, Multidisciplinary Space Technology, Project 5025, Space Materials Development, in order to more effectively manage and provide oversight of the efforts.

(U) A. Mission Description and Budget Item Justification

This project develops the materials and processing technology base for spacecraft and launch systems to improve affordability, maintainability, and performance of current and future Air Force space systems. Families of affordable lightweight materials are being developed, including metals, polymers, ceramics, metallic composites, and nonmetallic composites to provide new capabilities for spacecraft, ballistic missile, and propulsion systems to meet the future space requirements. Rocket propulsion materials development in this project supports the Integrated High Payoff Rocket Propulsion Technology (IHRPPT) program. Advanced high-temperature protection materials are being developed that are affordable, lightweight, dimensionally stable, thermally conductive, and/or ablation and erosion resistant to meet space and ballistic missile requirements. Materials technologies are also being developed to enable surveillance and terrestrial situational awareness systems and subsystems for space and ballistic missile applications.

(U) B. Accomplishments/Planned Program (\$ in Millions)

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) MAJOR THRUST: Develop materials and processes to dramatically improve performance, durability, and cost of rocket propulsion systems. Note: In FY 2008, efforts were reduced to fund efforts for high-temperature protection systems.	11.160	3.581	3.241
(U) In FY 2007: Developed new candidate materials and improved processing techniques to ensure more consistent material characteristics to meet the next level of performance goals for high-speed turbopump housings and turbines, ducts, valves, solid rocket casings, insulation, and nozzle throats. Evaluated performance of subscale test components in representative rocket engine environment. Analyzed material behavior in rocket combustion environment. Demonstrated innovative high-temperature metal, ceramic, and composite material candidates for solid rocket nozzles, exit cones, throats, and spacecraft propulsion components. Validated material models for direct replacement of materials. Scaled-up testing from coupon level to more complex shapes and sizes. Fabricated subscale components. Incorporated innovative materials and concepts on demonstrator engines. Identified materials characteristics required to meet advanced performance and cost goals. Improved and optimized selected materials, test sub-elements, and sub-components for thrust chambers, nozzles, and catalysts.			
(U) In FY 2008: Optimize candidate materials and processing techniques to ensure more consistent material characteristics to meet the next level of performance goals for high-speed turbopump housings and turbines, ducts, valves, solid rocket casings, insulation, and nozzle throats. Develop processes to produce full scale test components that can be tested in rocket engine environment. Analyze material behavior in rocket combustion environment. Construct pervasive materials requirements to meet advanced performance and cost goals. Validate and demonstrate			

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

02 Applied Research

PE NUMBER AND TITLE

0602102F Materials

PROJECT NUMBER AND TITLE

01SP Space Materials Development

(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
materials, test sub-elements, and sub-components for thrust chambers, nozzles, and catalyts.			
(U) In FY 2009: Down select the highest payoff materials and processes for high-speed turbopump housings and turbines, ducts, valves, solid rocket casings, insulation, and nozzle throats and develop mechanical property databases for design consideration. Optimize processes to produce full scale test components that can be tested in rocket engine environment. Analyze material behavior in rocket combustion environment. Focus development plans on pervasive materials requirements to meet advanced performance and cost goals. Optimize selected materials, test sub-elements, and sub-components for thrust chambers, nozzles, and catalyts.			
(U)			
(U) MAJOR THRUST: Develop affordable, advanced structural and non-structural materials and processing technologies for Air Force space applications. Note: In FY 2008, efforts were increased for high-temperature protection systems. In FY 2008 Congress reduced this effort by \$1.5 million for program growth.	10.586	18.701	14.739
(U) In FY 2007: Validated initial material design concept of candidate metallic systems for thin gage structures for component operation in robust high-temperature, long duration cruise, or access to space environments. Analyzed research results and developed knowledge base on liquid oxygen compatibility with National Aeronautics and Space Administration (NASA) and industry. Evaluated large integrated concepts using composite materials in cryogenic environments and provided expertise for design and assessment of structural cryogenic tanks. Demonstrated high-temperature protection systems for expendable and reusable high-speed vehicle applications in collaboration with industry. Validated oxidation protection schemes for carbon-carbon materials for high-speed vehicle applications. Developed multifunctional nano-tailored composite technologies for space system capabilities and evaluated enhancements obtained. Developed wear-resistant materials, lubricants, and Micro-Electro-Mechanical System (MEMS) devices for moving mechanical assemblies on spacecraft. Evaluated candidate space materials and collected critical data to facilitate materials transition.			
(U) In FY 2008: Develop and validate test methodology and evaluation techniques for processing, durability, and life prediction of thermal protection system applications for selected thin gage metallic materials. Develop scale-up processing and integration techniques that will provide the capability for fabrication of complex geometries and built-up structures. Explore materials options for high-temperature protection systems for expendable and reusable high-speed vehicle applications in collaboration with industry. Transition data on oxidation protection schemes for carbon-carbon materials. Demonstrate benefits of nano-tailored composite materials for multifunctional space applications. Validate wear-resistant materials, lubricants, and MEMS devices for moving mechanical assemblies on spacecraft against environment specific criteria. Evaluate candidate space materials and collect critical data to facilitate materials transition.			
(U) In FY 2009: Optimize initial test methodology and evaluation techniques for processing, durability, and life			

UNCLASSIFIED

Exhibit R-2a, RDT&E Project Justification		DATE February 2008		
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602102F Materials	PROJECT NUMBER AND TITLE 01SP Space Materials Development		
		<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u> prediction of thermal protection system applications for component operation in robust high-temperature, long-duration cruise, or access to space environments. Continue materials processing development and demonstrate structural integration into sub-scale components for testing in relative environments. Develop materials candidates for high-temperature protection systems for expendable and reusable high-speed vehicle applications in collaboration with industry. Evaluate candidate space materials and collect critical data to facilitate materials transition.				
(U)				
(U) MAJOR THRUST: Develop materials and materials processing technologies to enable improved performance and affordability of surveillance, tracking, targeting, situational awareness systems, and space-based communications/computing. Note: Beginning in FY 2008, there in an increased emphasis on efforts in this major thrust.		3.982	10.507	11.062
(U) In FY 2007: Initiated development of nano-photonic materials for high performance optoelectronic devices for optical communications and system control architectures. Validated processes and developed process control methodology to enable very long wavelength infrared detection. Developed suitable materials and materials process technologies for application in combined optical and radio frequency communication system apertures. Initiated research in nano-photonic materials for applications in very high bandwidth communications and modulators, laser communications, and radar.				
(U) In FY 2008: Demonstrate processes and process control methodology to enable very long wavelength infrared detection. Develop materials processing technology for short wavelength detectors that will provide capability of staring focal plane arrays with more than 4 million pixels (2k x 2k). Develop nano-photonic materials for high performance optoelectronic devices for optical communications and system control architectures. Demonstrate materials and materials process technologies for application in combined optical and radio frequency communication system apertures.				
(U) In FY 2009: Continue to demonstrate processes and process control methodology to enable very long wavelength infrared focal plane arrays. Demonstrate processing technology for short wavelength infrared detectors by hybridization and characterization of 2k x 2k format focal plane array. Demonstrate nano-photonic materials for high performance optoelectronic devices for optical communications and system control architectures. Transition suitable materials and materials process technologies for application in combined optical and radio frequency communication system apertures.				
(U)				
(U) CONGRESSIONAL ADD: Intelligent Carbon Nanotube Based Computer Devices for Space Applications.		0.000	4.769	0.000
(U) In FY 2007: Not Applicable.				
(U) In FY 2008: Conduct Congressionally-directed effort for Intelligent Carbon Nanotube Based Computer Devices for				

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602102F Materials	PROJECT NUMBER AND TITLE 01SP Space Materials Development
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(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
Space Applications.			
(U) In FY 2009: Not Applicable.			
(U)			
(U) Total Cost	25.728	37.558	29.042

(U) <u>C. Other Program Funding Summary (\$ in Millions)</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to</u>	<u>Total Cost</u>
	<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Complete</u>	

(U) Related Activities:
 (U) This project has been coordinated through the Reliance 21 process to harmonize efforts and eliminate duplication.

(U) **D. Acquisition Strategy**
 Not applicable.

Exhibit R-2a, RDT&E Project Justification

DATE
February 2008

BUDGET ACTIVITY 02 Applied Research				PE NUMBER AND TITLE 0602102F Materials			PROJECT NUMBER AND TITLE 4347 Materials for Structures, Propulsion, and Subsystems		
Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
4347 Materials for Structures, Propulsion, and Subsystems	70.723	73.257	44.313	52.955	54.892	56.284	55.495	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project develops the materials and processing technology base for aircraft and missiles to improve affordability, maintainability, and performance of current and future Air Force systems. A family of affordable lightweight materials is being developed, including metals, polymers, ceramics, metallic composites, and nonmetallic composites to provide upgraded capabilities for existing aircraft, missile, and propulsion systems to meet the future system requirements. Develops high-temperature turbine engine materials that will enable engine designs to double the turbine engine thrust-to-weight ratio. Advanced high temperature protection materials are being developed that are affordable, lightweight, dimensionally stable, thermally conductive, and/or ablation and erosion resistant to meet aerospace and missile requirements. Alternative or replacement materials are being developed to maintain the performance of aging operational systems. Friction and wear-resistant materials, paints, coatings, and other pervasive nonstructural materials technologies are being developed for propulsion and subsystems on aircraft, spacecraft, and missiles. Develops novel materials for electromagnetic interactions with matter for electromagnetic pulse (EMP), high power microwave (HPM), and lightning strike protection. Concurrently develops advanced processing methods to enable adaptive processing of aerospace materials.

(U) B. Accomplishments/Planned Program (\$ in Millions)

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) MAJOR THRUST: Develop ceramics and ceramic matrix composite technologies for revolutionary performance and supportability improvements in advanced propulsion systems and high temperature aerospace structures.	3.714	3.171	2.389
(U) In FY 2007: Demonstrated advanced ceramic composite performance through testing under real and simulated engine service life conditions. Incorporated environmental degradation analysis into the ceramic composite life prediction model to address time dependent degradation associated with environmental exposure. Demonstrated the severe environment durability of advanced ceramic composite systems with advanced interfaces via mechanical testing.			
(U) In FY 2008: Demonstrate advanced ceramic composite performance through testing under real and simulated engine service life conditions. Demonstrate environmental degradation analysis in the ceramic composite life prediction model. Validate the severe environment durability of advanced ceramic composite systems with advanced interfaces via mechanical testing.			
(U) In FY 2009: Validate advanced ceramic composite performance through testing under real and simulated engine service life conditions. Validate the life prediction model to address time dependent degradation associated with environmental exposure. Validate the severe environment durability of advanced ceramic composite systems with advanced interfaces via mechanical testing.			
(U)			

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY
02 Applied ResearchPE NUMBER AND TITLE
0602102F MaterialsPROJECT NUMBER AND TITLE
**4347 Materials for Structures,
Propulsion, and Subsystems****(U) B. Accomplishments/Planned Program (\$ in Millions)**

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) MAJOR THRUST/CONGRESSIONAL ADD: Develop enabling polymeric materials for diverse aerospace applications including enhanced aircraft canopies, electromagnetic hardening, and improved low-observable platforms. Develop nanoscale architectures to address electromagnetic applications. Note: In FY 2009, this increase in funding is due to greater emphasis on metamaterials. This effort includes Congressional Add funding of \$5.7 million in FY 2007 (\$2.3 million for ONAMI Safer Nanomaterials and Nanomanufacturing, \$1.4 million for Consortium for Nanomaterials for Aerospace Commerce and Technology (CONTACT), \$1.0 million for Advanced Materials Development for Force Protection, and \$1.0 million for Enabling Polymeric Materials for Three-Dimensional (3D) Microdevice Construction).	11.017	6.324	13.320
(U) In FY 2007: Developed second-generation TPA materials for night vision goggle and optical limiting applications. Demonstrated optical limiting with improvements in nonlinear optical properties using photonic crystals. Demonstrated improved life nanostructured aircraft tires. Demonstrated aromatic hyperbranched polymers as rheology-modifying additives for structural component manufacture via resin transfer molding processes. Demonstrated organic-inorganic nanostructured materials for Air Force electromagnetic applications. Developed adaptive (shape memory and actuator) materials based on polymer nanocomposites for adaptive aircraft structures, wings, fins, antennas, and mirrors. Demonstrated polymer proton exchange membranes for Air Force fuel cell applications. Demonstrated polymer photovoltaic materials for high efficiency, long life, lightweight, solar cell applications.			
(U) In FY 2008: Deliver second-generation TPA materials for night vision goggle evaluation. Transition photonic crystals for super prism applications. Transition aromatic hyperbranched polymers for structural component manufacture via resin transfer molding processes. Develop organic-inorganic metamaterials for Air Force electromagnetic and photonic applications for reduced aperture size, conformal radar, and antenna systems. Transition organic-inorganic nanostructured materials for lightning strike resistant refueling boom. Develop electromagnetic interference (EMI) and high power microwave (HPM) shielding for electronics hardening. Develop adaptive (shape memory and actuator) materials based on polymer nanocomposites for adaptive aircraft structures, wings, fins, antennas, and mirrors. Develop lightweight, low-cost photovoltaics for uninhabited air vehicle applications.			
(U) In FY 2009: Develop organic-inorganic metamaterials for Air Force electromagnetic and photonic applications for reduced aperture size, conformal radar, and antenna systems. Develop EMI and HPM shielding for electronics hardening. Investigate and develop lightweight, conformal metamaterials with properties that will enable compact sensor applications including: conformal array antennas, low EMI electronics, and optical elements based upon complex media. Evaluate the properties of these materials and determine performance enhancement of fixed			

UNCLASSIFIED

Exhibit R-2a, RDT&E Project Justification		DATE February 2008		
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602102F Materials	PROJECT NUMBER AND TITLE 4347 Materials for Structures, Propulsion, and Subsystems		
		<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) B. Accomplishments/Planned Program (\$ in Millions) frequency metamaterial optical elements. Assess the viability of obtaining metamaterial properties consistent with the demonstration of highly integrated subsystems based on radio frequency integrated circuit applications to enable small, highly directional antenna element device drivers.				
(U) MAJOR THRUST/CONGRESSIONAL ADD: Develop affordable lightweight metallic materials, behavior and life prediction technologies, higher temperature intermetallic alloys, and metals processing technology to enable enhanced performance, lower acquisition costs, increased durability, and improved reliability for Air Force weapon systems. Note: This effort includes Congressional Add funding of \$4.3 million in FY 2007 (\$1.0 million for Domestic Titanium Powder Manufacturing Initiative and \$3.3 million for Advanced Aerospace Manufacturing Technologies).		20.805	15.639	11.035
(U) In FY 2007: Developed materials-damage predictive approaches for engine health determination and life extension capability. Explored advanced metallic materials for enhanced performance propulsion for air platforms with an emphasis on higher temperature capability. Developed computational methods supporting development and processing to reduce costs to accelerate insertion of advanced metals into Air Force systems. Demonstrated processes and protocols for unitized manufacturing of aerospace components.				
(U) In FY 2008: Develop materials-damage predictive approaches for engine health determination and life extension capability. Develop advanced metallic materials for enhanced performance propulsion for air platforms with an emphasis on higher temperature capability. Validate computational methods supporting development and processing to reduce costs to accelerate insertion of advanced metals into Air Force systems.				
(U) In FY 2009: Validate materials-damage predictive approaches for engine health determination and life extension capability. Develop and validate advanced metallic materials for enhanced performance propulsion for air platforms with an emphasis on higher temperature capability. Transition computational methods supporting development and processing to reduce costs to accelerate insertion of advanced metals into Air Force systems.				
(U) MAJOR THRUST/CONGRESSIONAL ADD: Develop affordable, advanced organic matrix composite structural materials and technologies for Air Force systems applications including lightweight structures for aerospace subcomponents and other structures requiring thermal and/or structural management for environmental control. Note: This effort includes Congressional Add funding of \$4.0 million in FY 2007 (\$2.0 million for Domestic High Modulus PAN Carbon Fiber Qualification Initiative, \$1.0 million for High Temperature Aerogel Materials for Global Strike Vehicles, and \$1.0 million for Hybrid Materials Integration).		13.386	8.715	7.943
(U) In FY 2007: Demonstrated tools and methodologies required for life prediction of materials in high temperature				

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

02 Applied Research

PE NUMBER AND TITLE

0602102F Materials

PROJECT NUMBER AND TITLE

4347 Materials for Structures,
Propulsion, and Subsystems(U) **B. Accomplishments/Planned Program (\$ in Millions)**FY 2007FY 2008FY 2009

turbine engine and airframe structures environments. Demonstrated high temperature organic matrix composites onto relevant DoD platforms. Initiated new material development and affordable processing for space and high-speed vehicle applications. Developed new materials and processes for nanotailored composites with multifunctional capabilities. Continued nanomaterial modeling and technology efforts. Developed and demonstrated advanced material concepts and processes for thermal management applications.

(U) In FY 2008: Continue demonstration of life prediction tools for engine and airframe applications. Transition high temperature organic matrix composites. Downselect and optimize most promising new material systems for space and high speed vehicle applications. Demonstrate the multifunctional payoffs of nanotailored composite materials for aerospace platform applications. Develop and demonstrate nanomaterials modeling and technology with an emphasis on accelerating the insertion and transition of this class of materials. Validate advanced composite material concepts and processes for specific weapon system needs.

(U) In FY 2009: Validate benefits of life prediction tools for engine and airframe applications. Demonstrate improved performance of new material systems for space and high-speed vehicle applications. Integrate the developed models into commercial and industry tools. Develop advanced material concepts and processes to address thermal management applications for weapon and air vehicle platforms.

(U)

(U) MAJOR THRUST/CONGRESSIONAL ADD: Develop nonstructural materials for fluids, lubricants, aircraft topcoat and corrosion resistant coatings, and specialty treatments to improve system performance and reduce life cycle costs. Note: This effort includes Congressional Add funding of \$7.2 million in FY 2007 (\$1.3 million for Durable Hybrid Coatings for Aircraft Systems, \$1.0 million for Chrome Free Environmentally Friendly Corrosion Protection for Aircraft, \$1.0 million for Secure Coating Systems Technology, \$1.0 million for Integral Fuel Tank Protective Coating System, and \$2.9 million for Advanced Coating Technologies for JSF and F-22 Survivability).

15.440

6.717

4.355

(U) In FY 2007: Demonstrated candidate gap treatment materials on air vehicles. Completed validation of the advanced analytical models that will be used to predict the optical properties of specialty coatings based on measured data. Demonstrated and validated the non-chromate surface treatments for aircraft corrosion protection systems. Formulated chrome-free primer for corrosion protection systems with a 30-year life expectancy. Validated multifunctional coatings on engineering components. Downselected surface treatment candidates for further development for friction, stiction, and wear control in micro devices.

(U) In FY 2008: Transition candidate gap treatment materials on low observable air vehicles. Demonstrate the analytical models that will be used to predict the optical properties of specialty coatings based on measured data. Transition the non-chromate surface treatments for aircraft corrosion protection systems. Validate chrome-free

Exhibit R-2a, RDT&E Project Justification		DATE February 2008		
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602102F Materials	PROJECT NUMBER AND TITLE 4347 Materials for Structures, Propulsion, and Subsystems		
		<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) B. Accomplishments/Planned Program (\$ in Millions)				
primer for corrosion protection systems with a 30-year life expectancy. Demonstrate improved low friction wear multifunctional coatings on engineering components. Develop and optimize surface treatment candidates for friction, stiction, and wear control in micro devices.				
(U) In FY 2009: Integrate the analytical models into the coatings development applications. Demonstrate chrome-free primer for corrosion protection systems with a 30-year life expectancy. Continue to demonstrate improved low friction wear multifunctional coatings on engineering components. Demonstrate surface treatment candidates for friction, stiction, and wear control in micro devices.				
(U)				
(U) MAJOR THRUST: Develop nanomaterials science and technology in the areas of nanoenergetics to provide nano-reactive materials, additives, coated powders and laminates for munitions and propulsion with reduced size and higher lethality. Note: In FY 2008, this major thrust pulls together existing technologies from across the Air Force Research Laboratory to create an integrated nanoenergetics effort.		0.000	6.062	5.271
(U) In FY 2007: Not Applicable.				
(U) In FY 2008: Investigate large-scale synthesis and characterization of energetic nanomaterials to provide stable, triggerable, nanoscale energetic materials for enhanced energy release munitions and access to space. Discover and design unconventional nanomaterial behavior with regard to energy release via robust modeling and simulation. Investigate the transport and compartmentalization of nanoparticles within the environment. Develop microstructural characterization tools to provide robust processing-performance correlations of nanoenergetic systems. Investigate multi-component, structured nanoparticle catalyses as controlled release agents for enhancing stability and storage as well as providing enhanced ignition for high efficiency air-breathing propulsion.				
(U) In FY 2009: Develop large-scale synthesis and characterization of energetic nanomaterials to provide stable, triggerable, nanoscale energetic materials for enhanced energy release munitions, high efficiency air-breathing propulsion, and access to space. Establish modeling and simulation tools to support nanoenergetics development. Analyze the transport and compartmentalization of nanoparticles being investigated as nanoenergetics to evaluate potential environmental impact. Develop microstructural characterization tools to provide robust processing-performance correlations of nanoenergetic systems. Investigate multi-component, structured nanoparticle catalyses as controlled release agents for enhancing stability and storage as well as providing enhanced ignition.				
(U)				
(U) CONGRESSIONAL ADD: Air Force Minority Leaders Program.		5.383	5.962	0.000
(U) In FY 2007: Conducted Congressionally-directed effort for Air Force Minority Leader Program.				
(U) In FY 2008: Conduct Congressionally-directed effort for Air Force Minority Leaders Program.				

UNCLASSIFIED

Exhibit R-2a, RDT&E Project Justification		DATE February 2008		
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602102F Materials	PROJECT NUMBER AND TITLE 4347 Materials for Structures, Propulsion, and Subsystems		
<u>B. Accomplishments/Planned Program (\$ in Millions)</u>		<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) In FY 2009: Not Applicable.				
(U) CONGRESSIONAL ADD: Pennsylvania Nanomaterials Commercialization Center.		0.978	1.589	0.000
(U) In FY 2007: Conducted Congressionally-directed effort for NanoMaterials Commercialization Center.				
(U) In FY 2008: Conduct Congressionally-directed effort for Pennsylvania Nanomaterials Commercialization Center.				
(U) In FY 2009: Not Applicable.				
(U) CONGRESSIONAL ADD: Carbon Nano-Materials for Advanced Aerospace Applications, AQW Rice University.		0.000	1.589	0.000
(U) In FY 2007: Not Applicable.				
(U) In FY 2008: Conduct Congressionally-directed effort for Carbon Nano-Materials for Advanced Aerospace Applications, AQW Rice University.				
(U) In FY 2009: Not Applicable.				
(U) CONGRESSIONAL ADD: Nanocomposites for Lightning Protection of Composite Airframe Structures.		0.000	1.589	0.000
(U) In FY 2007: Not Applicable.				
(U) In FY 2008: Conduct Congressionally-directed effort for Nanocomposites for Lightning Protection of Composite Airframe Structures.				
(U) In FY 2009: Not Applicable.				
(U) CONGRESSIONAL ADD: Nanotechnology Research.		0.000	4.970	0.000
(U) In FY 2007: Not Applicable.				
(U) In FY 2008: Conduct Congressionally-directed effort for Nanotechnology Research.				
(U) In FY 2009: Not Applicable.				
(U) CONGRESSIONAL ADD: ONAMI Safer Nanomaterials and Nanomanufacturing.		0.000	3.182	0.000
(U) In FY 2007: Not Applicable.				
(U) In FY 2008: Conduct Congressionally-directed effort for ONAMI Safer Nanomaterials and Nanomanufacturing.				
(U) In FY 2009: Not Applicable.				
(U) CONGRESSIONAL ADD: University of Houston Consortium for Nanomaterials for Aerospace Commerce and Technology (CONTACT).		0.000	2.385	0.000

UNCLASSIFIED

Exhibit R-2a, RDT&E Project Justification	DATE February 2008
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BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602102F Materials	PROJECT NUMBER AND TITLE 4347 Materials for Structures, Propulsion, and Subsystems
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(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) In FY 2007: Not Applicable.			
(U) In FY 2008: Conduct Congressionally-directed effort for University of Houston CONTACT.			
(U) In FY 2009: Not Applicable.			
(U)			
(U) CONGRESSIONAL ADD: Innovative Polymeric Materials for Three-Dimensional (3-D) Microdevice Construction.	0.000	0.993	0.000
(U) In FY 2007: Not Applicable.			
(U) In FY 2008: Conduct Congressionally-directed effort for Innovative Polymeric Materials for 3-D Microdevice Construction.			
(U) In FY 2009: Not Applicable.			
(U)			
(U) CONGRESSIONAL ADD: High Temperature Aerogel Materials for Global Strike Vehicles.	0.000	1.589	0.000
(U) In FY 2007: Not Applicable.			
(U) In FY 2008: Conduct Congressionally-directed effort for High Temperature Aerogel Materials for Global Strike Vehicles.			
(U) In FY 2009: Not Applicable.			
(U)			
(U) CONGRESSIONAL ADD: Durable Hybrid Coatings for Aircraft Systems.	0.000	1.192	0.000
(U) In FY 2007: Not Applicable.			
(U) In FY 2008: Conduct Congressionally-directed effort for Durable Hybrid Coatings for Aircraft Systems.			
(U) In FY 2009: Not Applicable.			
(U)			
(U) CONGRESSIONAL ADD: Chrome Free Environmentally Friendly Corrosion Protection for Aircraft.	0.000	1.589	0.000
(U) In FY 2007: Not Applicable.			
(U) In FY 2008: Conduct Congressionally-directed effort for Chrome Free Environmentally Friendly Corrosion Protection for Aircraft.			
(U) In FY 2009: Not Applicable.			
(U)			
(U) Total Cost	70.723	73.257	44.313

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY
02 Applied Research

PE NUMBER AND TITLE
0602102F Materials

PROJECT NUMBER AND TITLE
4347 Materials for Structures,
Propulsion, and Subsystems

(U) **C. Other Program Funding Summary (\$ in Millions)**

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to</u>	<u>Total Cost</u>
	<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Complete</u>	

(U) Related Activities:

(U) PE 0603112F, Advanced
Materials for Weapon Systems.

(U) PE 0603211F, Aerospace
Technology Dev/Demo.

(U) PE 0603216F, Aerospace
Propulsion and Power
Technology.

(U) This project has been
coordinated through the
Reliance 21 process to
harmonize efforts and eliminate
duplication.

(U) **D. Acquisition Strategy**

Not Applicable.

Exhibit R-2a, RDT&E Project Justification

DATE
February 2008

BUDGET ACTIVITY 02 Applied Research				PE NUMBER AND TITLE 0602102F Materials			PROJECT NUMBER AND TITLE 4348 Materials for Electronics, Optics, and Survivability		
Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
4348 Materials for Electronics, Optics, and Survivability	26.687	29.751	21.480	19.990	17.982	20.032	15.807	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project develops materials technologies for surveillance and situational awareness systems and subsystems for aircraft and missile applications, including sensor, microwave, and infrared detection and countermeasures devices used for targeting, electronic warfare, and active aircraft protection. Materials for protection of aircrews, sensors, and aircraft from laser and high-power microwave directed energy threats are also developed. Electronic and optical materials are being developed to enable surveillance and situational awareness with faster operating speeds, greater tunability, higher power output, improved thermal management (including higher operating temperatures), greater sensitivity, and extended dynamic range. New materials are being developed to counter the most prominent laser threats and to respond to emerging and agile threat wavelengths without impairing mission effectiveness.

(U) B. Accomplishments/Planned Program (\$ in Millions)

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) MAJOR THRUST: Develop, evaluate, and mature infrared (IR) detector materials and materials processing technologies to enable improved performance, affordability, and operational capability of Air Force surveillance, tracking, targeting, and situational awareness systems.	1.184	1.720	1.917
(U) In FY 2007: Validated optical, structural, and electronic properties of innovative IR materials to determine their ability to provide unique IR detection properties of interest to the Air Force. Characterized and evaluated the utility of single element multispectral IR materials with responses to more than two discrete wavelengths. Investigated the potential for three-dimensional material growth to exploit unique detection properties of complex IR materials. Validated promising materials growth technologies for nano-scale IR detection materials.			
(U) In FY 2008: Explore and validate suitable materials and structures for innovative IR materials in order to assess appropriateness for Air Force IR detection applications. Design and demonstrate IR materials systems capable of responses to more than two discrete wavelengths. Assess feasibility of further research and utility of three-dimensional material growth to exploit unique detection properties of complex IR materials. Develop promising materials growth technologies for nano-scale IR detection materials. Develop epitaxial materials and devices fabricated for high power applications. Investigate materials to enable development of design capabilities. Improve materials matching between device and substrates to enable higher power efficiency, better reliability, and increased power density to enable power dense devices.			
(U) In FY 2009: Develop materials and transition strategies for innovative IR materials while continuing to exploit newly emerging material concepts. Validate and optimize IR materials systems capable of responses to more than two discrete wavelengths. Develop candidate materials for three-dimensional growth to exploit unique detection			

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY
02 Applied ResearchPE NUMBER AND TITLE
0602102F MaterialsPROJECT NUMBER AND TITLE
**4348 Materials for Electronics,
Optics, and Survivability**

(U) B. Accomplishments/Planned Program (\$ in Millions)	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
properties of complex IR materials. Develop promising materials growth technologies for nano-scale IR detection materials. Demonstrate epitaxial materials device and substrate improvements. Develop design capability, leveraging new materials and substrates. Develop tools and methodologies that address the physics of failure for power dense devices.			
(U)			
(U) MAJOR THRUST: Develop and demonstrate enabling materials technologies to enhance the safety, survivability, and mission effectiveness of aircrews, sensors, viewing systems, and related assets.	7.613	9.721	9.522
(U) In FY 2007: Incorporated optimized nonlinear optical limiter materials for damage protection of eyes and sensor systems. Optimized photorefractive materials properties for Air Force passive protection applications. Incorporated switchable filter technology into device concepts for eye and sensor system protection.			
(U) In FY 2008: Demonstrate optimized nonlinear optical limiter materials for damage protection of eyes and sensor systems. Validate photorefractive materials properties for Air Force passive protection applications. Develop devices using switchable filter technology into eye and sensor system protection concepts.			
(U) In FY 2009: Develop nonlinear optical limiter materials into device concepts for damage protection of eyes and sensor systems. Develop photorefractive materials into device concepts for Air Force passive protection applications. Demonstrate devices using switchable filter technology into eye and sensor system protection concepts.			
(U)			
(U) MAJOR THRUST/CONGRESSIONAL ADD: Develop and demonstrate materials and process technologies for power generation, power control, and microwave components to provide improved performance, affordability, and operational capability for Air Force surveillance, tracking, targeting, situational awareness, and lethal and non-lethal weapon systems. Note: This effort includes Congressional Add funding of \$2.4 million in FY 2007 (\$1.4 million for Power Electronics Reliability and \$1.0 million for Advanced Materials Deposition for Semiconductor).	9.767	8.231	8.340
(U) In FY 2007: Demonstrated capabilities of advanced materials and materials process technologies to enable airborne lethal and non-lethal directed energy weapons in fighter-sized aircraft. Demonstrated scale-up of materials and materials processes to provide presently unattainable performance for power control systems, advanced radar, and electronic countermeasures. Demonstrated capabilities of advanced materials and materials process technologies to provide improvements and additional capabilities relative to baseline materials/processes for ultra-lightweight, ultra-high-power aircraft electrical generators enabling airborne lethal and non-lethal directed energy weapons in fighter-sized aircraft. Validated and demonstrated selected materials and materials process technologies for use in Terahertz components, supporting high speed communications and advanced sensors.			
(U) In FY 2008: Explore materials impact on device reliability for power control systems, advanced radar, and electronic			

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

02 Applied Research

PE NUMBER AND TITLE

0602102F Materials

PROJECT NUMBER AND TITLE

4348 Materials for Electronics,
Optics, and Survivability

(U) B. Accomplishments/Planned Program (\$ in Millions)	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
countermeasures application. Demonstrate the capabilities of advanced materials process technologies as well as investigate the reliability of materials as applied to ultra-lightweight, ultra-high-power aircraft electrical generators enabling airborne lethal and non-lethal directed energy weapons in fighter-sized aircraft. Demonstrate performance of candidate materials for use in Terahertz components, supporting high speed communications and advanced sensors.			
(U) In FY 2009: Optimize materials properties for enhanced device reliability. Assess the reliability of materials for ultra-lightweight, ultra-high-power aircraft electrical generator applications, enabling airborne lethal and non-lethal directed energy weapons in fighter-sized aircraft. Demonstrate performance of candidate materials for use in Terahertz components, supporting high speed communications and advanced sensors.			
(U)			
(U) MAJOR THRUST: Develop enabling and foundational biotechnologies for the areas of guidance and control, rapid tagging, tracking, and identification of targets, and bio-integrated electronics and sensing for continued Air Force dominance. Note: In FY 2008, this major thrust pulls together existing technologies from across the Air Force Research Laboratory to create an integrated biotechnologies effort for taggants.	0.000	1.972	1.701
(U) In FY 2007: Not Applicable.			
(U) In FY 2008: Investigate use of biological/nanomaterial-based taggants for the detection and identification of CBRNE targets at a distance using hybrid constructs. Assess effectiveness of CBRNE destruction using taggants in counterproliferation operations. Neutralize biological and chemical agents with the inherent and supplementary properties of the taggant nanoparticles. Develop active and passive polymer encapsulation technologies for taggant materials.			
(U) In FY 2009: Develop new biological/nanomaterial hybrids for the detection and identification of CBRNE agents. Analyze efficacy data of using taggants to destroy CBRNE agents. Incorporate taggants into a variety of media (polymers, paints) for optimal and mission-specific dispersal. Model dispersion properties of polymer-encapsulated taggants for optimal release and coverage.			
(U)			
(U) CONGRESSIONAL ADD: Engineered Optical Materials for Quantum Cryptography.	0.978	0.000	0.000
(U) In FY 2007: Conducted Congressionally-directed effort for Engineered Optical Materials for Quantum Cryptography.			
(U) In FY 2008: Not Applicable.			
(U) In FY 2009: Not Applicable.			
(U)			

UNCLASSIFIED

Exhibit R-2a, RDT&E Project Justification		DATE February 2008		
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602102F Materials	PROJECT NUMBER AND TITLE 4348 Materials for Electronics, Optics, and Survivability		
(U) B. Accomplishments/Planned Program (\$ in Millions)		<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) CONGRESSIONAL ADD: Electronic Type-specific Buckytubes for Next Generation Defense Electronics.		1.959	0.000	0.000
(U) In FY 2007: Conducted Congressionally-directed effort for Electronic Type-specific Buckytubes for Next Generation Defense Electronics.				
(U) In FY 2008: Not Applicable.				
(U) In FY 2009: Not Applicable.				
(U)				
(U) CONGRESSIONAL ADD: Fabrication and Processing of Adaptive Optics and Optical Materials.		1.370	0.000	0.000
(U) In FY 2007: Conducted Congressionally-directed effort for Fabrication and Processing of Adaptive Optics and Optical Materials.				
(U) In FY 2008: Not Applicable.				
(U) In FY 2009: Not Applicable.				
(U)				
(U) CONGRESSIONAL ADD: Quantum Wire Program for Defense.		0.978	0.000	0.000
(U) In FY 2007: Conducted Congressionally-directed effort for Quantum Wire Program for Defense.				
(U) In FY 2008: Not Applicable.				
(U) In FY 2009: Not Applicable.				
(U)				
(U) CONGRESSIONAL ADD: Wide Bandgap Materials Integration for Power Electronic, Sensor, and Optical Devices.		2.838	0.000	0.000
(U) In FY 2007: Conducted Congressionally-directed effort for Wide Bandgap Materials Integration for Power Electronic, Sensor, and Optical Devices.				
(U) In FY 2008: Not Applicable.				
(U) In FY 2009: Not Applicable.				
(U)				
(U) CONGRESSIONAL ADD: Advanced Engineered Non-Linear Optical Materials for Critical Wavelengths.		0.000	0.955	0.000
(U) In FY 2007: Not Applicable.				
(U) In FY 2008: Conduct Congressionally-directed effort for Advanced Engineered Non-Linear Optical Materials for Critical Wavelengths.				
(U) In FY 2009: Not Applicable.				
(U)				
(U) CONGRESSIONAL ADD: Free Electron Laser Capabilities for Aerospace Microfabrication.		0.000	1.589	0.000
(U) In FY 2007: Not Applicable.				

UNCLASSIFIED

Exhibit R-2a, RDT&E Project Justification		DATE February 2008		
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602102F Materials	PROJECT NUMBER AND TITLE 4348 Materials for Electronics, Optics, and Survivability		
(U) B. Accomplishments/Planned Program (\$ in Millions)		<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) In FY 2008: Conduct Congressionally-directed effort for Free Electron Laser Capabilities for Aerospace Microfabrication.				
(U) In FY 2009: Not Applicable.				
(U) CONGRESSIONAL ADD: Gallium Nitride (GaN) RF Power Technology.		0.000	1.589	0.000
(U) In FY 2007: Not Applicable.				
(U) In FY 2008: Conduct Congressionally-directed effort for Gallium Nitride (GaN) RF Power Technology.				
(U) In FY 2009: Not Applicable.				
(U) CONGRESSIONAL ADD: Large Area, APVT Materials Development for High Power Devices.		0.000	1.589	0.000
(U) In FY 2007: Not Applicable.				
(U) In FY 2008: Conduct Congressionally-directed effort for Large Area, APVT Materials Development for High Power Devices.				
(U) In FY 2009: Not Applicable.				
(U) CONGRESSIONAL ADD: Plasma-Sphere Array for Flexible Electronics.		0.000	1.589	0.000
(U) In FY 2007: Not Applicable.				
(U) In FY 2008: Conduct Congressionally-directed effort for Plasma-Sphere Array for Flexible Electronics.				
(U) In FY 2009: Not Applicable.				
(U) CONGRESSIONAL ADD: Polymer Nanocomposites for Energy Storage and Pulsed Power.		0.000	0.796	0.000
(U) In FY 2007: Not Applicable.				
(U) In FY 2008: Conduct Congressionally-directed effort for Polymer Nanocomposites for Energy Storage and Pulsed Power.				
(U) In FY 2009: Not Applicable.				
(U) Total Cost		26.687	29.751	21.480

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY
02 Applied Research

PE NUMBER AND TITLE
0602102F Materials

PROJECT NUMBER AND TITLE
4348 Materials for Electronics,
Optics, and Survivability

(U) **C. Other Program Funding Summary (\$ in Millions)**

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to</u>	<u>Total Cost</u>
	<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Complete</u>	
(U) Related Activities:									
(U) PE 0603112F, Advanced Materials for Weapon Systems.									
(U) PE 0602202F, Human Effectiveness Applied Research.									
(U) PE 0602204F, Aerospace Sensors.									
(U) PE 0603211F, Aerospace Technology Dev/Demo.									
(U) PE 0603231F, Crew Systems and Personnel Protection Technology.									
(U) This project has been coordinated through the Reliance 21 process to harmonize efforts and eliminate duplication.									
(U) D. Acquisition Strategy Not Applicable.									

Exhibit R-2a, RDT&E Project Justification

DATE
February 2008

BUDGET ACTIVITY 02 Applied Research				PE NUMBER AND TITLE 0602102F Materials			PROJECT NUMBER AND TITLE 4349 Materials Technology for Sustainment		
Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
4349 Materials Technology for Sustainment	21.550	27.642	18.662	17.692	17.590	18.698	18.771	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project develops materials and materials processing technologies to support operational Air Force mission areas by providing the ability to inspect the quality of delivered systems, transitioning more reliable and maintainable materials, establishing a capability to detect and characterize performance threatening defects, characterizing materials processes and properties necessary for materials transition, and providing quick reaction support and failure analysis to the operational commands and repair centers. Repair techniques and nondestructive inspection/evaluation (NDI/E) methods are developed that are needed for metallic and non-metallic structures, coatings, corrosion control processes, and to support integration of composite structures for aerospace systems. Various NDI/E methods are essential to ensure optimum quality in the design and production of aircraft, propulsion, and missile systems. These NDI/E methods are also essential to monitor and detect the onset of any service-initiated damage and/or deterioration due to aging of operational systems.

(U) B. Accomplishments/Planned Program (\$ in Millions)

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) MAJOR THRUST: Develop NDI/E technologies to identify and characterize damage in aging aerospace structures, propulsion systems, and complex, low-observable (LO) materials and structures.	6.046	6.303	6.890
(U) In FY 2007: Developed computer simulations and models of NDI/E technique response to enable rapid assessment of multiple NDI/E technologies for depot level inspections. Developed NDI/E technologies for inspection of thick (multi-layer) aging aircraft structures with complex geometries. Developed advanced LO NDI/E methods and systems for use in battle damage assessment and for inspection following battle damage repair.			
(U) In FY 2008: Mature modeling and simulation methodologies for rapid assessment of multiple NDI/E technologies for depot level inspections. Validate NDI/E technologies for inspection of thick (multi-layer) aging aircraft structures with complex geometries. Initiate studies of harsh environment sensors to enable health management for turbine engines and thermal protection systems.			
(U) In FY 2009: Demonstrate novel NDI/E methods and techniques to detect and track damage in a wide variety of materials and components for aerospace systems. Demonstrate NDI/E technologies for inspection of thick (multi-layer) aging aircraft structures with complex geometries. Develop sensing technology to detect changes in temperature, strain, pressure, and vibration to enable on-demand health status of turbine engines, aircraft structures, wiring systems, and thermal protection systems.			
(U) MAJOR THRUST: Develop support capabilities, information, and processes to resolve problems with materials in the repair of aircraft structures and to reduce aircraft corrosion.	7.401	4.859	5.163
(U) In FY 2007: Evaluated corrosion and erosion resistance of new and emerging materials used in operationally fielded			

Exhibit R-2a, RDT&E Project Justification		DATE February 2008
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602102F Materials	PROJECT NUMBER AND TITLE 4349 Materials Technology for Sustainment

(U) B. Accomplishments/Planned Program (\$ in Millions)	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
Air Force systems. Evaluated methodologies to test failure limits for MEMS structures and subsystems. Validated effects of defects in laser additive manufactured parts.			
(U) In FY 2008: Develop advanced techniques to evaluate corrosion and erosion resistance of new and emerging materials used in operationally fielded Air Force systems. Develop advanced materials and processes technology to repair Air Force legacy systems and test failure limits for emerging Air Force systems. Initiate analysis to understand the effects of materials processes, such as the application of residual stress on the surface of steel and other structural metals, to support customer focused studies and point design solutions that will extend the life of specific components on Air Force systems. Demonstrate technologies for improved maintainability of advanced LO materials and designs, such as conductive outer-mold-line, applique, door edges and seals, and multifunctional systems.			
(U) In FY 2009: Validate advanced techniques to evaluate corrosion and erosion resistance of new and emerging materials used in operationally fielded Air Force systems. Evaluate advanced materials and processes technology to repair Air Force legacy systems and test failure limits for emerging Air Force systems. Develop test methods and techniques to understand the effects of materials processes, such as the application of residual stress on the surface of steel and other structural metals, to support studies and point design solutions that will extend the life of specific structural components on Air Force systems. Demonstrate and transition technologies for improved maintainability of advanced LO materials and designs, such as conductive outer-mold-line, applique, door edges and seals, and multifunctional systems.			
(U) MAJOR THRUST: Develop support capabilities, information, and processes to resolve materials problems and provide electronic and structural failure analysis of components.	4.906	5.749	6.609
(U) In FY 2007: Performed failure analysis and materials investigations for field, acquisition, and depot organizations. Demonstrated electrostatic discharge protection technologies and procedures for emerging avionics subsystems. Validated new test methodologies for analyzing structural failures of emerging materials for Air Force systems. Evaluated and validated wiring materials technologies to replace aging wiring systems and new wiring technologies for emerging weapons systems.			
(U) In FY 2008: Perform quick response failure analysis and materials investigations for fielded system, acquisition organization, depot system materials failures, and provide advanced materials solutions to ensure system availability and safety of flight. Develop advanced electrostatic discharge protection technologies and procedures for emerging avionics subsystems. Demonstrate advanced test methodologies for analyzing structural failures of emerging materials for Air Force systems. Develop advanced wiring materials technologies to replace aging wiring systems			

UNCLASSIFIED

Exhibit R-2a, RDT&E Project Justification		DATE February 2008		
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602102F Materials	PROJECT NUMBER AND TITLE 4349 Materials Technology for Sustainment		
	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	
(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u>				
and new wiring technologies for emerging weapons systems.				
(U) In FY 2009: Perform quick response failure analysis and materials investigations for fielded system, acquisition organization, depot system materials failures, and provide advanced materials solutions to ensure system availability and safety of flight. Develop advanced electrostatic discharge protection technologies and procedures for emerging avionics subsystems. Demonstrate advanced test methodologies for analyzing structural failures of emerging materials for Air Force systems. Develop advanced wiring materials technologies to replace aging wiring systems and new wiring technologies for emerging weapons systems.				
(U)				
(U) MAJOR THRUST: Develop enabling technologies to reduce the Air Force LO maintenance burden. Note: In FY 2008, efforts in this thrust will be combined with other major thrusts in this project.	0.825	0.000	0.000	
(U) In FY 2007: Developed technologies for improved maintainability of advanced LO materials and designs, such as conductive outer-mold-line, applique, door edges and seals, multifunctional systems, and embedded LO NDI/E.				
(U) In FY 2008: Not Applicable.				
(U) In FY 2009: Not Applicable.				
(U)				
(U) CONGRESSIONAL ADD: Accelerated Insertion of Advanced Materials for Materials Substitution and Repair-National Institute for Aviation Research.	1.272	0.000	0.000	
(U) In FY 2007: Conducted Congressionally-directed effort for Accelerated Insertion of Advanced Materials for Materials Substitution and Repair-National Institute for Aviation Research.				
(U) In FY 2008: Not Applicable.				
(U) In FY 2009: Not Applicable.				
(U)				
(U) CONGRESSIONAL ADD: Accelerated Insertion of Advanced Materials and Certification for Military Aircraft Structure Material.	1.100	2.783	0.000	
(U) In FY 2007: Conducted Congressionally-directed effort for Accelerated Insertion of Advanced Materials and Certification for Military Aircraft Structure Material Substitution and Repair.				
(U) In FY 2008: Conduct Congressionally-directed effort for Accelerated Insertion of Advanced Materials and Certification for Military Aircraft Structure Material.				
(U) In FY 2009: Not Applicable.				
(U)				
(U) CONGRESSIONAL ADD: Aircraft Active Corrosion Protective Compounds.	0.000	0.993	0.000	

UNCLASSIFIED

Exhibit R-2a, RDT&E Project Justification	DATE February 2008
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BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602102F Materials	PROJECT NUMBER AND TITLE 4349 Materials Technology for Sustainment
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(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) In FY 2007: Not Applicable.			
(U) In FY 2008: Conduct Congressionally-directed effort for Aircraft Active Corrosion Protective Compounds.			
(U) In FY 2009: Not Applicable.			
(U) CONGRESSIONAL ADD: Institute for Science and Engineering Simulation (ISES) / Aircraft Fatigue Modeling and Simulation.	0.000	2.484	0.000
(U) In FY 2007: Not Applicable.			
(U) In FY 2008: Conduct Congressionally-directed effort for Institute for Science and Engineering Simulation (ISES) / Aircraft Fatigue Modeling and Simulation.			
(U) In FY 2009: Not Applicable.			
(U) CONGRESSIONAL ADD: Polymer Stress and Sensor Damage Sensors for Composites.	0.000	2.882	0.000
(U) In FY 2007: Not Applicable.			
(U) In FY 2008: Conduct Congressionally-directed effort for Polymer Stress and Sensor Damage Sensors for Composites.			
(U) In FY 2009: Not Applicable.			
(U) CONGRESSIONAL ADD: Science for Sustainment Initiative to Improve Mission.	0.000	1.589	0.000
(U) In FY 2007: Not Applicable.			
(U) In FY 2008: Conduct Congressionally-directed effort for Science for Sustainment Initiative to Improve Mission.			
(U) In FY 2009: Not Applicable.			
(U) Total Cost	21.550	27.642	18.662

(U) <u>C. Other Program Funding Summary (\$ in Millions)</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to</u>	<u>Total Cost</u>
	<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Complete</u>	
(U) Related Activities:									
(U) PE 0603112F, Advanced Materials for Weapons Systems.									
(U) PE 0603211F, Aerospace Technology Dev/Demo.									

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

02 Applied Research

PE NUMBER AND TITLE

0602102F Materials

PROJECT NUMBER AND TITLE

**4349 Materials Technology for
Sustainment****(U) C. Other Program Funding Summary (\$ in Millions)**

(U) This project has been coordinated through the Reliance 21 process to harmonize efforts and eliminate duplication.

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY 02 Applied Research				PE NUMBER AND TITLE 0602102F Materials			PROJECT NUMBER AND TITLE 4915 Deployed Air Base Technology		
Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
4915 Deployed Air Base Technology	6.750	11.308	3.646	2.706	2.734	2.899	3.005	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project develops new deployable airbase technologies to reduce airlift and manpower requirements, setup times, and sustainment costs, and to improve protection and survivability of deployed Air Expeditionary Force (AEF) warfighters. Affordable, efficient technologies are developed for base infrastructure, fire fighting, and force protection to improve Expeditionary Combat Support operations.

(U) B. Accomplishments/Planned Program (\$ in Millions)

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) MAJOR THRUST: Develop new deployable airbase technologies to reduce airlift and manpower requirements, setup times, and sustainment costs in support of AEF operations.	1.939	1.226	1.650
(U) In FY 2007: Developed high-efficiency solar shelter fabrics. Developed advanced heat and mass transfer technologies and demonstrated logistic fuel processing planar technology. Investigated behavior of soil and stabilizer interaction with airfield matting and begin model development. Developed non-radar wave methods of nondestructive inspection of airfield surface anomalies. Synthesized polymer materials using biocatalysts and reagents for producing reduced cost, tailored characteristics in aerospace materials.			
(U) In FY 2008: Develop and analyze solar power for bare base applications. Transition fuel cell reformer specification for acquisition. Begin development of advanced integrated power technologies. Investigate and evaluate high temperature effects on operating surfaces and develop repair technology. Demonstrate nondestructive inspection of airfield surface evaluation technologies. Demonstrate cost effectiveness and performance of synthesized polymer materials.			
(U) In FY 2009: Analyze and demonstrate renewable power technologies applicable to deployed forces. Demonstrate advanced integrated power technologies. Evaluate and develop mitigation for high temperature effects on operating surfaces. Demonstrate and analyze nondestructive inspection of airfield surface evaluation technologies.			
(U) MAJOR THRUST/CONGRESSIONAL ADD: Develop affordable technologies to provide force protection and survivability to AEF deployed warfighters and infrastructure. Note: This effort includes Congressional Add funding of \$3.1 million in FY 2007 (\$2.0 million for Blast Resistant Panels for Buildings, Shelters, and Vehicles and \$1.1 million for Fire and Blast Resistant Materials for Force Protection).	4.811	1.338	1.996
(U) In FY 2007: Demonstrated emerging fire suppression technologies for integrated crash/rescue capability. Integrated individual fire fighter effectiveness technologies for a combined technology demonstration. Demonstrated resilient structural materials and methodologies for improved protection of structures and inhabitants. Developed technologies to protect against the ballistic and fragmentation effects of improvised explosive device threats, and			

UNCLASSIFIED

Exhibit R-2a, RDT&E Project Justification		DATE February 2008		
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602102F Materials	PROJECT NUMBER AND TITLE 4915 Deployed Air Base Technology		
	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	
(U) B. Accomplishments/Planned Program (\$ in Millions) initiated protective material development against high energy threats. Developed characterization data for atmospheric models for protection of deployed warfighters from asymmetric threats.				
(U) In FY 2008: Develop methodologies to characterize candidate fire suppression agents and begin development of supporting fire suppression technologies for crash/rescue. Develop and evaluate combined technologies for fire fighter effectiveness. Demonstrate and analyze effectiveness of resilient structural materials and methodologies for improved protection of structures and inhabitants. Investigate and analyze effectiveness of innovative improvised explosive detection and defeat for high energy threat. Investigate mechanisms of gas phase kinetics. Develop and evaluate accuracy for atmospheric models for protection of deployed warfighters from asymmetric threats.				
(U) In FY 2009: Develop and demonstrate methodologies to characterize candidate fire suppression agents and continue to develop supporting fire suppression technologies for crash/rescue. Develop and analyze combined technologies for fire fighter effectiveness. Validate and demonstrate resilient structural materials and methodologies for improved protection of structures and inhabitants. Develop and demonstrate effectiveness of innovative defeat of IED and high energy threats.				
(U) CONGRESSIONAL ADD: Blast Resistant Concrete Products. In FY 2007: Not Applicable.	0.000	1.589	0.000	
(U) In FY 2008: Conduct Congressionally-directed effort for Blast Resistant Concrete Products.				
(U) In FY 2009: Not Applicable.				
(U) CONGRESSIONAL ADD: Life Shield Blast Resistant Panels. In FY 2007: Not Applicable.	0.000	0.995	0.000	
(U) In FY 2008: Conduct Congressionally-directed effort for Life Shield Blast Resistant Panels.				
(U) In FY 2009: Not Applicable.				
(U) CONGRESSIONAL ADD: Fire and Blast Resistant Materials for Force Protection. In FY 2007: Not Applicable.	0.000	1.589	0.000	
(U) In FY 2008: Conduct Congressionally-directed effort for Fire and Blast Resistant Materials for Force Protection.				
(U) In FY 2009: Not Applicable.				
(U) CONGRESSIONAL ADD: Advanced Carbon Fiber Research and Testing Initiative. In FY 2007: Not Applicable.	0.000	2.982	0.000	
(U) In FY 2008: Conduct Congressionally-directed effort for Advanced Carbon Fiber Research and Testing Initiative.				

Exhibit R-2a, RDT&E Project Justification	DATE February 2008
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BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602102F Materials	PROJECT NUMBER AND TITLE 4915 Deployed Air Base Technology
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(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) In FY 2009: Not Applicable.			
(U) CONGRESSIONAL ADD: Advanced Aerospace Carbon Foam Heat Exchangers.	0.000	1.589	0.000
(U) In FY 2007: Not Applicable.			
(U) In FY 2008: Conduct Congressionally-directed effort for Advanced Aerospace Carbon Foam Heat Exchangers.			
(U) In FY 2009: Not Applicable.			
(U) Total Cost	6.750	11.308	3.646

(U) <u>C. Other Program Funding Summary (\$ in Millions)</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to</u>	<u>Total Cost</u>
	<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Complete</u>	
(U) Related Activities:									
(U) PE 0603112F, Advanced Materials for Weapon Systems.									
(U) This project has been coordinated through the Reliance 21 process to harmonize efforts and eliminate duplication.									
(U) <u>D. Acquisition Strategy</u> Not Applicable.									

UNCLASSIFIED

PE NUMBER: 0602201F
 PE TITLE: Aerospace Vehicle Technologies

Exhibit R-2, RDT&E Budget Item Justification	DATE February 2008
---	------------------------------

BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602201F Aerospace Vehicle Technologies
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Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
Total Program Element (PE) Cost	115.423	139.855	122.870	143.289	145.056	140.955	142.111	Continuing	TBD
22SP Applied Space Access Vehicle Tech	3.688	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	TBD
2401 Structures	44.663	37.890	37.411	51.243	50.081	44.424	57.697	Continuing	TBD
2403 Flight Controls and Pilot-Vehicle Interface	36.253	42.032	33.477	36.791	38.931	38.040	37.150	Continuing	TBD
2404 Aeromechanics and Integration	30.819	59.933	51.982	55.255	56.044	58.491	47.264	Continuing	TBD

Note: In FY 2007, Project 6266SP, Applied Space Access Vehicle Technology, efforts were transferred from PE 0602500F, Multidisciplinary Space Technology, Project 625030, Applied Space Access Vehicle Technology, in order to effectively manage and provide oversight of the efforts.

(U) A. Mission Description and Budget Item Justification

This program investigates, develops, and analyzes aerospace and access to space vehicle technologies in the three primary areas of structures, controls, and aeromechanics. Advanced structures concepts are explored and developed to exploit new materials, fabrication processes, and design techniques. Flight control technologies are developed and simulated for aerospace vehicles. Advanced aerodynamic vehicle configurations are developed and analyzed through simulations, experiments, and multi-disciplinary analysis. Resulting technologies reduce life cycle costs and improve the performance of existing and future manned and unmanned aerospace vehicles. Note: In FY 2008, Congress added \$1.9 million for Advancement of Intelligent Aerospace Systems (AIAS) for the U.S. Air Force, \$0.9 million for Cognitive Unmanned Air Vehicle, \$0.9 million for Modeling and Simulation for Rapid Integration and Technology Evaluation, \$3.9 million for Characterization of Airborne Environment for Tactical Lasers, and \$0.7 million for Single-Mode Optical Connectors for Advanced Air Vehicles.

This program is in Budget Activity 2, Applied Research, since it develops and determines the technical feasibility and military utility of evolutionary and revolutionary aerospace vehicle technologies.

(U) B. Program Change Summary (\$ in Millions)

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) Previous President's Budget	118.901	131.948	119.637
(U) Current PBR/President's Budget	115.423	139.855	122.870
(U) Total Adjustments	-3.478	7.907	
(U) Congressional Program Reductions			
Congressional Rescissions	0.001	-0.893	
Congressional Increases		8.800	
Reprogrammings	-1.478		
SBIR/STTR Transfer	-2.001		

(U) Significant Program Changes:

Exhibit R-2, RDT&E Budget Item Justification

DATE

February 2008

BUDGET ACTIVITY

02 Applied Research

PE NUMBER AND TITLE

0602201F Aerospace Vehicle Technologies

Not Applicable.
(U) C. Performance Metrics
Under Development

Exhibit R-2a, RDT&E Project Justification

DATE
February 2008

BUDGET ACTIVITY 02 Applied Research				PE NUMBER AND TITLE 0602201F Aerospace Vehicle Technologies			PROJECT NUMBER AND TITLE 22SP Applied Space Access Vehicle Tech		
Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
22SP Applied Space Access Vehicle Tech	3.688	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

Note: In FY 2007, Project 6266SP, Applied Space Access Vehicle Technology, efforts were transferred from PE 0602500F, Multidisciplinary Space Technology, Project 625030, Applied Space Access Vehicle Technology, in order to effectively manage and provide oversight of the efforts. In FY 2008, efforts were terminated due to higher Air Force priorities.

(U) A. Mission Description and Budget Item Justification

This project develops technologies in areas of advanced structures, flight controls, and aerodynamics to enable affordable on-demand military access to space. Resulting technologies contribute significantly towards the development of reliable, responsive space access systems with aircraft-like operations. Payoffs to the warfighter include enhanced mission effectiveness, improved flight safety, improved maintenance, and decreased size, weight, and cost.

(U) B. Accomplishments/Planned Program (\$ in Millions)

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) MAJOR THRUST: Develop advanced structure, flight control, and aerodynamic technologies to enable horizontal launch for affordable on-demand military access to space.	3.688	0.000	0.000
(U) In FY 2007: Defined and developed integrated guidance and control laws to expand the launch vehicle performance envelope.			
(U) In FY 2008: Not Applicable.			
(U) In FY 2009: Not Applicable.			
(U) Total Cost	3.688	0.000	0.000

(U) C. Other Program Funding Summary (\$ in Millions)

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to Complete</u>	<u>Total Cost</u>
	<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>		
(U) Related Activities:									
(U) PE 0603211F, Aerospace Technology Dev/Demo.									

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification

DATE
February 2008

BUDGET ACTIVITY 02 Applied Research				PE NUMBER AND TITLE 0602201F Aerospace Vehicle Technologies			PROJECT NUMBER AND TITLE 2401 Structures		
Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
2401 Structures	44.663	37.890	37.411	51.243	50.081	44.424	57.697	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

- (U) **A. Mission Description and Budget Item Justification**
 This project develops advanced structures concepts to exploit new materials and fabrication processes and investigates new structural concepts and design techniques. New structural concepts include incorporating subsystem hardware items (e.g., antennas, sensors, directed energy weapon components, and integrated energy storage) and adaptive mechanisms into the actual aircraft structures and/or skin of the aircraft. Resulting technologies strengthen and extend the life of current and future manned and unmanned aerospace vehicle structures, while providing increased capabilities. Payoffs to the warfighter include reduced weight and cost, as well as improved operability and maintainability of aerospace vehicles.
- (U) **B. Accomplishments/Planned Program (\$ in Millions)**
- | | | | |
|--|----------------|----------------|----------------|
| | <u>FY 2007</u> | <u>FY 2008</u> | <u>FY 2009</u> |
| (U) MAJOR THRUST: Develop an economic service life analysis capability comprised of analysis tools, methodologies, and structural health monitoring schemes. | 2.082 | 3.705 | 3.593 |
- (U) In FY 2007: Continued development of structural health management schemes for structures susceptible to damage. Continued the development of economic service life analysis and structural design tools for current and future aircraft, enhancing capabilities, component replacement, and technology direction. Incorporated newly developed analysis tools into life prediction and failure analysis. Continued to develop failure criteria tools for advanced high temperature aircraft components and concepts.
- (U) In FY 2008: Based upon results of demonstration efforts in PE 0603211F - Aerospace Technology Dev/Demo, refine development of structural health management schemes for structures susceptible to damage. Continue the development of economic service life analysis and structural design tools for current and future aircraft, enhancing capabilities, component replacement, and technology direction. Continue the development analysis tools into life prediction and failure analysis. Continue to develop failure criteria tools for advanced high temperature aircraft components and concepts.
- (U) In FY 2009: Continue development of structural health management schemes for structures susceptible to damage. Continue the development of economic service life analysis and structural design tools for current and future aircraft, enhancing capabilities, component replacement, and technology direction. Continue the development analysis tools into life prediction and failure analysis. Continue to develop failure criteria tools for advanced high temperature aircraft components and concepts.
- | | | | |
|--|-------|-------|-------|
| (U) MAJOR THRUST: Develop methodologies to allow for analytical airworthiness certification that will reduce the cost and time involved in actual full-scale testing of components and aircraft prior to obtaining airworthiness | 7.058 | 3.716 | 3.322 |
|--|-------|-------|-------|

Exhibit R-2a, RDT&E Project Justification		DATE
BUDGET ACTIVITY 02 Applied Research		February 2008
PE NUMBER AND TITLE 0602201F Aerospace Vehicle Technologies		PROJECT NUMBER AND TITLE 2401 Structures
(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u>		<u>FY 2007</u> <u>FY 2008</u> <u>FY 2009</u>
certification. Note: In FY 2008 and out decrease due to completion of medium- and high-fidelity and real-time analytical certification methodologies that improve airworthiness certification process.		
(U) In FY 2007: Continued development of analytical certification methodologies that incorporate advanced methods, concepts, diagnostic techniques, and manufacturing technologies into aircraft components and airframe design. Completed development of medium- and high-fidelity and real-time analytical certification methodologies that improve airworthiness certification process and reduce development and testing for aircraft and components subject to dynamics loads.		
(U) In FY 2008: Continue development of analytical certification methodologies that incorporate advanced methods, concepts, diagnostic techniques, and manufacturing technologies into aircraft components and airframe design. Incorporate newly developed analysis in real-time analytical certification methodologies that improve airworthiness certification process and reduce development and testing for aircraft and components subject to dynamics loads.		
(U) In FY 2009: Continue development of analytical certification methodologies that incorporate advanced methods, concepts, diagnostic techniques, and manufacturing technologies into aircraft components and airframe design. Initiate development of high-fidelity and continue real-time analytical certification methodologies that improve airworthiness certification process and reduce development and testing for aircraft and components subject to dynamics loads.		
(U)		
(U) MAJOR THRUST: Develop design methods to capitalize on new materials and integration of various subsystem hardware items (e.g., antennas, sensors, direct energy weapon components, and integrated energy storage) and adaptive mechanisms into the actual aircraft structures and/or skin of the aircraft.	18.822	17.442 17.118
(U) In FY 2007: Continued the development, evaluation, and assessment of design and analysis methods and components that enable the integration of structures with other air vehicle functions to reduce cost and weight, as well as increase the survivability and performance of future systems. Continued the development, evaluation, assessment, and ground testing of adaptive structures, subsystem hardware, and antenna integration into load-bearing structures to create multi-function or ultra-lightweight concepts. Completed feasibility determination efforts of energy storage concepts that are integrated into load-bearing structures. Completed the development and analysis, and initiated evaluation and testing of critical subsystem hardware integration methods that enable directed energy weapons to be carried out on future air vehicles. Initiated development, analysis, and evaluation of innovative technologies that integrate active aeroelastic design concepts, adaptive structures, and aerodynamic flow control technologies to enable viable long-range and long endurance air vehicle concepts.		
(U) In FY 2008: Continue the development, evaluation, and assessment of design and analysis methods and components		

Exhibit R-2a, RDT&E Project Justification	DATE February 2008
--	------------------------------

BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602201F Aerospace Vehicle Technologies	PROJECT NUMBER AND TITLE 2401 Structures
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	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
<p>(U) B. Accomplishments/Planned Program (\$ in Millions)</p> <p>that enable the integration of structures with other air vehicle functions to reduce cost and weight, as well as increase the survivability and performance of future systems. Continue the development, evaluation, assessment, and ground testing of adaptive structures, subsystem hardware, and antenna integration into load-bearing structures to create multi-function or ultra-lightweight concepts. Continue development, analysis, evaluation, and simulation of innovative technologies to advance active aero elastic design concepts, adaptive structures, aerodynamic flow control technologies, system health reasoners, and active denial concepts. Initiate characterization of high energy laser concepts. Initiate development, evaluation, and assessment of multi-functional structures to include ground demonstration of energy storage concepts, integrated distributed electronics, and homogeneous sensor integration systems.</p>			
<p>(U) In FY 2009: Continue the development, evaluation, and assessment of design and analysis methods and components that enable the integration of structures with other air vehicle functions to reduce cost and weight, as well as increase the survivability and performance of future systems. Initiate analysis for capabilities for conformal load bearing antenna structure. Continue the development, evaluation, assessment, and ground testing of adaptive structures, subsystem hardware, and antenna integration into load-bearing structures to create multi-function or ultra-lightweight concepts, which provides for increased energy efficiencies. Continue development, analysis, evaluation, and simulation of innovative technologies to advance active aero elastic design concepts, adaptive structures, aerodynamic flow control technologies, system health reasoners, and active denial concepts. Continue characterization of high energy laser concepts. Continue development, evaluation, and assessment of multi-functional structures to include ground demonstration of energy storage concepts, integrated distributed electronics, and homogeneous sensor integration systems.</p>			
<p>(U) MAJOR THRUST: Develop technologies that will permit the structural development of aircraft that can operate at an extreme altitude, while at sustained speeds greater than Mach 2.</p>	16.701	13.027	13.378
<p>(U) In FY 2007: Further developed technologies that incorporate advanced materials and design concepts for the creation of an integrated air vehicle structure that can withstand extreme flight environments. Technologies improved durability of existing and future aerospace vehicle structures resulting in reduced cost and increased life. Completed development of concepts germane to advanced, all weather, durable, thermal protections systems; attachment techniques; vehicle health management; hot primary structures; hybrid structures; joining concepts; and tanks.</p>			
<p>(U) In FY 2008: Further develop technologies that incorporate advanced materials and design concepts for the creation of an integrated air vehicle structure that can withstand extreme flight environments. Technologies will improve</p>			

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602201F Aerospace Vehicle Technologies	PROJECT NUMBER AND TITLE 2401 Structures
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(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
durability of existing and future aerospace vehicle structures resulting in reduced cost and increased life. Incorporate newly developed structural concepts and analysis methods for design and evaluation of hot primary structure.			
(U) In FY 2009: Further develop technologies that incorporate advanced materials and design concepts for the creation of an integrated air vehicle structure that can withstand extreme flight environments. Technologies will improve durability of existing and future aerospace vehicle structures resulting in reduced cost and increased life. Incorporate newly developed structural concepts and analysis methods for design and evaluation of hot primary structure.			
(U)			
(U) Total Cost	44.663	37.890	37.411

(U) <u>C. Other Program Funding Summary (\$ in Millions)</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to</u>	<u>Total Cost</u>
	<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Complete</u>	
(U) Related Activities:									
(U) PE 0602102F, Materials.									
(U) PE 0603112F, Advanced Materials for Weapon Systems.									
(U) PE 0603211F, Aerospace Technology Dev/Demo.									
(U) PE 0604015F, Next Generation Bomber.									
(U) This project has been coordinated through the Reliance 21 process to harmonize efforts and eliminate duplication.									
(U) <u>D. Acquisition Strategy</u>									
Not Applicable.									

Exhibit R-2a, RDT&E Project Justification

DATE
February 2008

BUDGET ACTIVITY 02 Applied Research				PE NUMBER AND TITLE 0602201F Aerospace Vehicle Technologies			PROJECT NUMBER AND TITLE 2403 Flight Controls and Pilot-Vehicle Interface		
Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
2403 Flight Controls and Pilot-Vehicle Interface	36.253	42.032	33.477	36.791	38.931	38.040	37.150	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

- (U) **A. Mission Description and Budget Item Justification**
 This project develops technologies that enable maximum affordable capability from manned and unmanned aerospace vehicles. Advanced flight control technologies are developed for maximum vehicle performance throughout the flight envelope and simulated in virtual environments. Resulting technologies contribute significantly towards the development of reliable autonomous unmanned air vehicles, space access systems with aircraft-like operations, and extended-life legacy aircraft. Payoffs to the warfighter include enhanced mission effectiveness, optimized flight safety, increased survivability, improved maintenance, and decreased size, weight, and cost. Leverages a network of synthetic environments for evaluation of advanced concepts.
- (U) **B. Accomplishments/Planned Program (\$ in Millions)**
- | | | | |
|--|----------------|----------------|----------------|
| | <u>FY 2007</u> | <u>FY 2008</u> | <u>FY 2009</u> |
| (U) MAJOR THRUST: Develop advanced flight control systems, components, and integrated vehicle health monitoring systems for both manned and unmanned aircraft. In addition to increased reliability, efforts will also focus on reducing the size, weight, and cost of control and prognostic systems. Note: Increased funding in FY 2008, is due to increased emphasis being placed on incorporating data from air vehicle monitoring components into the flight control systems. | 15.482 | 20.515 | 18.088 |
- (U) In FY 2007: Furtherd the development and assessment of advanced control mechanization technologies to provide highly reliable operations for manned and unmanned systems under adverse environments at significantly reduced size, weight, and cost. Developed high-density optical component technologies for adverse environments that reduce subsystem size, weight, and cost while considering maintainability. Designed systems for safety-critical control using high-density optical components. Continued to develop and assess tools and processes for the affordable validation and verification of complex, adaptive, and autonomous control software. Refined technologies and analysis tools for reconfigurable control systems. Completed the evaluation of sensing and associated interpretation techniques for unmanned system situational awareness in aerospace operations. Refined technologies that permit integrated vehicle health management.
- (U) In FY 2008: Further the development and assessment of advanced control mechanization technologies to provide highly reliable operations for manned and unmanned systems under adverse environments at significantly reduced size, weight, and cost. Complete development of high-density optical component technologies for adverse environments that reduce subsystem size, weight, and cost while considering maintainability. Complete systems design for safety-critical electromagnetic tolerant systems. Complete the assessment of enhanced tools and processes for the affordable validation and verification of complex, adaptive, and autonomous control software. Complete

UNCLASSIFIED

Exhibit R-2a, RDT&E Project Justification		DATE February 2008		
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602201F Aerospace Vehicle Technologies	PROJECT NUMBER AND TITLE 2403 Flight Controls and Pilot-Vehicle Interface		
B. Accomplishments/Planned Program (\$ in Millions)		<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) refinement of actuation fault compensation technologies for integrated vehicle health management.				
(U) In FY 2009: Further the development and assessment of advanced control mechanization technologies to provide highly reliable operations for manned and unmanned systems under adverse environments at significantly reduced size, weight, and cost. Initiate development of control architecture enhancements to enable design for certification to ease validation and verification for complex and adaptive unmanned systems. Initiate development of low-maintenance/fault tolerant control-effector technology for aerospace applications.				
(U)				
(U)	MAJOR THRUST: Develop flight control systems that will permit safe interoperability between manned aircraft and unmanned aircraft. Concepts will also provide mission responsiveness and adaptability for improved operational effectiveness of manned and unmanned systems.	9.630	9.817	8.665
(U)	In FY 2007: Continued to develop and assess novel control automation techniques and adaptive algorithms to enable safe and interoperable application of manned and unmanned aerospace systems. Continued to enhance reliability and performance analysis of self-organizing, distributed control of multi-unmanned vehicle flight formations. Initiated development and assessment of cooperative control techniques for close-in surveillance of urban environments. Initiated control and situational awareness requirements development for interoperability of unmanned vehicles in terminal area and ground operations.			
(U)	In FY 2008: Continue to develop and assess novel control automation techniques and adaptive algorithms to enable safe and interoperable application of manned and unmanned aerospace systems. Continue to enhance reliability and performance analysis of self-organizing, distributed control of multi-unmanned vehicle flight formations. Continue development and assessment of cooperative control techniques for close-in surveillance of urban environments. Complete control and situational awareness requirements development for interoperability of unmanned vehicles in terminal area and ground operations. Develop and assess adaptive guidance and control technologies for fault/damage tolerant aerospace vehicle operations.			
(U)	In FY 2009: Continue to develop and assess novel control automation techniques and adaptive algorithms to enable safe and interoperable application of manned and unmanned aerospace systems. Complete reliability and performance analysis of self-organizing, distributed control of multi-unmanned vehicle flight formations. Complete development and assessment of cooperative control techniques for close-in surveillance of urban environments. Initiate technology development for interoperability of unmanned vehicles in terminal area and ground operations. Continue to develop and assess adaptive guidance and control technologies for fault/damage tolerant aerospace vehicle operations.			
(U)				

UNCLASSIFIED

Exhibit R-2a, RDT&E Project Justification		DATE February 2008		
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602201F Aerospace Vehicle Technologies	PROJECT NUMBER AND TITLE 2403 Flight Controls and Pilot-Vehicle Interface		
		<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) B. Accomplishments/Planned Program (\$ in Millions)		6.758	6.932	6.724
(U) MAJOR THRUST: Develop tools and methods for capitalizing on simulation-based research and development of future aircraft.				
(U) In FY 2007: Completed assessments of advanced manned and unmanned aerospace concepts in simulated future environments. Completed analysis of long endurance intelligence, surveillance, and reconnaissance platforms in a network centric environment. Conducted technology trade studies for next generation theater transports. Conducted the analysis of new concepts in access to space missions. Conducted analyses of new concepts in hostile urban environments.				
(U) In FY 2008: Refine network-centric environment to broaden advanced technology assessment capability. Expand breadth of simulation analyses in refined net-centric environment to address multi-directorate technology trade studies for refined long-range strike and reconnaissance concepts. Continue technology trade studies for next generation theater transports. Conduct simulations to analyze advanced launch and reentry technologies for access-to-space concepts. Continue technology trade studies of small and medium sized unmanned air vehicles in hostile urban environments.				
(U) In FY 2009: Refine network-centric environment to broaden advanced technology assessment capability. Expand breadth of simulation analyses in refined net-centric environment to address multi-directorate technology trade studies for refined long-range strike and reconnaissance concepts. Continue technology trade studies for next generation theater transports. Conduct simulations to analyze advanced launch and reentry technologies for access-to-space concepts. Continue technology trade studies of small and medium sized unmanned air vehicles in hostile urban environments.				
(U) CONGRESSIONAL ADD: Sentient Adaptive Systems Technology for Vehicle Condition-Based Maintenance.		0.996	0.000	0.000
(U) In FY 2007: Conducted Congressionally-directed effort for sentient adaptive systems technology for vehicle condition-based maintenance.				
(U) In FY 2008: Not Applicable.				
(U) In FY 2009: Not Applicable.				
(U) CONGRESSIONAL ADD: Neurobiologically Autonomus Vehicle Operations.		2.391	0.000	0.000
(U) In FY 2007: Conducted Congressionally-directed effort for neurobiologically autonomus vehicle operations.				
(U) In FY 2008: Not Applicable.				
(U) In FY 2009: Not Applicable.				
(U)				

UNCLASSIFIED

Exhibit R-2a, RDT&E Project Justification		DATE February 2008		
BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE		
02 Applied Research	0602201F Aerospace Vehicle Technologies	2403 Flight Controls and Pilot-Vehicle Interface		
(U) B. Accomplishments/Planned Program (\$ in Millions)		<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) CONGRESSIONAL ADD: Unmanned Air Vehicle Research.		0.996	0.000	0.000
(U) In FY 2007: Conducted Congressionally-directed effort for unmanned air vehicle research.				
(U) In FY 2008: Not Applicable.				
(U) In FY 2009: Not Applicable.				
(U)				
(U) CONGRESSIONAL ADD: Advancement of Intelligent Aerospace Systems (AIAS) for the U.S. Air Force		0.000	1.987	0.000
(U) In FY 2007: Not Applicable.				
(U) In FY 2008: Conduct Congressionally-directed effort for Advancement of Intelligent Aerospace Systems (AIAS) for the U.S. Air Force				
(U) In FY 2009: Not Applicable.				
(U)				
(U) CONGRESSIONAL ADD: Cognitive Unmanned Air Vehicle		0.000	0.993	0.000
(U) In FY 2007: Not Applicable.				
(U) In FY 2008: Conduct Congressionally-directed effort for Cognitive unmanned air vehicles.				
(U) In FY 2009: Not Applicable.				
(U)				
(U) CONGRESSIONAL ADD: Modeling and Simulation for Rapid Integration and Technology Evaluation		0.000	0.993	0.000
(U) In FY 2007: Not Applicable				
(U) In FY 2008: Conduct Congressionally-directed effort for Modeling and Simulation for Rapid Integration and Technology Evaluation				
(U) In FY 2009: Not Applicable.				
(U)				
(U) CONGRESSIONAL ADD: Single-Mode Opitcal Connectors for Advanced Air Vehicles		0.000	0.795	0.000
(U) In FY 2007: Not Applicable.				
(U) In FY 2008: Conduct Congressionally-directed effort for Single-Mode Opitcal Connectors of Advanced air vehicles.				
(U) In FY 2009: Not Applicable.				
(U)				
(U) Total Cost		36.253	42.032	33.477

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY
02 Applied Research

PE NUMBER AND TITLE
0602201F Aerospace Vehicle
Technologies

PROJECT NUMBER AND TITLE
2403 Flight Controls and Pilot-Vehicle
Interface

(U) **C. Other Program Funding Summary (\$ in Millions)**

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to</u>	<u>Total Cost</u>
	<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Complete</u>	

- (U) Related Activities:
- (U) PE 0602202F, Human Effectiveness Applied Research.
- (U) PE 0602204F, Aerospace Sensors.
- (U) PE 0603211F, Aerospace Technology Dev/Demo.
- (U) PE 0604015F, Next Generation Bomber.
- (U) This project has been coordinated through the Reliance 21 process to harmonize efforts and eliminate duplication.

(U) **D. Acquisition Strategy**
Not Applicable.

Exhibit R-2a, RDT&E Project Justification

DATE
February 2008

BUDGET ACTIVITY 02 Applied Research				PE NUMBER AND TITLE 0602201F Aerospace Vehicle Technologies			PROJECT NUMBER AND TITLE 2404 Aeromechanics and Integration			
Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total	
2404 Aeromechanics and Integration	30.819	59.933	51.982	55.255	56.044	58.491	47.264	Continuing	TBD	
Quantity of RDT&E Articles	0	0	0	0	0	0	0			

(U) A. Mission Description and Budget Item Justification

This project develops aerodynamic configurations of a broad range of revolutionary, affordable air vehicles. It matures and applies modeling and numerical simulation methods for fast and affordable aerodynamics prediction, and integrates and demonstrates multi-disciplinary advances in airframe, propulsion, weapon, and air vehicle control integration. Technologies developed will greatly enhance warfighter capability in aircraft, missiles, and high-speed aerospace vehicles. The payoffs from these technology programs include lower vehicle costs (both production, and operations and support costs), increased payload and range capability, and improved supportability, safety, and survivability of aerospace vehicles.

(U) B. Accomplishments/Planned Program (\$ in Millions)

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) MAJOR THRUST: Develop aerodynamic prediction efforts centered on expanding the design capabilities of manned and unmanned air vehicles.	3.305	4.061	3.508
(U) In FY 2007: Continued efforts to develop and assess aeronautical technologies that enable broad use of unmanned air vehicles in future missions, including offensive missions, to reduce life cycle costs and decrease human risk. Continued to perform mission assessment and develop low-cost unmanned air vehicle concept to perform tactical surveillance and weapon delivery. Initiated development and evaluation of flow control techniques to complex air vehicle designs to achieve reduced drag and improved propulsion system performance on low speed vehicles. Continued to develop technologies for improved weapon delivery and propulsion system performance in unmanned air vehicles.			
(U) In FY 2008: Continue efforts to develop and assess aeronautical technologies that enable broad use of unmanned air vehicles in future missions, including offensive missions, to reduce life cycle costs and decrease human risk. Continue to perform mission assessment and develop low-cost unmanned air vehicle concept to perform tactical surveillance and weapon delivery. Continue development and evaluation of flow control techniques to complex air vehicle designs to achieve reduced drag and improved propulsion system performance on low-speed vehicles. Initiate development of fluid-based thrust vectoring concept for unmanned air vehicle. Continue to develop technologies for improved weapon delivery and propulsion system performance in unmanned air vehicles.			
(U) In FY 2009: Continue efforts to develop and assess aeronautical technologies that enable broad use of unmanned air vehicles in future missions, including offensive missions, to reduce life cycle costs and decrease human risk. Continue to perform mission assessment and develop low-cost unmanned air vehicle concept to perform tactical surveillance and weapon delivery. Initiate development of innovative aerodynamic control methods for small unmanned air vehicles. Refine development of fluid-based thrust vectoring concept for unmanned air vehicle.			

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY
02 Applied ResearchPE NUMBER AND TITLE
**0602201F Aerospace Vehicle
Technologies**PROJECT NUMBER AND TITLE
2404 Aeromechanics and Integration

(U) B. Accomplishments/Planned Program (\$ in Millions)	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
Continue to develop technologies for improved weapon delivery and propulsion system performance in unmanned air vehicles.			
(U) MAJOR THRUST: Develop new and improved concepts, designs, and analysis of technologies to enable revolutionary capabilities for sustained high-speed flight and re-useable high altitude aerospace vehicle efforts. Note: In FY 2008 and out, increased emphasis has been placed on assessing the next generation long-range, high-speed air vehicle concepts. Note: Provide support to SECAF-directed effort (Energy Conservation - Assured Fuels Initiative) to identify and develop technologies that provide revolutionary aircraft configurations that enable the use of domestic fuel sources for military energy needs.	15.857	26.731	21.262
(U) In FY 2007: Continued development and assessment of aerospace technologies that enable sustained high-speed flight to permit global reach. Continued development of integrated airframe propulsion design concepts for high-speed aerospace vehicles. Conducted sub-scale aerodynamic testing of integrated inlet concepts on high efficiency aero configurations for system level performance validation. Developed and analyzed thermally integrated structures for lightweight integrated exhaust systems and airframes. Conducted high fidelity aerodynamic testing of advance control techniques for low-speed and high-speed operation. Developed analytical stability and control simulations to verify system level operability. Completed development of analytic methods for modeling the plasma flow field over high-speed vehicles to significantly reduce drag.			
(U) In FY 2008: Continue development and assessment of aerospace technologies that enable sustained high-speed flight to permit global reach. Continue development of integrated airframe propulsion design concepts for high-speed aerospace vehicles. Initiate study of energy-based analysis and optimization techniques for vehicle design. Evaluate supersonic tailless aerodynamic concepts. Initiate efforts to characterize hypersonic phenomena and develop and validate fundamental hypersonic component technologies through experimental flight techniques in a relevant high-speed environment. Initiate efforts to integrate self-defense systems to counter multi-spectrum system threats. Evaluate sub-scale aerodynamic integrated inlet concepts on high efficiency aero configurations for system level performance. Evaluate thermally integrated structures for lightweight integrated exhaust systems and airframes. Continue high fidelity aerodynamic testing of advance control techniques for low-speed and high-speed operation. Validate analytical stability and control simulations for system level operability. Note: Provide support to SECAF-directed effort (Energy Conservation - Assured Fuels Initiative) to identify and develop technologies that provide revolutionary aircraft configurations that enable the use of domestic fuel sources for military energy needs.			
(U) In FY 2009: Continue development and assessment of aerospace technologies that enable sustained high-speed flight to permit global reach. Continue development of integrated airframe propulsion design concepts for			

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

02 Applied Research

PE NUMBER AND TITLE

0602201F Aerospace Vehicle
Technologies

PROJECT NUMBER AND TITLE

2404 Aeromechanics and Integration

(U) **B. Accomplishments/Planned Program (\$ in Millions)**FY 2007FY 2008FY 2009

high-speed aerospace vehicles. Continue efforts to integrate self-defense systems to counter multi-spectrum system threats. Initiate advanced high-speed aero/flight control development. Initiate study of interaction of high-load, high-temperature flexible structural materials and fluid mechanics of inlet. Initiate component development enabling shock/boundary layer interaction control. Initiate study of exhaust systems for advanced hypersonic vehicles, and initiate cold-flow testing of sub scale components. Continue efforts to characterize high-speed phenomena and develop and validate fundamental high-speed component technologies through experimental flight techniques in a relevant environment. Note: Provide support to SECAF-directed effort (Energy Conservation - Assured Fuels Initiative) to identify and develop technologies that provide revolutionary aircraft configurations that enable the use of domestic fuel sources for military energy needs.

(U)

(U) MAJOR THRUST: Develop new and improved concepts, designs, and analysis of technologies to enable revolutionary capabilities for re-useable, high altitude vehicle. Note: In FY 2008 and out, increased emphasis has been placed on assessing the next generation long-range, high-speed air vehicle concepts.

1.792

6.717

7.965

(U) In FY 2007: Developed and assessed aerospace technologies that enable reusable, high altitude vehicle. Completed development and evaluation of computational, multi-disciplinary, experimental, and analytical tools to simulate and control the flow fields around advanced concepts for ultra-high-speed aerospace vehicles in extreme flight environments, including staging. Completed development of techniques to evaluate transatmospheric vehicle aerodynamic configurations to validate aero thermodynamic predictions and analysis techniques.

(U) In FY 2008: Continue development and assessment of aerospace technologies that enable reusable, space-access vehicle. Develop robust design methodology and integration approaches for high-speed aeropropulsion. Develop extensive application and 3D validation experience in applying aerothermal computational tools to conceptual, ground-tested and flight-tested vehicles traveling at high-speeds. Develop unique high temperature structures and materials in support of re-usable space-access aircraft. Pursue multi-disciplinary optimization of complex high speed, high temperature, reusable air vehicles.

(U) In FY 2009: Continue development and assessment of aerospace technologies that enable reusable, space-access vehicle. Enhance robust design methodology and integration approaches for high-speed aeropropulsion. Continue extensive application and 3D validation experience in applying aerothermal computational tools to conceptual, ground-tested and flight-tested vehicles traveling at high-speeds. Refine unique high temperature structures and materials in support of high speed re-usable space-access aircraft. Continue multi-disciplinary optimization of complex high-speed, high temperature, reusable air vehicles. Initiate design and test of components of integrated high-speed space-access air vehicle system.

UNCLASSIFIED

Exhibit R-2a, RDT&E Project Justification		DATE February 2008		
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602201F Aerospace Vehicle Technologies	PROJECT NUMBER AND TITLE 2404 Aeromechanics and Integration		
(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u>		<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) MAJOR THRUST: Develop enabling technologies to allow integration of directed energy weapons into current and future air vehicle platforms.		1.739	2.278	1.205
(U) In FY 2007: Completed development and evaluation of critical aeronautical technologies that enable directed energy weapons to be carried on future air vehicles, including maneuvering fighter aircraft, to improve combat effectiveness. Completed measurements of the actual aero-optics effects encountered when employing a laser weapon on a fighter aircraft.				
(U) In FY 2008: Initiate development of combined flow control and adaptive optics systems to optimize directed energy system performance on large low speed aircraft. Initiate development of analysis tools for predicting the performance of advanced flow control and adaptive optics systems.				
(U) In FY 2009: Continue development of combined flow control and adaptive optics systems to optimize directed energy system performance on large low-speed aircraft. Continue development of analysis tools for predicting the performance of advanced flow control and adaptive optics systems.				
(U) MAJOR THRUST: Develop and assess technologies for the next generation of multi-role large aircraft. Note: In FY 2008 and out, investment is increasing due to higher Air Force priority for next generation large aircraft.		5.934	16.171	18.042
(U) In FY 2007: Furthered development and assessment of aeronautical technologies including high lift systems, transonic, and structural that enable revolutionary tanker and transport aircraft designs for rapid global mobility. Continued to develop technologies that enable multiple roles and missions for delivery and support aircraft.				
(U) In FY 2008: Continue development and assessment of aeronautical technologies including high-lift systems, transonic, and structural concepts that enable revolutionary tanker and transport aircraft designs for rapid global mobility. Continue to develop technologies that enable multiple roles and missions for delivery and support aircraft. Initiate trade studies between short take-off and landing performance, and high-speed cruise. Initiate development of inlet and integration technologies for an advanced mobility platform designed to operate efficiently at transonic speeds and provide short take-off capabilities.				
(U) In FY 2009: Continue development and assessment of aeronautical technologies including high-lift systems, transonic, and structural concepts that enable revolutionary tanker and transport aircraft designs for rapid global mobility. Continue to develop technologies that enable multiple roles and missions for delivery and support aircraft. Optimize configuration for trade-off between short take-off and landing performance, and high speed cruise. Continue development of inlet and integration technologies for an advanced mobility platform designed to operate efficiently at transonic speeds and provide short take-off capabilities.				

Exhibit R-2a, RDT&E Project Justification	DATE February 2008
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BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602201F Aerospace Vehicle Technologies	PROJECT NUMBER AND TITLE 2404 Aeromechanics and Integration
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(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) CONGRESSIONAL ADD: Wright Brothers Institute (WBI) - Characterization of Airborne Environment for Tactical Lasers.	2.192	3.975	0.000
(U) In FY 2007: Conducted Congressionally-directed effort for WBI - characterization of airborne environment for tactical lasers.			
(U) In FY 2008: Conducted Congressionally-directed effort for WBI - characterization of airborne environment for tactical lasers.			
(U) In FY 2009: Not Applicable.			
(U) Total Cost	30.819	59.933	51.982

(U) <u>C. Other Program Funding Summary (\$ in Millions)</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to Complete</u>	<u>Total Cost</u>
	<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>		
(U) Related Activities:									
(U) PE 0603211F, Aerospace Technology Dev/Demo.									
(U) PE 0604015F, Next Generation Bomber.									
(U) This project has been coordinated through the Reliance 21 process to harmonize efforts and eliminate duplication.									
(U) <u>D. Acquisition Strategy</u> Not Applicable.									

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PE NUMBER: 0602202F
 PE TITLE: Human Effectiveness Applied Research

Exhibit R-2, RDT&E Budget Item Justification	DATE February 2008
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BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602202F Human Effectiveness Applied Research
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Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
Total Program Element (PE) Cost	106.435	92.068	82.091	92.603	82.481	87.555	90.356	Continuing	TBD
1123 Warfighter Training	17.933	16.916	13.602	13.091	13.245	14.098	14.177	Continuing	TBD
7184 Decision Effectiveness & Biosciences	63.435	51.468	49.496	60.024	51.006	54.464	57.091	Continuing	TBD
7757 Bioeffects and Protection	25.067	23.684	18.993	19.488	18.230	18.993	19.088	Continuing	TBD

(U) A. Mission Description and Budget Item Justification

This program establishes technical feasibility and develops technology for protecting and enhancing human effectiveness for Air Force weapon systems and for operational readiness. The program addresses warfighter training, deployment and sustainment of forces in extreme environments, warfighter system interface, biodynamic response, directed energy bioeffects, crew performance and protection, and counterproliferation. The Warfighter Training project focuses on the development and evaluation of new methods and technologies to enhance Air Force training and education. The Decision Effectiveness and Biosciences project develops and evaluates technologies that will improve human performance and combat effectiveness. The Bioeffects and Protection project develops technologies to predict and mitigate the biological effects of multiple military unique stressors in extreme environments or during sustained operations, directed energy, and other threats on personnel and mission performance. Note: In FY 2008, Congress added \$1.6 million for Warfighter Pocket XP-Next Gen, \$1.6 million for Imaging Tools for Human Performance Enhancement and Diagnostics, \$0.8 million for Ubiquitous RFID Chem/Bio Detection, \$4.0 million for Component Object Model (COM) Attitude Control System Simulation/Trainer, \$3.2 million for Solid Electrolyte Oxygen Separator, and \$1.6 million for MAICE. This program is in Budget Activity 2, Applied Research, since it develops and determines the technical feasibility and military utility of evolutionary and revolutionary technologies.

(U) B. Program Change Summary (\$ in Millions)

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) Previous President's Budget	109.174	79.856	79.377
(U) Current PBR/President's Budget	106.435	92.068	82.091
(U) Total Adjustments	-2.739	12.212	
(U) Congressional Program Reductions		-0.010	
Congressional Rescissions		-0.578	
Congressional Increases		11.200	
Reprogrammings	-1.146	1.600	
SBIR/STTR Transfer	-1.593		

(U) Significant Program Changes:

Not Applicable.

C. Performance Metrics

Exhibit R-2, RDT&E Budget Item Justification

DATE

February 2008

BUDGET ACTIVITY

02 Applied Research

PE NUMBER AND TITLE

0602202F Human Effectiveness Applied Research

Under Development.

Exhibit R-2a, RDT&E Project Justification

DATE
February 2008

BUDGET ACTIVITY 02 Applied Research				PE NUMBER AND TITLE 0602202F Human Effectiveness Applied Research			PROJECT NUMBER AND TITLE 1123 Warfighter Training		
Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
1123 Warfighter Training	17.933	16.916	13.602	13.091	13.245	14.098	14.177	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project identifies and analyzes new methods and technologies to improve Air Force training and education. The research focuses on aircrew training; technical training; mission rehearsal; training in support of complex decision-making; information warfare training; and warfighter readiness training. It investigates the spectrum of new and advanced technologies to design and implement training, and to evaluate training effectiveness. It combines fundamental knowledge from the cognitive and neural sciences with information technology to create desktop tutors, courseware development tools and technologies, assessment methodologies, and simulation technologies to achieve maximum learning effectiveness for specific needs at minimum cost. These technologies and methods will increase operational readiness by providing more effective methods and approaches to train and assess personnel. This project contributes to a more highly trained and flexible cadre of personnel at a reduced cost.

(U) B. Accomplishments/Planned Program (\$ in Millions)

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) MAJOR THRUST: Explore perceptual issues involving the development of new visual and sensor simulation technologies to enhance Distributed Mission Operations (DMO) and decision dominance environments. Identify the visual requirements necessary for realistic aircrew training and mission rehearsal, allowing Air Force warfighters to train as they intend to fight.	2.304	1.593	1.814
(U) In FY 2007: Researched and analyzed key perceptual performance parameters for new deployable visual display technologies including resolution, image stability, target tracking database characteristics, accuracy, and transport delay. Performed human training research of head-mounted and deployable displays. Researched and evaluated visual system requirements for air-to-ground and composite force training.			
(U) In FY 2008: Research perceptual issues for out-the-window display and targeting pod simulation systems that will allow for greater realistic composite force training. Explore perceptual characteristics for new deployable visual display technologies. Expand human factors visual research to define display requirements for a fully immersive collaborative environment for DMO.			
(U) In FY 2009: Perform human factors analysis, tests, and evaluations of visual and sensor simulation components for air-to-ground and air-to-air composite force training using air-to-surface operational testbed. Conduct perceptual evaluations of compact immersive display concepts and components. Transition results to address broader range of AF mission areas and initiate research on sensory-driven decision making in complex environments.			
(U) MAJOR THRUST: Research and analyze tools, strategies, and performance support methods for improving combat mission training, rehearsal, and operations for aircrews and command and control forces. Apply the empirical data	8.081	7.986	8.208

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

02 Applied Research

PE NUMBER AND TITLE

0602202F Human Effectiveness
Applied Research

PROJECT NUMBER AND TITLE

1123 Warfighter Training

(U) **B. Accomplishments/Planned Program (\$ in Millions)**FY 2007FY 2008FY 2009

to develop guidelines for improving learning in training for combat air forces and global strike operations. Enhances the quality, management, and effectiveness of all aspects of DMO, live operations training, rehearsal and exercise environments through the identification and application of competency-based training methods. Explore technologies that will enable DMO and mission rehearsals to run new, complex models/simulations at real- or near real-time. Apply results to provide vastly improved synthetic forces and aircraft simulator capabilities that feature high fidelity electronic warfare, aerodynamic, and weapons effect models that accurately represent the actual capabilities of both current and future systems and threats.

(U) In FY 2007: Evaluated capability to assess learning and proficiency within live, virtual, and constructive operational contexts. Identified metrics and developed preliminary guidelines for initial, refresher, and continuation training and rehearsal. Identified common competency requirements and evaluated instructional designs for common training requirements across operational mission areas. Analyzed fully immersive, just-in-time training environments, with realistic, interactive content and training strategies that can be adapted for use within and across missions. Created a learning management-based migration plan for integrating full fidelity training and rehearsal systems with more generalizable software-driven training, rehearsal, and exercise environments.

(U) In FY 2008: Evaluate approaches and tools for integrating principles of learning in live, virtual, and constructive environments. Identify methods and tools to manage learning in operational training contexts. Identify and analyze methods of routinely assessing knowledge and skills for combat readiness. Analyze field data to identify opportunities for competency-based training integration. Analyze how to monitor the integration of distributed training and rehearsal into operational readiness contexts. Evaluate common measurement tools for assessing readiness in air-to-air, air-to-ground, and close air support training, rehearsal, and exercise events. Explore scenario sequencing methods for continuous learning. Conduct in-depth analysis of the training related shortfalls of current DMO computer generated forces. Explore hardware and software solutions allowing functional processing of selected friendly/enemy interactions for extremely high fidelity training. Research and analyze parameters for a network server for high-fidelity weapons models which allows real- or near real-time processing of DMO interactions for more accurate weapons effects and engagements.

(U) In FY 2009: Develop tools to permit AF planners and managers to integrate competency-based methods into readiness parameters and assessment in operational training, rehearsal, and exercise. Identify alternative approaches for evaluating the individual, team, and team of team (coalition) performance impacts of collaborative, distributed spin-up training and rehearsal. Evaluate integrated instructional development and management methods for continuous learning in Live, Virtual, and Constructive (LVC) contexts and explore task allocation methods for performance aiding and training in operational contexts. Identify functional requirements for instructor operator

UNCLASSIFIED

Exhibit R-2a, RDT&E Project Justification		DATE February 2008		
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602202F Human Effectiveness Applied Research	PROJECT NUMBER AND TITLE 1123 Warfighter Training		
(U) B. Accomplishments/Planned Program (\$ in Millions)	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	
(U) station capabilities. Investigate and evaluate physics-based directed energy threat models for DMO systems. Define improved rule sets to enhance training utility of computer generated forces. Assess feasibility of enhanced threat avoidance and rehearsal training combining selected aerodynamic models, directed energy models, and validated visual special effects.				
(U) MAJOR THRUST: Explore performance improvement techniques to enhance aerospace operational training in realistic mission training environments. Develop enabling technologies for improving readiness across an assortment of AF career fields, from combat air forces to command and control personnel.	2.937	3.362	3.580	
(U) In FY 2007: Integrated the communication model with a synthetic communication agent/teammate and assessed training value. Verified and validated the knowledge and skill tracking prediction models with actual training data. Implemented initial semi-automated parameter search capability with high performance computing for moderator models.				
(U) In FY 2008: Expand the depth of the communication models to support the full range of vocabulary and grammar used in the AOC training environment. Conduct empirical study with skill acquisition/retention models. Extend automation functionality to include dynamic model validity and refinement capability.				
(U) In FY 2009: Expand the breadth of the communication model to support end-to-end language processing. Integrate knowledge and skill tracking prediction system with mission essential competencies to predict training requirements for airmen and demonstrate ability to produce individualized training programs. Conduct empirical study with skill acquisition/retention models. Validate semi-automated, adaptive parameter search and model optimization capability and implement graphical user interface for performance moderator prediction system.				
(U)				
(U) CONGRESSIONAL ADD: Airman Performance Integration (AIRPRINT).	1.964	0.000	0.000	
(U) In FY 2007: Conducted Congressionally-directed effort for AIRPRINT.				
(U) In FY 2008: Not Applicable.				
(U) In FY 2009: Not Applicable.				
(U)				
(U) CONGRESSIONAL ADD: Component Object Model (COM) Attitude Control System Simulation/Trainer.	1.080	3.975	0.000	
(U) In FY 2007: Conducted Congressionally-directed effort for COM Attitude Control System Simulation/Trainer.				
(U) In FY 2008: Conduct Congressionally-directed effort for COM Attitude Control System Simulation/Trainer.				
(U) In FY 2009: Not Applicable.				
(U)				

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602202F Human Effectiveness Applied Research	PROJECT NUMBER AND TITLE 1123 Warfighter Training
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(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) CONGRESSIONAL ADD: C4ISR Fusion System.	1.567	0.000	0.000
(U) In FY 2007: Conducted Congressionally-directed effort for C4ISR Fusion System.			
(U) In FY 2008: Not Applicable.			
(U) In FY 2009: Not Applicable.			
(U)			
(U) Total Cost	17.933	16.916	13.602

(U) <u>C. Other Program Funding Summary (\$ in Millions)</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to</u>	<u>Total Cost</u>
	<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Complete</u>	
(U) Related Activities:									
(U) PE 0602233N, Human Systems Technology.									
(U) PE 0602716A, Human Factors Engineering Technology.									
(U) PE 0602785A, Personnel Performance and Training Technologies.									
(U) PE 0603231F, Crew Systems and Personnel Protection Technology.									
(U) PE 0604227F, Distributed Mission Training (DMT).									
(U) This project has been coordinated through the Reliance 21 process to harmonize efforts and eliminate duplication.									
(U) <u>D. Acquisition Strategy</u> Not Applicable.									

Exhibit R-2a, RDT&E Project Justification

DATE
February 2008

BUDGET ACTIVITY 02 Applied Research				PE NUMBER AND TITLE 0602202F Human Effectiveness Applied Research			PROJECT NUMBER AND TITLE 7184 Decision Effectiveness & Biosciences		
Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
7184 Decision Effectiveness & Biosciences	63.435	51.468	49.496	60.024	51.006	54.464	57.091	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) **A. Mission Description and Budget Item Justification**

This project develops the Air Force unique technology to identify human impact from deployment, and enhance deployment capabilities, human performance, biodynamic response, and survivability in dispersed operational environments. By investigating the technologies to enhance deployment capabilities this program seeks to improve logistical support for peacetime and combat operations. This research further defines the physical and cognitive parameters, capabilities, and limits of systems operators; it determines human responses to military unique stresses such as operations in sustained and extreme environments including the effects of noise, impact, vibration, and maneuvering acceleration, and it explores ways to assess and manage human operator workload by optimizing the human-machine interface. It produces human-centered design criteria, guidelines, and design tools for developing effective human-system interfaces. It develops and assesses technologies for information display, team communications, and modeling and simulation for human-centered aerospace and cyber operations. It conducts experiments and evaluations of control interfaces, crew station layout and functional integration, and human information processing. It also develops biotechnologies and tools to identify and minimize the risks and mission impact to AF personnel from exposure to military unique stressors while also reducing human weapon systems life cycle cost.

(U) **B. Accomplishments/Planned Program (\$ in Millions)**

	FY 2007	FY 2008	FY 2009
(U) MAJOR THRUST: Develop interface technologies that enhance human-human and human-machine collaboration in network-centric warfare environments. These technologies will enable the common operational understanding and shared, distributed decision making required on the modern battlefield.	5.765	4.958	4.997
(U) In FY 2007: Determined the risk and benefit of adding language, accent, and domain models into the laboratory speech recognizer/synthesizer, and advanced speech processing technology. Completed development of a collaboration toolkit for air battle management command and control (BMC2). Developed and evaluated BMC2 decision support technologies, and formulated plans to demonstrate operational benefits in an advanced technology program. Demonstrated the ability of the cognitive state assessment package to evaluate real-time human-machine collaboration during simulated BMC2 missions.			
(U) In FY 2008: Begin to develop multinational speech translator technologies for obscure languages and continue to advance technologies that support mobile, speech-based interfaces. Complete a style guide for applying collaborative tools in BMC2 environments. Begin to develop a collaboration toolkit for non-airborne command and control missions. Expand the operator cognitive state assessor to incorporate operator performance data, operator performance and situational awareness models, and tactical situation information for better decision support.			
(U) In FY 2009: Explore the use of transparent multilingual collaboration tools for distributed multi-entity teaming. Continue development of multinational speech translation technologies for obscure languages. Determine the effects			

Exhibit R-2a, RDT&E Project Justification		DATE February 2008		
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602202F Human Effectiveness Applied Research	PROJECT NUMBER AND TITLE 7184 Decision Effectiveness & Biosciences		
		<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u>				
of collaboration technologies on performance efficiency, shared situation awareness, workload and decision making for tactical command and control. Begin development of adaptive automated human-machine interfaces to improve real-time human-machine task sharing. Develop predictive operator state models and assessment tools for dynamic workflow and workload management.				
(U)				
(U)	MAJOR THRUST: Develop cognitive system interface technologies to achieve common understanding at all echelons of operations and to improve decision-making and predictive battlespace awareness. These technologies offer breakthrough potential for understanding and modeling human behavior, in order to assure timely and effective decisions, while also providing context-sensitive human-computer interfaces that support decision effectiveness.	4.725	3.952	4.385
(U)	In FY 2007: Developed and began the transition to advanced development of software design patterns that enable the standardization of human-computer interface elements in command and control ISR systems. Developed collaboration techniques and methods to embed them into command and control systems. Researched the cultural and ethnic bases of human decision making and began to develop human performance models that reflect these differences to enable effects-based operations.			
(U)	In FY 2008: Continue advancement of software design patterns that enable the standardization and re-use of human-computer interface elements in command and control ISR systems. Begin to develop a DoD software design patterns library. Continue development of collaboration techniques and methods to embed these techniques into command and control systems. Demonstrate collaboration techniques in a distributed net-centric environment. Continue researching the cultural and ethnic bases of human decision making and proceed with developing human performance models that reflect cultural differences for effects-based operations.			
(U)	In FY 2009: Expand contents of DoD software design patterns library. Begin embedding design patterns in graphical user interface building tools. Continue to demonstrate collaboration techniques in a distributed net-centric environment. Investigate how collaboration techniques can enable distributed team self-synchronization. Continue researching the cultural and ethnic bases of human decision making and developing human performance models that reflect cultural differences to enable effects-based operations.			
(U)				
(U)	MAJOR THRUST: Establish the technology base for a decision support environment that enables the Joint Forces Commander, Joint Forces Air Component Commander, and command staffs to interrelate the past, present, and future battlefield mission states and to predict the intent and actions of adversaries during joint operations.	3.791	1.922	2.237
(U)	In FY 2007: Developed advanced visualization techniques that enable the uncertainty associated with information to be incorporated into the iconic or graphic portrayal scheme for command center display. Developed and began to			

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

02 Applied Research

PE NUMBER AND TITLE

0602202F Human Effectiveness
Applied Research

PROJECT NUMBER AND TITLE

7184 Decision Effectiveness &
Biosciences(U) **B. Accomplishments/Planned Program (\$ in Millions)**FY 2007FY 2008FY 2009

transition to advanced development methods needed to simulate enemy potential courses of action, beginning with simple models of adversary behavior. Conducted laboratory experiments to evaluate “sensemaking” tools and displays for dynamic battlefields. Developed knowledge representation techniques to model potential adversaries and complex systems of systems. Developed an integrated set of anticipatory planning and operations (APO) work aids to achieve persistent operational planning, persistent prediction, and focused execution even as military and broad national security objectives are dynamically changing.

(U) In FY 2008: Begin the transition of advanced uncertainty visualization techniques for command center displays. Transition towards advanced development, the needed methods to simulate enemy potential courses of action, including more complex adversary behavior. Evaluate results of the laboratory experiments on “sensemaking” tools and displays for dynamic battlefields. Identify gaps for further research. Begin incorporating the extrapolated, select “sensemaking” results into display development. Refine the knowledge representation techniques to model potential adversaries and complex systems of systems and begin integrating into displays. Initiate transition of integrated set of APO work aids to achieve persistent operational planning, persistent prediction, and focused execution. Conduct initial demonstration of the integration of the developed displays and technologies.

(U) In FY 2009: Analyze the results of the initial demonstration of the integration of the displays and technologies. Complete the transition of advanced uncertainty visualization techniques for command center display. Continue transition of methods needed to simulate enemy potential courses of action, including more complex adversary behavior. Incorporate more extrapolated “sensemaking” results into displays. Refine the knowledge representation techniques to model potential adversaries and complex systems of systems and begin integrating into displays. Continue transitioning the integrated set of APO work aids to achieve persistent operational planning, persistent prediction, and focused execution and evaluate the effect. Conduct follow-on demonstration of the integration of the developed displays and technologies.

(U)

(U) MAJOR THRUST: Develop system control interface concepts enabling full operator exploitation of all AF platform capabilities. Identify the best mix of intelligent methods and traditional design to unambiguously direct the operator's attention, which is critical for net-centric operations. Employ real-time and wargaming simulations to quantify operational benefits from new information portrayal concepts.

4.918

4.675

4.514

(U) In FY 2007: Demonstrated real-time assessment tools and advanced decision support interfaces, including prediction capability, for maximizing single operator supervision of multiple highly autonomous unmanned aerial vehicles (UAVs) within net-centric environments. Began design and development of second generation control-display concepts that reduce operator task load and mitigate channelized attention. Began algorithm

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

02 Applied Research

PE NUMBER AND TITLE

0602202F Human Effectiveness
Applied Research

PROJECT NUMBER AND TITLE

7184 Decision Effectiveness &
Biosciences(U) **B. Accomplishments/Planned Program (\$ in Millions)**FY 2007FY 2008FY 2009

development to blend display imagery with computer-generated graphical representations of terrain and real-time data to conduct autonomous landing and ground operations at night and during adverse weather.

- (U) In FY 2008: Evaluate single operator supervision of multiple autonomous UAVs in a net-centric context using real-time assessment tools and advanced decision support interfaces during testing and simulated ground operations. Transition field test results of first generation control-display concepts that reduce operator task loading and channelized attention into second generation control-display workstations. Apply basic algorithms that blend display imagery with computer-generated graphical representations of terrain and real-time data during simulation and/or flight-testing of autonomous landing and ground operations.

- (U) In FY 2009: Integrate real-time assessment tools into second generation control-display operator workstations to optimize operator task loading and avoid channelized attention. Use second generation operator workstations during field testing and flight demonstration to control multiple, highly autonomous UAVs. Begin software design and development of common interface and software architectures of control-display concepts that allow minimal numbers of operators to control autonomous UAVs in urban environments and/or in large-scale, strategic military operations.

(U)

- (U) MAJOR THRUST: Develop technologies associated with collecting and optimizing visually displayed information for best assimilation by warfighters. Develop, evaluate, and organize algorithms for enhancing input to the visual system through the fusion of multi-spectral sensors, digital image processing, and solid-state display technologies in order to enhance real-time, day/night imaging systems. Devise human-centered command and control symbology and techniques for integration with visual displays, permitting natural situation understanding of complex information rich environments.

4.451

4.693

4.608

- (U) In FY 2007: Evaluated and improved algorithms to electronically enhance vision when using head-mounted solid state imagers. Improved methods to depict command and control and other complex types of information in intuitive, easy-to-understand ways. Evaluated the methods using realistic simulations of the targeted combat environments.

- (U) In FY 2008: Down-select and implement image-enhancing algorithms that are optimized for speed, visual performance, and real-time tactical use. Develop a laboratory-grade test bed usable to perform field tests. Continue to develop and evaluate new and innovative ways to visualize and interact with large amounts of information in visually rich environments. Evaluate display symbologies and mechanizations in simulated Air and Space Operations Center environments.

- (U) In FY 2009: Perform multispectral, real-time field evaluations of display algorithm sets that have been optimized for

Exhibit R-2a, RDT&E Project Justification	DATE February 2008
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BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602202F Human Effectiveness Applied Research	PROJECT NUMBER AND TITLE 7184 Decision Effectiveness & Biosciences
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	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
<p>(U) B. Accomplishments/Planned Program (\$ in Millions) different tactical scenarios. Refine information portrayal and interaction techniques to enhance decision-making by testing more intuitive visualizations and user interfaces. Test these methods against current state-of-the-art to prove and improve total system effectiveness. Begin to develop visualization technologies that enhance cyberspace understanding in command centers.</p>			
<p>(U) MAJOR THRUST: Develop advanced audio display technologies for human-to-human collaboration including three-dimensional (3-D) audio, active noise reduction, and related technologies that mitigate effects of noise and enhance performance and information processing in the operational environment. In particular, these battlespace acoustic interfaces will integrate with warfighter equipment and amplify information delivery to the warfighter.</p>	4.426	3.933	3.826
<p>(U) In FY 2007: Researched acoustic signal control to improve human-to-human communications in operational environments by improving noise reduction technologies and use of acoustic signal processing to improve information gathering for security forces. Began to research methods to incorporate weather effects on noise propagation and ways to represent weather effects in dynamic noise models. Developed auditory information aiding technologies for remote collaboration. Explored how to improve audio symbology for streamlining command and control operations including 3-D audio symbology. Began to explore the human processes that lead to communication breakdown.</p>			
<p>(U) In FY 2008: Explore the potential of acoustic aiding during urban operations to improve machine-to-human communications by using acoustic signal processing to improve security forces' information gathering. Begin to research ways to adapt current noise models to enhance decision-making and acoustic detectability during offensive operations. Continue to develop auditory information-aiding technologies for remote collaboration, by exploiting advances in communication theory for individuals. Continue to explore the individual and group processes that lead to communication breakdown. Explore improved auditory sensing to create virtual auditory reality for human interface to remote sensing.</p>			
<p>(U) In FY 2009: Develop acoustic aiding for urban operations to improve machine-to-human communications by using ultrasonic and laser technology advances to improve security forces' information gathering. Continue to explore methods and develop models to predict acoustic detectability under dynamic conditions for improved offensive operations. Continue to develop auditory information-aiding technologies for remote collaboration by exploiting advances in communication theory for individuals. Continue to explore the individual and group processes that lead to communication breakdown. Improve auditory sensing technology to create virtual auditory reality for human interface to remote sensing, emphasizing its application to security forces.</p>			
<p>(U)</p>			

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

02 Applied Research

PE NUMBER AND TITLE

0602202F Human Effectiveness
Applied Research

PROJECT NUMBER AND TITLE

7184 Decision Effectiveness &
Biosciences(U) **B. Accomplishments/Planned Program (\$ in Millions)**

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) MAJOR THRUST: Develop integrated human-centered Information/Cyber Operations and Intelligence, Surveillance, and Reconnaissance (ISR) technologies to provide quicker and more intuitive access to information, enhanced decision-making capabilities, more effective training procedures, and improved tools for Information Operations (IO)/ISR/Cyber operators' use in performing their respective missions.	11.545	9.091	12.056
(U) In FY 2007: Conducted research and implementation of models for IO and ISR. Developed conceptual human system interfaces for additional Measurement and Signatures Intelligence (MASINT) capabilities, specifically in the spectral area. Developed tools and models for assessing the effectiveness of influence operations. Completed development of proof-of-concept technologies to specify, measure, and model key parameters. Researched and developed counter-Improvised Explosive Device (IED) concepts/devices.			
(U) In FY 2008: Validate conceptual human-system interfaces for additional MASINT capabilities. Develop and validate tools and models for assessing the effectiveness of influence operations. Continue research and development of tools and capabilities for Influence Operations and counter-Influence Operations. Continue development of tools and models for assessing the effectiveness of influence operations. Continue research and validation of speech-to-speech translation tool. Develop capability to anticipate adversarial behavior, both individually and in groups. Continue counter-IED research.			
(U) In FY 2009: Continue development and validation of advanced IO/Influence Operations research tools and training techniques to enable increased offensive and defensive combat capabilities which counter asymmetric adversarial threats. Validate and complete IO/Influence Operations models and simulation capabilities. Develop and validate prototype of advanced speech-to-speech translation tool. Continue development of capability to anticipate adversarial behavior, both individually and in group, with application in the psychological operations domain. Investigate methods to enhance human ability to uncover concealed information. Develop collaborative tools and training for ISR team applications with emphasis on distributed operations.			
(U) MAJOR THRUST: Develop human injury criteria and protective system technologies to provide sanctuary from injury and disability causing threats to military personnel. Develop technologies to ensure accommodation and safety of all airmen during military operations, such as flight, ground patrols, crashes, emergency escape, extended missions, and parachute opening shock.	5.807	4.457	4.698
(U) In FY 2007: Developed injury criterion for multi-axial dynamic neck loading and standards for gender and demographics. Determined the effects and interrelationships between equipment fit, workload, marginal anthropometry, physical capability, cognitive capability, and increased equipment loads on pilot crew performance. Using risk-based analysis, identified primary musculoskeletal disability causes and began addressing equipment,			

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

02 Applied Research

PE NUMBER AND TITLE

0602202F Human Effectiveness
Applied Research

PROJECT NUMBER AND TITLE

7184 Decision Effectiveness &
Biosciences

(U) B. Accomplishments/Planned Program (\$ in Millions)	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
procedure, or physical training improvements. Developed initial data mining and analysis tools for searching across biomechanics, safety, and medical information systems.			
(U) In FY 2008: Conduct focused injury surveillance studies on specific career fields and assignments to identify those that have high rates of injury and disability. Based on these studies, begin developing technologies to reduce musculoskeletal disabilities and injuries due to personal equipment and workstation designs. Develop procedures and training improvements to reduce high training attrition due to injury, especially focused on battlefield airmen training. Expand initial biomechanics collaborative information system to coordinate DoD biomechanics data collections and analysis capabilities.			
(U) In FY 2009: Optimize equipment technologies, refine procedures, and improve training processes to address the most common AF job-related injuries and disabilities. Extend these improvements to not only prevent injuries but also to optimize human performance. Develop workstation design criteria to maximize operator performance and minimize fatigue, based on interrelationships between equipment fit, workload, anthropometry, physical capability, and cognitive capability. Use biomechanics collaborative information technologies to collect and analyze data to protect forces against threats in hostile environments.			
(U) MAJOR THRUST: Quantify and model operator performance in stressful environments and develop technologies to mitigate the effects of operational stressors on cognitive function, safety, and mission effectiveness. Develop solutions to enhance human performance and ensure combat effectiveness in AF operations.	1.563	1.991	1.066
(U) In FY 2007: Developed concepts to reduce effects of heavy flight helmets in the high-G environment. Completed validation and transition of high-G cognitive model for simulation-based acquisition. Explored biobehavioral technologies to augment cognition and enhance operator performance.			
(U) In FY 2008: Continue behavioral research to characterize human performance and mitigate cognitive degradation during demanding military operations. Develop real-time biobehavioral performance monitoring technology to evaluate cognitive readiness and decision making in command and control applications, tactical operations, and mission rehearsal. Explore emerging cognitive disruption technologies and potential countermeasures.			
(U) In FY 2009: Continue behavioral neuroscience research to characterize and mitigate human cognitive degradation during demanding military operations. Refine real-time biobehavioral performance monitoring technology and develop operational employment concepts. Continue to investigate cognitive disruption technologies and potential countermeasures.			
(U) MAJOR THRUST: Develop, demonstrate, and apply experimental models for predicting toxicological compromises	2.093	1.769	1.941

Exhibit R-2a, RDT&E Project Justification	DATE February 2008
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BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602202F Human Effectiveness Applied Research	PROJECT NUMBER AND TITLE 7184 Decision Effectiveness & Biosciences
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	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u> in human mission performance and create in-house and field methods to assure protection of AF personnel from toxic hazards and exposures in Joint operational environments. Using integrated biological approaches, create predictive algorithms to describe functional cellular dynamics and engineering constructs for advancing detection and performance of AF systems. Improve commander decision-making ability to properly balance mission and force protection requirements.			
(U) In FY 2007: Applied procedures and computer simulation models to predict effects of toxic compound and nanomaterial exposure on Air Expeditionary Forces and improved the protection of AF personnel in operational environments. Further developed and demonstrated algorithms to describe the function of cellular dynamics with the potential for improved logic and sensor capability for Air Force systems.			
(U) In FY 2008: Develop and apply procedures and computer simulation models to predict effects of large volume material, toxic compound, and nanomaterial exposure on Joint Service and Air Expeditionary Forces. Using computer modeling and integrated biological approaches to understand functional cellular dynamics and engineering, explore and create integrated new sensor and material constructs for AF applications.			
(U) In FY 2009: Further develop procedures and computer simulation models to predict effects of toxic compound and nanomaterial exposure on Joint Service and Air Expeditionary Forces. Using computer modeling and systems biology approaches to understand functional cellular dynamics and engineering, continue to explore and create integrated new sensor and material constructs for AF applications.			
(U) MAJOR THRUST: Develop biotechnologies to identify warfighter exposures to hazardous agents before they result in illness or a reduction in mission performance, thus greatly improving force protection and the probability of mission success.	5.931	4.072	3.836
(U) In FY 2007: Conducted genomic, proteomic, and metabolite studies to identify target-organ biomarkers in body fluids of the deployed airmen exposed to hazardous agents. Completed kidney and assessed liver organ response biomarker patterns for early detection of the effects of unknown hazardous agents on AF personnel.			
(U) In FY 2008: Continue to conduct genomic, proteomic, and metabolite studies to identify target-organ biomarkers and their assessment methods for hazardous agent exposure. Complete validation panel for selected kidney biomarkers and down-select liver organ response biomarker patterns for early detection of the effects of unknown hazardous agents on AF personnel.			
(U) In FY 2009: Complete genomic, proteomic, and metabolite studies to identify and validate kidney and liver biomarkers of hazardous agent exposure in deployed airmen. Extend program to investigate connective tissue, lung, and brain biomarkers of degradation from hazardous agent exposure in AF personnel.			

UNCLASSIFIED

Exhibit R-2a, RDT&E Project Justification		DATE February 2008		
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602202F Human Effectiveness Applied Research	PROJECT NUMBER AND TITLE 7184 Decision Effectiveness & Biosciences		
<u>B. Accomplishments/Planned Program (\$ in Millions)</u>		<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) MAJOR THRUST: Develop logistics readiness technology options and perform feasibility studies to support large-scale advanced technology development programs. These technologies will lead to more efficient utilization of logistics resources for Air Expeditionary Force operations. Note: In FY 2009, this effort is reduced due to higher Air Force priorities.		2.236	2.775	1.332
(U) In FY 2007: Investigated and applied new techniques for future logistics and maintenance technical data presentation and for task/job aiding and training. Completed work on defining sense-respond capabilities which will promote effects-based logistics using a net-centric environment. Identified technology gaps to meet previously defined emergency response logistics requirements.				
(U) In FY 2008: Investigate methods for performance measurement and evaluation of augmented reality, virtual reality, and versatile media formats in packaging and delivering job/task aiding and training solutions for maintenance work. Investigate integration mechanisms for these human-centered technologies with on-board diagnostic/health monitoring technologies to promote more accurate system repair processes at the point of maintenance.				
(U) In FY 2009: Further explore and apply integrated, multifunction job aiding concepts in laboratory and controlled field tests. Investigate the usefulness of collaboration support for troubleshooting and complex field repair problems. Explore the hardware, software, and packaging issues for combined job aid and on-the-job training devices for maintenance work.				
(U) CONGRESSIONAL ADD: Networked Warfighter Decision Support.		0.981	0.000	0.000
(U) In FY 2007: Conducted Congressionally-directed effort for Networked Warfighter Decision Support.				
(U) In FY 2008: Not Applicable.				
(U) In FY 2009: Not Applicable.				
(U) CONGRESSIONAL ADD: Bio Medical DNA Program.		0.982	0.000	0.000
(U) In FY 2007: Conducted Congressionally-directed effort for Bio Medical DNA Program.				
(U) In FY 2008: Not Applicable.				
(U) In FY 2009: Not Applicable.				
(U) CONGRESSIONAL ADD: Eyewear Display for Battlefield Operations.		0.981	0.000	0.000
(U) In FY 2007: Conducted Congressionally-directed effort for Eyewear Display for Battlefield Operations.				
(U) In FY 2008: Not Applicable.				

UNCLASSIFIED

Exhibit R-2a, RDT&E Project Justification		DATE February 2008		
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602202F Human Effectiveness Applied Research	PROJECT NUMBER AND TITLE 7184 Decision Effectiveness & Biosciences		
(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u>		<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) In FY 2009: Not Applicable.				
(U) CONGRESSIONAL ADD: Battlefield Automatic Life Status Monitor.		1.278	0.000	0.000
(U) In FY 2007: Conducted Congressionally-directed effort for Battlefield Automatic Life Status Monitor.				
(U) In FY 2008: Not Applicable.				
(U) In FY 2009: Not Applicable.				
(U) CONGRESSIONAL ADD: Miniature Tri-Axial Accelerometer.		0.981	0.000	0.000
(U) In FY 2007: Conducted Congressionally-directed effort for Miniature Tri-Axial Accelerometer.				
(U) In FY 2008: Not Applicable.				
(U) In FY 2009: Not Applicable.				
(U) CONGRESSIONAL ADD: Unmasking Deception and Denial.		0.981	0.000	0.000
(U) In FY 2007: Conducted Congressionally-directed effort for Unmasking Deception and Denial.				
(U) In FY 2008: Not Applicable.				
(U) In FY 2009: Not Applicable.				
(U) CONGRESSIONAL ADD: Imaging Tools for Human Performance Enhancement and Diagnostics.		0.000	1.590	0.000
(U) In FY 2007: Not Applicable.				
(U) In FY 2008: Conduct Congressionally-directed effort for Imaging Tools for Human Performance Enhancement and Diagnostics.				
(U) In FY 2009: Not Applicable.				
(U) CONGRESSIONAL ADD: Warfighter Pocket XP-Next Gen.		0.000	1.590	0.000
(U) In FY 2007: Not Applicable.				
(U) In FY 2008: Conduct Congressionally-directed effort for Warfighter Pocket XP-Next Gen.				
(U) In FY 2009: Not Applicable.				
(U) Total Cost		63.435	51.468	49.496

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY
02 Applied Research

PE NUMBER AND TITLE
0602202F Human Effectiveness
Applied Research

PROJECT NUMBER AND TITLE
7184 Decision Effectiveness &
Biosciences

(U) **C. Other Program Funding Summary (\$ in Millions)**

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to</u>	<u>Total Cost</u>
	<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Complete</u>	

- (U) Related Activities:
- (U) PE 0602201F, Aerospace Flight Dynamics.
- (U) PE 0602204F, Aerospace Sensors.
- (U) PE 0602702F, Command, Control, and Communications.
- (U) PE 0603205F, Flight Vehicle Technology.
- (U) PE 0603231F, Crew Systems and Personnel Protection Technology.
- (U) PE 0603245F, Flight Vehicle Technology Integration.
- (U) PE 0604706F, Life Support Systems.
- (U) This project has been coordinated through the Reliance 21 process to harmonize efforts and eliminate duplication.
- (U) **D. Acquisition Strategy**
Not Applicable.

Exhibit R-2a, RDT&E Project Justification

DATE
February 2008

BUDGET ACTIVITY 02 Applied Research				PE NUMBER AND TITLE 0602202F Human Effectiveness Applied Research			PROJECT NUMBER AND TITLE 7757 Bioeffects and Protection			
Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total	
7757 Bioeffects and Protection	25.067	23.684	18.993	19.488	18.230	18.993	19.088	Continuing	TBD	
Quantity of RDT&E Articles	0	0	0	0	0	0	0			

(U) A. Mission Description and Budget Item Justification

The project assesses the bioeffects of directed energy for force protection, special operations, military operations other than war, and peacekeeping applications; and provides tailored/agile human performance optimization technologies to confront asymmetric threats. The project enables the safe operational use of AF aerospace systems through technology developments that ameliorate/counter/exploit the biological effects of operational stressors and other threats. It addresses areas such as safety, risk assessment, mission planning, countermeasures, personnel protection, and counterproliferation research, technology development, and validation.

(U) B. Accomplishments/Planned Program (\$ in Millions)

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) MAJOR THRUST: Conduct laboratory experiments and field research on laser bioeffects, enabling military exploitation of laser technology while providing countermeasures for optical hazards/threats.	6.423	6.314	6.678
(U) In FY 2007: Developed technologies to improve combat vision, including human factors methodologies. Provided laser eye protection in an integrated format. Evaluated impacts of multiwavelength lasers upon the human visual system. Developed robust modeling and simulation programs and first approximations of near real-time probabilistic risk assessment tools. Developed first models of dynamic bidirectional reflectivity distribution function for laser scatter for high energy laser applications.			
(U) In FY 2008: Integrate dynamic bidirectional reflectivity distribution mathematical models into diagnostic tools of laser eye damage for collateral hazard assessments of typical laser systems. Expand laser damage threshold database for multiple wavelengths to validate DoD, national, and international safety standards. Evaluate impact of visible lasers upon critical aircrew and ground force missions.			
(U) In FY 2009: Perform field and laboratory experiments to verify and validate optical physics model of bidirectional reflectivity distribution calculations for use as high energy laser collateral hazard assessment tool. Integrate collateral hazard assessment software model into airborne laser platform performing high energy laser system demonstrations. Initiate experiments for future high energy laser weapon systems to predict, evaluate, and explore target bioeffects.			
(U) MAJOR THRUST: Conduct electromagnetic (EM) field bioeffects laboratory experiments and field research to enable the safe exploitation of directed energy technologies for communication, target identification, and weapons development while identifying countermeasures to EM hazards/threats.	6.225	6.050	6.542
(U) In FY 2007: Further refined methods to evaluate the bioeffects of directed energy weapons and support safety and effectiveness assessments of emerging directed energy weapons. Extended laboratory and field assessment			

Exhibit R-2a, RDT&E Project Justification	DATE February 2008
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BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602202F Human Effectiveness Applied Research	PROJECT NUMBER AND TITLE 7757 Bioeffects and Protection
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	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) B. Accomplishments/Planned Program (\$ in Millions)			
techniques into the terahertz range. Enhanced modeling and simulation tools to evaluate the human health, behavior, and performance impact of high frequency EM systems. Evaluated human health in response to high power and high peak power EM systems using biotechnology. Conducted research to support scientifically-based human exposure standards.			
(U) In FY 2008: Explore tissue interactions from terahertz frequencies to evaluate safe exposure levels and tissue vulnerabilities. Improve EM tissue models to include terahertz and high power EM effects. Continue research to support fielding and effectiveness of radio frequency (RF) directed energy weapon systems.			
(U) In FY 2009: Conduct experiments to refine and eliminate gaps in RF exposure standards for microwave, ultra-wide band, high peak power RF systems, and terahertz frequency ranges. Integrate and improve human behavior, bioeffects, and target effects computer models based on RF studies in microwave, ultra-wide band, high peak power, and terahertz sources. Investigate RF bioeffects as a foundation for future RF weapons.			
(U) MAJOR THRUST: Develop biotechnologies to accurately and affordably support the detection, identification, neutralization, and assessment of threat agents. Perform counterproliferation research to enable air operations to continue in the most efficient manner.	5.329	4.006	3.731
(U) In FY 2007: Developed technologies to identify the production source of threat agents. Developed and validated methods to assess the viability of threat agents after active countermeasures have been employed. Refined counterproliferation research to better predict and further minimize collateral damage.			
(U) In FY 2008: Continue to develop and validate methods to assess the viability and activity of threat agents after active countermeasures have been employed. Begin to develop technologies that will enable the AF to locate biological warfare agents behind walls and inside of containers. Characterize organic semiconductor material interactions with directed energy to enhance agent neutralization capabilities.			
(U) In FY 2009: Refine viability assessment technologies and develop models that predict plume distribution patterns to minimize collateral damage from counterforce weapon detonations. Continue to develop advanced biological taggant technologies that will locate biological warfare agents behind walls and in containers. Investigate counterproliferation technologies capable of effectively neutralizing genetically modified biological threat agents.			
(U) MAJOR THRUST: Develop novel technology solutions integrating behavioral psychology, metabolomic research, nutritional strategies, and personal protective technologies to enable human performance optimization in multiple stressor environments. Results will optimize operational execution through increased human effectiveness, reduced attrition/lost training days, and faster post-mission recovery.	1.544	1.749	2.042

UNCLASSIFIED

Exhibit R-2a, RDT&E Project Justification		DATE February 2008		
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602202F Human Effectiveness Applied Research	PROJECT NUMBER AND TITLE 7757 Bioeffects and Protection		
		<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) B. Accomplishments/Planned Program (\$ in Millions)				
(U) In FY 2007: Investigated individual differences in human performance variability and response to performance optimizing interventions. Extended individual performance research to quantify effects of workload distribution, task novelty, and experience on collaborative team performance in a cognitively demanding environment. Developed methodologies to tailor behavioral and physiological regimens to achieve flexible task-based human performance capabilities.				
(U) In FY 2008: Continue to develop methodologies to tailor behavioral and physiological regimens and integrate revolutionary concepts in metabolomics/human performance technologies with existing training/operations. Continue research to quantify effects of workload distribution, task novelty, and experience on team performance in a cognitively demanding environment.				
(U) In FY 2009: Continue development and assess benefit of tailored/agile human performance optimization regimens to confront asymmetric threats. Expand biobehavioral performance models to incorporate individual differences in human performance vulnerability.				
(U) MAJOR THRUST: Develop technologies and procedures to counter physiological effect of high altitude flight, improve pilot performance under high, rapid-onset gravitational forces, and deliver oxygen. Research will enhance airman safety during global attack, global mobility, and special operations missions. Note: Effort terminated in FY 2007 due to higher AF priorities.		0.343	0.000	0.000
(U) In FY 2007: Evaluated ability of candidate integrated aircrew ensemble technology components to address identified life support equipment deficiencies. Assessed oxygen generation systems technology effectiveness in a chemical environment.				
(U) In FY 2008: Not Applicable.				
(U) In FY 2009: Not Applicable.				
(U) CONGRESSIONAL ADD: Solid Electrolyte Oxygen Separator (SEOS).				
(U) In FY 2007: Conducted Congressionally-directed effort for SEOS.		4.221	3.180	0.000
(U) In FY 2008: Conduct Congressionally-directed effort for SEOS.				
(U) In FY 2009: Not Applicable.				
(U) CONGRESSIONAL ADD: Warfighter Sustainability: Maximizing Human Performance.				
(U) In FY 2007: Conducted Congressionally-directed effort for Warfighter Sustainability: Maximizing Human Performance.		0.982	0.000	0.000

Exhibit R-2a, RDT&E Project Justification	DATE February 2008
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BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602202F Human Effectiveness Applied Research	PROJECT NUMBER AND TITLE 7757 Bioeffects and Protection
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(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) In FY 2008: Not Applicable.			
(U) In FY 2009: Not Applicable.			
(U)			
(U) CONGRESSIONAL ADD: Ubiquitous RFID Chem/Bio Detection.	0.000	0.795	0.000
(U) In FY 2007: Not Applicable.			
(U) In FY 2008: Conduct Congressionally-directed effort for Ubiquitous RFID Chem/Bio Detection.			
(U) In FY 2009: Not Applicable.			
(U)			
(U) CONGRESSIONAL ADD: Modeling of Aggregates of Individuals and Crowd Environments (MAICE).	0.000	1.590	0.000
(U) In FY 2007: Not Applicable.			
(U) In FY 2008: Conduct Congressionally-directed effort for MAICE.			
(U) In FY 2009: Not Applicable.			
(U)			
(U) Total Cost	25.067	23.684	18.993

(U) <u>C. Other Program Funding Summary (\$ in Millions)</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to</u>	<u>Total Cost</u>
	<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Complete</u>	
(U) Related Activities:									
(U) PE 0602720A, Environmental Quality Technology.									
(U) PE 0603231F, Crew Systems and Personnel Protection Technology.									
(U) PE 0604617F, Agile Combat Support.									
(U) PE 0604706F, Life Support Systems.									
(U) This project has been coordinated through the Reliance 21 process to harmonize efforts and eliminate									

Exhibit R-2a, RDT&E Project Justification	DATE February 2008
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BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602202F Human Effectiveness Applied Research	PROJECT NUMBER AND TITLE 7757 Bioeffects and Protection
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(U) **C. Other Program Funding Summary (\$ in Millions)**

duplication.

(U) **D. Acquisition Strategy**

Not Applicable.

UNCLASSIFIED

PE NUMBER: 0602203F
 PE TITLE: Aerospace Propulsion

Exhibit R-2, RDT&E Budget Item Justification	DATE February 2008
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BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602203F Aerospace Propulsion
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Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
Total Program Element (PE) Cost	220.143	217.172	218.049	202.638	178.565	178.795	183.615	Continuing	TBD
3012 Advanced Propulsion Technology	29.077	21.844	18.055	17.057	22.924	19.949	20.446	Continuing	TBD
3048 Fuels and Lubrication	24.022	30.752	25.497	24.963	19.197	19.981	20.697	Continuing	TBD
3066 Turbine Engine Technology	48.345	56.247	87.771	71.314	49.947	47.101	49.024	Continuing	TBD
3145 Aerospace Power Technology	43.560	44.201	29.280	29.588	29.798	31.534	31.889	Continuing	TBD
33SP Space Rocket Component Tech	56.623	53.477	48.258	49.014	49.188	48.468	49.486	0.000	0.000
4847 Rocket Propulsion Technology	18.516	10.651	9.188	10.702	7.511	11.762	12.073	Continuing	TBD

Note: In FY 2007, Project 33SP, Space Rocket Component Technology was transferred from PE 0602500F, Multi-Disciplinary Space Technology, Project 5026, Rocket Propulsion Component Technology, and Project 5027, High Speed Airbreathing Propulsion Technology, in order to more effectively manage and provide oversight of the efforts. In FY 2007, Project 3012, Advanced Propulsion Technology, combined efforts with a thrust from Project 33SP, Space Rocket Component Technology, in order to more effectively manage cooperative Combined Cycle Engine (CCE) developments. Funds for the FY 2007 Congressionally-directed High Energy Laser for Detection Inspection and Non-Destructive Testing in the amount of \$2.7 million were moved to the Defense Advanced Research Projects Agency, from PE 0602203F, Aerospace Propulsion, for execution. Funds for the FY 2007 and 2008 Congressionally-directed Center for Solar Electricity and Hydrogen were moved from PE 0602203F to PE 0602601F, Space Technology, for execution.

(U) A. Mission Description and Budget Item Justification

This program develops propulsion and power technologies to achieve enabling and revolutionary aerospace technology capabilities. The program has six projects, each focusing on a technology area critical to the Air Force. Advanced Propulsion Technology develops high-speed airbreathing propulsion engines to include combined cycle, ramjet, and hypersonic scramjet technologies to enable revolutionary propulsion capability for the Air Force. Fuels and Lubrication evaluates fuels, lubricants, and combustion concepts and technologies for new and existing engines, evaluates alternative fuels and additives, and directly supports the Versatile Affordable Advanced Turbine Engine (VAATE) program. Turbine Engine Technology develops enabling capabilities to enhance performance and affordability of existing weapon systems to include efforts that are part of the VAATE program. Aerospace Power Technology develops electrical power and thermal management technologies for military applications that are part of the High Power Aircraft (HiPAC) program. Space Rocket Component Technology develops advances in rocket propulsion technologies for space access, space maneuver, and missiles. Rocket Propulsion Technology develops advances in rocket technologies for the sustainment of strategic systems and tactical rockets. Finally, Adaptive Cycle Technologies develops component technologies for an adaptive cycle engine architecture to provide optimized performance/fuel efficiency for widely varying mission needs. Note: In FY 2008, Congress added \$3.5 million for Active Combustion Control System for Military Aircraft; \$0.8 million for Advanced Fuel Cell Based Power Systems for Small UAVs; \$1.6 million for an Advanced Vehicle and Propulsion Center; \$10.0 million for Alternative Energy Research; \$1.6 million for Development and Testing of Advanced Paraffin-Based Hybrid Rockets for Space Applications; \$6.0 million for High Energy Superior Lithium Ion Battery Technology; \$2.4 million for Hybrid Bearing research; \$1.2 million for a Hydrocarbon Boost Technology Demonstrator; \$1.6 million for an Integrated Propulsion Analysis Tool; \$2.0 million for an Integrated Starter/Generator/IES; \$1.0 million for LOX/Methane Cooled Upper Stage Rocket Engine technology; \$1.4 million for Modified F-22 Maintenance-Free Nickel Cadmium Aircraft Batteries for the F-16; \$3.5 million for THEMA - Thermal and

Exhibit R-2, RDT&E Budget Item Justification

DATE

February 2008

BUDGET ACTIVITY

02 Applied Research

PE NUMBER AND TITLE

0602203F Aerospace Propulsion

Energy Management for Aerospace applications; \$1.6 million for VDVP for UAV/UCAV Aircraft Engines; and \$1.2 million for WASH Oxygen Sensor and Cell Level Battery Controller technologies. This program is in Budget Activity 2, Applied Research, since it develops and determines the technical feasibility and military utility of evolutionary and revolutionary technologies.

(U) **B. Program Change Summary (\$ in Millions)**

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) Previous President's Budget	218.657	179.161	217.394
(U) Current PBR/President's Budget	220.143	217.172	218.049
(U) Total Adjustments	1.486	38.011	
(U) Congressional Program Reductions			
Congressional Rescissions		-1.389	
Congressional Increases		37.800	
Reprogrammings	4.804	1.600	
SBIR/STTR Transfer	-3.318		

(U) **Significant Program Changes:**

In FY 2009, change in funding is due to increased emphasis on component development in support of adaptive cycle technologies, improved fuel efficiency, and highly efficient embedded turbine engines.

C. Performance Metrics

(U) Under Development.

Exhibit R-2a, RDT&E Project Justification

DATE
February 2008

BUDGET ACTIVITY 02 Applied Research				PE NUMBER AND TITLE 0602203F Aerospace Propulsion			PROJECT NUMBER AND TITLE 3012 Advanced Propulsion Technology		
Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
3012 Advanced Propulsion Technology	29.077	21.844	18.055	17.057	22.924	19.949	20.446	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

Note: In FY 2007, funding was increased to accelerate efforts to develop technologies to support an Air Force scramjet effort. In FY 2007, Project 3012, Advanced Propulsion Technology, absorbed Combined Cycle Engine (CCE) efforts from Project 33SP, Space Rocket Component Technology, in order to more effectively manage cooperative CCE developments.

(U) A. Mission Description and Budget Item Justification

This project develops combined/advanced cycle airbreathing high-speed (up to Mach 4) and hypersonic (Mach 4 to 8+) propulsion technologies to provide revolutionary propulsion options for the Air Force. These new engine technologies will enable future high-speed/hypersonic weapons and aircraft concepts. The primary focus is on hydrocarbon-fueled engines capable of operating over a broad range of flight Mach numbers. Efforts include modeling, simulations, and proof of concept demonstrations of critical components; advanced component development; and ground-based demonstrations.

(U) B. Accomplishments/Planned Program (\$ in Millions)

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) MAJOR THRUST: Develop advanced fuel-cooled scramjet engine technologies to support flight demonstration and enable the broad application of hypersonics to meet future warfighter needs. Note: Component work supporting demo nears completion in FY 2008.	11.649	1.092	3.069
(U) In FY 2007: Developed and demonstrated flight weight engine components and a control system with closed loop controller. Performed trajectory optimization for flight test. Evaluated options for scramjet start, including gas generator/heat exchanger system, barbotage fuel injection, plasma ignition, and silane injection with a mechanical throat or air throttle. Verified operation of engine control techniques, based on rapid shock train identification and characterization coupled with fuel control logic, to ensure stable scramjet operation. Completed ground test of a flight weight, fixed geometry inlet scramjet engine with improved operability to reduce flight test risk.			
(U) In FY 2008: Continue development and demonstration of scramjet flight weight engine components and advanced engine control logic. Continue performing trajectory optimization for flight test. Continue evaluating options for scramjet start, including gas generator/heat exchanger system, barbotage fuel injection, plasma ignition, and silane injection with a mechanical throat or air throttle. Initiate design and testing of advanced scramjet start techniques. Continue verification of operation of engine control techniques, based on rapid shock train identification and characterization coupled with fuel control logic, to ensure stable scramjet operation.			
(U) In FY 2009: Continue development and demonstration of flight weight engine components and advanced engine control logic. Continue performing trajectory optimization for flight test. Continue evaluating options for scramjet start, including gas generator/heat exchanger system, barbotage fuel injection, plasma ignition, and silane injection with a mechanical throat or air throttle. Complete ground testing of advanced scramjet start techniques. Complete			

UNCLASSIFIED

Exhibit R-2a, RDT&E Project Justification		DATE February 2008		
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602203F Aerospace Propulsion	PROJECT NUMBER AND TITLE 3012 Advanced Propulsion Technology		
(U) B. Accomplishments/Planned Program (\$ in Millions)		<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
development of scramjet engine control logic for flight test engines. Continue verification of operation of engine control techniques, based on rapid shock train identification and characterization coupled with fuel control logic, to ensure stable scramjet operation.				
(U)	MAJOR THRUST: Conduct assessments, technology design trades, and simulations to integrate combined cycle engines (CCEs) and advanced cycle airbreathing hypersonic propulsion technologies into future missiles and into manned and unmanned air and space vehicle concepts. CCEs require the development and demonstration of components to integrate scramjets with high speed turbines and/or rocket engines for efficient propulsion over a broad range of Mach numbers. Note: In FY 2009, efforts in this thrust were reduced due to higher Air Force priorities.	2.184	1.966	0.181
(U)	In FY 2007: Conducted trade studies to determine military payoff and establish component technology goals. Defined component and engine performance objectives to enable development of affordable hypersonic flight demonstrators jointly with NASA and DARPA. Developed advanced components for turbine-based and rocket-based CCEs. Fabricated and initiated test of advanced inlets for turbine-based CCEs capable of operating from Mach 0 to Mach 8.			
(U)	In FY 2008: Continue trade studies to determine military payoff and establish component technology goals. Continue defining component and engine performance objectives to enable development of affordable hypersonic flight demonstrators jointly with NASA and DARPA. Continue development of advanced components for turbine-based and rocket-based CCEs. Complete testing of advanced inlets for turbine-based CCEs capable of operating from Mach 0 to Mach 8. Design an advanced nozzle for turbine-based and rocket-based CCEs.			
(U)	In FY 2009: Continue CCE trade studies to determine military payoff and establish component technology goals. Continue defining component and engine performance objectives to enable development of affordable hypersonic flight demonstrators. Continue development of advanced components for turbine-based and rocket-based CCEs.			
(U)	MAJOR THRUST: Develop robust hydrocarbon fueled scramjet engine components and technologies to improve performance, operability, durability, and scalability for future missiles. Note: Starting in FY 2008, efforts shift towards much larger hot section testing and voluminous test data will be required to correlate the combustion scaling phenomena to the original baseline configuration to provide the knowledge to scale the scramjet configuration to larger applications potentially up to space launch. In FY 2009, efforts in this thrust were revamped due to higher Air Force priorities.	10.436	18.786	14.805
(U)	In FY 2007: Developed advanced engine components to improve scramjet operating margin and to establish			

UNCLASSIFIED

Exhibit R-2a, RDT&E Project Justification		DATE February 2008		
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602203F Aerospace Propulsion	PROJECT NUMBER AND TITLE 3012 Advanced Propulsion Technology		
		FY 2007	FY 2008	FY 2009
(U) B. Accomplishments/Planned Program (\$ in Millions)				
scramjet scaling laws for reusable applications. Developed variable geometry techniques to decrease scramjet take-over from Mach 4.5 to Mach 3.5 to provide robust options for CCEs. Completed test of round scramjet combustors for reusable applications with improved structural efficiency. Initiated development of improved durability engine concepts. Developed low internal drag flame stabilization devices and flight test engine components.				
(U) In FY 2008: Continue development of advanced engine components to improve scramjet operating margin and to establish scramjet scaling laws for reusable applications. Continue development of variable geometry techniques to decrease scramjet take-over from Mach 4.5 to Mach 3.5 to provide robust options for CCEs. Complete test of scramjet combustors 5 to 10 times baseline size for reusable applications with improved structural efficiency. Initiate development of improved durability engine concepts. Continue development of low internal drag flame stabilization devices and flight test engine components.				
(U) In FY 2009: Continue development of advanced engine components to improve scramjet operating margin and to establish scramjet scaling laws for reusable applications. Continue development of variable geometry techniques to decrease scramjet take-over from Mach 4.5 to Mach 3.5 to provide robust options for CCEs. Continue development of low internal drag flame stabilization devices and flight test engine components. Conduct assessment of ground test facilities and test techniques to demonstrate large (20 to 100 times) size scramjet engines.				
(U) CONGRESSIONAL ADD: Advanced High Speed Propulsion Development.		0.981	0.000	0.000
(U) In FY 2007: Enhanced the nation's ability to test and analyze high speed propulsion systems such as scramjets and combined cycle engines.				
(U) In FY 2008: Not Applicable.				
(U) In FY 2009: Not Applicable.				
(U) CONGRESSIONAL ADD: X-51 Robust Scramjet Flight Research.		3.827	0.000	0.000
(U) In FY 2007: Investigated the integration of alternative high speed combined cycle engine configurations (such as circular and rectangular scramjets) for potential flight demonstration under X-51 follow-on efforts.				
(U) In FY 2008: Not Applicable.				
(U) In FY 2009: Not Applicable.				
(U) Total Cost		29.077	21.844	18.055

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY
02 Applied Research

PE NUMBER AND TITLE
0602203F Aerospace Propulsion

PROJECT NUMBER AND TITLE
**3012 Advanced Propulsion
Technology**

(U) C. Other Program Funding Summary (\$ in Millions)

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to</u>	<u>Total Cost</u>
	<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Complete</u>	
(U) Related Activities:									
(U) PE 0601102F, Defense Research Sciences.									
(U) PE 0602201F, Aerospace Flight Dynamics.									
(U) PE 0602500F, Multi-Disciplinary Space Tech.									
(U) PE 0602602F, Conventional Munitions.									
(U) PE 0602702E, Tactical Technology.									
(U) PE 0603211F, Aerospace Structures.									
(U) PE 0603216F, Aerospace Propulsion and Power Technology.									
(U) PE 0603601F, Conventional Weapons Technology.									
(U) Program is reported to/coordinated by the Joint Army/Navy/NASA/Air Force (JANNAF) Executive Committee.									
(U) This project has been coordinated through the Reliance 21 process to harmonize efforts and eliminate duplication.									

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

02 Applied Research

PE NUMBER AND TITLE

0602203F Aerospace Propulsion

PROJECT NUMBER AND TITLE

3012 Advanced Propulsion
Technology

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification

DATE
February 2008

BUDGET ACTIVITY 02 Applied Research				PE NUMBER AND TITLE 0602203F Aerospace Propulsion			PROJECT NUMBER AND TITLE 3048 Fuels and Lubrication		
Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
3048 Fuels and Lubrication	24.022	30.752	25.497	24.963	19.197	19.981	20.697	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

Note: The funding in this project has been increased to provide emphasis on component development in support of adaptive cycle technologies. Funds for the FY 2007 Congressionally-directed High Energy Laser for Detection Inspection and Non-Destructive Testing in the amount of \$2.7 million are in the process of being moved to the Defense Advanced Research Projects Agency, from PE 062203F, Aerospace Propulsion, for execution.

(U) A. Mission Description and Budget Item Justification

This project evaluates fuels, lubricants, mechanical systems, and combustion concepts for advanced turbine engines, scramjets, pulse detonation, and combined cycle engines. This project also develops technologies to increase turbine engine operational reliability, durability, mission flexibility, and performance while reducing weight, fuel consumption, and cost of ownership. Applications include missiles, aircraft, sustained high-speed vehicles, and responsive space launch. Analytical and experimental areas of emphasis include fuels and fuels logistics, lubricants, bearings, electromagnetic rotor, oil-less engine technology, optical diagnostics, fundamental combustion, and detonations. Fuels and lubricants for these engines must be thermally stable, cost-effective, and operate over a broad range of conditions. Advanced combustion concepts must be cost-effective, durable, and reduce pollutant emissions. A portion of this project supports adaptive cycle technologies. This effort develops component technology for an adaptive cycle engine architecture that provides optimized performance/fuel efficiency for widely varying mission needs.

(U) B. Accomplishments/Planned Program (\$ in Millions)

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) MAJOR THRUST: Develop low-cost additive and fuel system approaches to improve fuel properties and to expand the flight envelope for manned and unmanned aircraft. Determine fuel cooling requirements and specifications for an adaptive cycle engine architecture. Design, fabricate, and test of key thermal management technologies. Note: Increased funding in FY 2008 and out due to emphasis on component development in support of adaptive cycle technologies.	2.179	3.102	6.628
(U) In FY 2007: Conducted lab-scale evaluation of approaches to increase JP-8 temperature capability to 900 degrees Fahrenheit including thermal stability additives, fuel deoxygenation, advanced alternative energy fuels, and improved materials and coatings. Initiated effort to validate component performance models on aircraft thermal management simulator. Developed approaches to assess and improve additive combustion behavior at low fuel and air temperatures. Tested fuel candidates in bench scale rigs simulating advanced high Mach propulsion systems.			
(U) In FY 2008: Continue conducting lab-scale evaluation of approaches to increase JP-8 temperature capability to 900 degrees Fahrenheit including thermal stability additives, fuel deoxygenation, advanced alternative fuels, and improved materials and coatings. Continue effort to validate component performance models on aircraft thermal management simulator. Complete the development of approaches to assess and improve additive combustion behavior at low fuel and air temperatures. Continue to test fuel candidates in bench scale rigs simulating advanced high Mach propulsion systems and the Highly Efficient Embedded Efficient Turbine Engine (HEETE). Develop a			

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

02 Applied Research

PE NUMBER AND TITLE

0602203F Aerospace Propulsion

PROJECT NUMBER AND TITLE

3048 Fuels and Lubrication

(U) B. Accomplishments/Planned Program (\$ in Millions)	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
robust mechanical and integrated engine thermal management system (mechanical and fuel systems) for optimum engine performance and durability at sustained supersonic cruise conditions.			
(U) In FY 2009: Continue conducting lab-scale evaluation of approaches to increase JP-8 temperature capability to 900 degrees Fahrenheit including thermal stability additives, fuel deoxygenation, advanced alternative energy fuels, and improved materials and coatings. Continue effort to validate component performance models on aircraft thermal management simulator. Continue to test fuel candidates in bench scale rigs simulating advanced high Mach propulsion systems and the HEETE. Conduct full-scale component rig testing of mechanical components with experimental lubricants. Conduct simulated high-Mach tests of an integrated thermal management system and mechanical system components.			
(U) MAJOR THRUST: Develop advanced additive approaches to reduce engine emissions and signature (including nano-scale additives), as well as advanced emission diagnostic test protocols.	1.342	1.206	1.785
(U) In FY 2007: Assessed novel fuel additives including nano-technologies and fuels derived from alternative energy resources to reduce emissions in laboratory scale combustion rigs. Initiated higher-pressure measurements of additive and fuel effects on sub-micron particulate generation during combustion.			
(U) In FY 2008: Complete assessing novel fuel additives including nano-technologies to reduce emissions in laboratory scale combustion rigs. Initiate improvement of combustion models for kerosene fuels. Continue higher-pressure measurements of additive and fuel effects on sub-micron particulate generation during combustion.			
(U) In FY 2009: Continue higher-pressure measurements of additive and fuel effects on sub-micron particulate generation during combustion. Initiate study of NOx/soot trade offs in combustor design. Continue improvement of combustion models for kerosene fuels.			
(U) MAJOR THRUST: Study and evaluate low-cost approaches to reduce fuel logistics footprint to simplify logistics and reduce cost (including field and on-board additive injections and improvements to existing fuel additive packages), as well as study fuel logistics vulnerabilities and develop detection and mitigation technologies.	1.341	1.207	1.785
(U) In FY 2007: Investigated performance of Fischer-Tropsch (F-T) and other alternative fuels for aircraft and other field hardware. Evaluated advanced nano-technology fuel sensors, nano-technology fuel additives, and novel detection and mitigation technologies for biological growth.			
(U) In FY 2008: Expand investigation of the performance of alternative fuels to include bio-derived fuels. Initiate development of bioreactors to simulate biological growth in aircraft fuel systems and ground storage facilities. Initiate development of knowledge base for certification of Fischer-Tropsch fuels for all Air Force tactical vehicles. Continue evaluation of advanced nano-technology fuel sensors, nano-technology fuel additives, and novel detection			

UNCLASSIFIED

Exhibit R-2a, RDT&E Project Justification		DATE February 2008		
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602203F Aerospace Propulsion	PROJECT NUMBER AND TITLE 3048 Fuels and Lubrication		
<u>B. Accomplishments/Planned Program (\$ in Millions)</u>		<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) and mitigation technologies for biological growth.				
(U) In FY 2009: Continue to investigate performance of biomass-derived fuels for aircraft and other field hardware. Initiate extension of knowledge base to other alternative fuels, such as those derived from biomass. Continue development of bioreactors to simulate biological growth in aircraft fuel systems and ground storage facilities. Continue development of knowledge base for certification of Fischer-Tropsch fuels for all Air Force tactical vehicles.				
(U) MAJOR THRUST: Investigate hydrocarbon and other high energy density fuels for advanced and combined cycle engines for high-speed aerospace vehicles and low-cost boost applications.		0.670	0.690	0.765
(U) In FY 2007: Assessed advanced hydrocarbon propellant stability under high heat flux conditions. Collected improved fuel property data for hydrocarbon propellant database.				
(U) In FY 2008: Complete study of refined kerosene propellants under high heat flux conditions, while continuing to study synthesized high-energy hydrocarbons. Continue to improve fuel property database and share with industry to improve design tools.				
(U) In FY 2009: Continue study of high-energy hydrocarbon propellant candidates. Complete improved physical property database for kerosene propellants at high pressure. Continue to collect improved physical property for high energy hydrocarbons and improve physical property models.				
(U) MAJOR THRUST: Develop, test, and evaluate revolutionary combustor and propulsion concepts for gas turbine, pulsed detonation, and combined cycle engines for missiles, manned and unmanned systems, and reusable access to space; perform payoff analyses and configuration trade studies for these systems; and evaluate the combustion and emissions characteristics of fuels and fuel additives.		4.526	4.310	5.864
(U) In FY 2007: Evaluated advanced combustion system performance at realistic operating conditions. Investigated inter-turbine burning concepts for large gas turbine engines. Integrated of Pulse Detonation Engine (PDE) into turbine-based hybrid concept. Evaluated and optimized advanced combustor, augmentor, and PDE concepts using modeling and simulation tools.				
(U) In FY 2008: Demonstrate small-scale inter-turbine burner (ITB) concepts in a relevant engine environment. Investigate the scalability of inter-turbine burners for large engines. Assess an integrated pulsed detonation/hybrid turbine concept performance with component fabrication and evaluation. Investigate combustor and augmentor systems for high-altitude low-high mach applications. Evaluate and optimize advanced combustor, augmentor, and PDE concepts using modeling and simulation tools.				
(U) In FY 2009: Evaluate advanced combustion system performance at realistic operating conditions. Demonstrate				

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

02 Applied Research

PE NUMBER AND TITLE

0602203F Aerospace Propulsion

PROJECT NUMBER AND TITLE

3048 Fuels and Lubrication

(U) B. Accomplishments/Planned Program (\$ in Millions)	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
small-scale ITB concepts in small engine. Identify concept designs of inter-turbine burning concepts for large gas turbine engines. Optimize component efficiency of the integrated pulsed detonation/hybrid turbine. Evaluate and optimize advanced combustor, augmentor, and PDE concepts using modeling and simulation tools covering wider flight conditions and applications.			
(U) MAJOR THRUST: Develop approaches to extend the life of endothermic fuels and fuel system components for sustained supersonic and reusable hypersonic cruise applications.	0.670	0.690	0.765
(U) In FY 2007: Developed improved surfaces/catalysts to mitigate coking and thus improve fuel heat sink capability. Assessed unconventional approaches to increase fuel heat sink and minimize regenerative cooling heat loads, including low heat rejection structures.			
(U) In FY 2008: Evaluate improved coke-mitigating surfaces/catalysts with 2nd generation endothermic fuels in bench-scale heat exchanger rigs. Assess unconventional approaches to increase fuel heat sink and minimize regenerative cooling heat loads in panel tests. Initiate study of relationship between fuel structure/properties and combustion behavior including blowout.			
(U) In FY 2009: Continue bench-scale tests to evaluate improved surfaces/catalysts for 2nd generation endothermic fuels. Continue assessment of unconventional approaches to increase fuel heat sink and minimize regenerative cooling heat loads. Continue study of relationship between fuel structure/properties and combustion behavior including blowout.			
(U) MAJOR THRUST: Develop and demonstrate optical, electromechanical, and laser diagnostic tools and sensors for application to revolutionary propulsion technologies.	0.670	0.862	1.020
(U) In FY 2007: Applied advanced diagnostics in a relevant gas turbine combustion system environment. Applied diagnostics to sensor development and validated sensors in relevant gas turbine engine system. Conducted experiments to obtain benchmark-quality data for improvement of combustion modeling and simulation tools.			
(U) In FY 2008: Demonstrate high-bandwidth (e.g., MHz-rate) planar laser-induced fluorescence for high-speed digital imaging of key combustion species in fundamental laboratory flames and relevant engine environments. Apply terahertz radiation (T-rays) for combustion temperature sensing and non-destructive inspection/evaluation of turbine engine components. Integrate current and next-generation combustion diagnostics to support RDT&E of augmentor solutions for fighter aircraft.			
(U) In FY 2009: Develop high-speed techniques for measuring carbon monoxide (CO) to evaluate CO oxidation and combustion efficiency in near constant volume combust on turbine environments. Exploit ultrafast (e.g., femtosecond), ultraintense (e.g., terawatt) laser systems to generate ultrashort x-ray bursts for soot-mitigation studies			

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

02 Applied Research

PE NUMBER AND TITLE

0602203F Aerospace Propulsion

PROJECT NUMBER AND TITLE

3048 Fuels and Lubrication

(U) B. Accomplishments/Planned Program (\$ in Millions)	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) and dense fuel spray imaging. Develop multi-pulse femtosecond ballistic imaging to understand and improve fuel sprays in combustor, augmentor, scramjet, and rocket applications.			
(U) MAJOR THRUST: Develop, test, and qualify advanced turbine engine lubricants for the Air Force. Establish target requirements and transition opportunities for new oils by working with DoD agencies, industry, and users. Generate and maintain military specifications for aviation engine lubricants, as well as continued field support activities for aviation lubrication technologies and DoD operational units.	2.514	2.413	3.315
(U) In FY 2007: Began technology insertion of advanced bearing and lubrication system concepts, components, and materials for improved engine performance, affordability, and engine health monitoring into demonstrator cores and engines. Conducted testing to focus and develop lubricants and mechanical systems for man-rated, expendable, and UAV turbine engines. Initiated 7cSt ester lubricant development for high Mach/high temperature military and commercial turbine engines. Coordinated and supported demonstration of Joint Oil Program lubricants in new fighter asset engines. Delivered military specifications and test methods for DoD lubricants to support new fighter engines.			
(U) In FY 2008: Complete qualification testing of the enhanced 5cSt ester candidate(s), transition to demo engine program and draft new oil specification. Ramp up qualification testing of hi-mach 7cSt ester in preparation of FY 2011 engine demo. Develop an integrated and effective bearing/oil health monitoring system with prognostics capability to address critical DoD safety, readiness, and life-cycle cost concerns. Conduct technology assessment of long-term, low-temperature (high-altitude) performance of engine lubricants and develop concepts for efficient mechanical system for highly efficient embedded turbine engines.			
(U) In FY 2009: Demonstrate enhanced 5cSt ester lubricant in Joint Strike Fighter thrust growth demo engines. Finalize and begin fielding new enhanced 5cSt oil specification. Conduct qualification testing of new hi-mach 7cSt ester lubricant. Demonstrate an integrated bearing/oil health monitoring/prognostic system in full-scale setting and validate life models. Fabricate and test an efficient mechanical system for highly efficient embedded turbine engine and adaptive versatile turbine engines (ADVENT). Continue development of high-temperature lubricants for Long Range Strike aircraft.			
(U) MAJOR THRUST: Develop and test advanced bearing material technology and bearing concepts for small, intermediate, and large-sized turbine engine applications.	2.850	2.758	3.570
(U) In FY 2007: Conducted airfoil bearing tests in larger shaft diameter sizes to determine load capacity and rotor size limitations of this technology. Developed and tested of affordable rotor support technology for small-, intermediate-, and large-sized turbine engine applications. Validated modeling and simulation tools to advance design, shorten			

UNCLASSIFIED

Exhibit R-2a, RDT&E Project Justification		DATE February 2008		
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602203F Aerospace Propulsion	PROJECT NUMBER AND TITLE 3048 Fuels and Lubrication		
		<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) B. Accomplishments/Planned Program (\$ in Millions)				
development time, and reduce test requirements for mechanical and electromagnetic rotor support and power generation systems. Improved the modeling of airfoil shaft bearings and initiated evaluation of insertion opportunities for advanced engine rotor support and power generation. Transitioned/transferred airfoil bearing technology to bearing and engine companies. Demonstrated hybrid (metal/ceramic) bearing and JOP lubricants in new fighter demonstrator engines. Initiated programs for hardware needed for optimum thermal protection designs for high mach/high temperature turbine engines and accelerators. Expanded the previous studies of advanced rotor support and power generation for turbine and combined cycle engines.				
(U) In FY 2008: Demonstrate new fatigue and spall propagation resistant bearing materials in advanced demo engines with enhanced 5cSt oil. Conduct subscale fatigue life and spall propagation studies of bearing materials with hi-mach 7cSt oil candidates. Develop preliminary design of propfan gearbox and conduct trade study of energy efficient mechanical system components (i.e., rolling element versus foil versus magnetic bearing) for HEETE.				
(U) In FY 2009: Continue complete sub-scale fatigue life and spall propagation studies of bearing materials and validate spall propagation models through with hi-mach 7cSt oil candidates and begin full-scale tests. Fabricate and test propfan gearbox in support of ADVENT. Down select mechanical system components and complete detailed design for highly efficient embedded turbine engines and ADVENT engines.				
(U) CONGRESSIONAL ADD: Ultrafast, Ultraintense Laser Microfabrication and Diagnostics (formerly Intense, Ultrafast Laser Microfabrication and Diagnostics).		0.981	0.000	0.000
(U) In FY 2007: Established the technical base required to evaluate and develop ultrafast, ultraintense lasers for fabrication, inspection, and repair of components for aerospace propulsion and other weapon systems.				
(U) In FY 2008: Not Applicable.				
(U) In FY 2009: Not Applicable.				
(U) CONGRESSIONAL ADD: Research Institute for Environmental Studies.		1.962	0.000	0.000
(U) In FY 2007: Accelerated the development and demonstration of a modular, portable wastewater treatment system that can meet EPA standards and can be deployed to forward bases within 24 hours.				
(U) In FY 2008: Not Applicable.				
(U) In FY 2009: Not Applicable.				
(U) CONGRESSIONAL ADD: High Energy Laser for Detection Inspection and Non-Destructive Testing.		2.649	0.000	0.000
(U) In FY 2007: Developed high-energy laser techniques for use as a non-destructive technique for inspection of gas turbine engine components.				

Exhibit R-2a, RDT&E Project Justification

DATE
February 2008

BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602203F Aerospace Propulsion	PROJECT NUMBER AND TITLE 3048 Fuels and Lubrication
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(U) B. Accomplishments/Planned Program (\$ in Millions)	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) In FY 2008: Not Applicable.			
(U) In FY 2009: Not Applicable.			
(U) CONGRESSIONAL ADD: Hybrid Bearings.	1.668	2.385	0.000
(U) In FY 2007: Developed a suite of advanced hybrid bearing technologies for transition to JSF thrust growth and advanced VAATE turbine engines. Demonstrated hybrid P675 bearing in JSF in accelerated mission engine test (Jul 07). Optimized P675 heat treatment for enhanced spall propagation resistance. Developed bearing spall and crack propagation models. Developed advanced bearing cages for improved bearing performance.			
(U) In FY 2008: Demonstrate optimized P675 bearing steel in sub-scale bearings. Continue manufacture of full-scale P675 bearings. Demonstrate nondestructive evaluation (NDE) equipment for silicon nitride rolling elements. Continue developing high performance bearing cage.			
(U) In FY 2009: Not Applicable.			
(U) CONGRESSIONAL ADD: Alternative Energy Research	0.000	9.937	0.000
(U) In FY 2007: Not Applicable.			
(U) In FY 2008: Perform research on alternative energy, focusing on alternative hydrocarbon fuels made from coal, biomass, oil shale. Research includes fuel property evaluation and enhancement, as well as component and engine testing of alternative fuels.			
(U) In FY 2009: Not Applicable.			
(U) CONGRESSIONAL ADD: WASH Oxygen Sensor and Cell Level Battery Controller	0.000	1.192	0.000
(U) In FY 2007: Not Applicable.			
(U) In FY 2008: Conduct research for the development of oxygen sensors for aircraft wing tanks with specific emphasis on evaluating performance and durability in realistic operating environments. Develop a cell level battery controller.			
(U) In FY 2009: Not Applicable.			
(U) Total Cost	24.022	30.752	25.497

(U) C. Other Program Funding Summary (\$ in Millions)	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to</u>	<u>Total Cost</u>
	<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Complete</u>	
(U) Related Activities:									
(U) PE 0601102F, Defense Research									

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

02 Applied Research

PE NUMBER AND TITLE

0602203F Aerospace Propulsion

PROJECT NUMBER AND TITLE

3048 Fuels and Lubrication**(U) C. Other Program Funding Summary (\$ in Millions)**

Sciences.

(U) PE 0602805F, Dual Use Science
and Technology.**(U)** PE 0603216F, Aerospace
Propulsion and Power
Technology.**(U)** This project has been
coordinated through the
Reliance 21 process to
harmonize efforts and eliminate
duplication.**(U) D. Acquisition Strategy**

Not Applicable.

Exhibit R-2a, RDT&E Project Justification

DATE
February 2008

BUDGET ACTIVITY 02 Applied Research				PE NUMBER AND TITLE 0602203F Aerospace Propulsion			PROJECT NUMBER AND TITLE 3066 Turbine Engine Technology		
Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
3066 Turbine Engine Technology	48.345	56.247	87.771	71.314	49.947	47.101	49.024	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

Note: The funding in this project has been increased to provide emphasis on adaptive cycle technologies, increased fuel efficiency, and highly efficient embedded turbine engines.

(U) A. Mission Description and Budget Item Justification

This project develops technology to increase turbine engine operational reliability, durability, mission flexibility, and performance, while reducing weight, fuel consumption, and cost of ownership. Analytical and experimental areas of emphasis are fans and compressors, high temperature combustors, turbines, internal flow systems, controls, augmentor and exhaust systems, integrated power and thermal management systems, engine inlet integration, mechanical systems, and structural design. This project supports the Integrated Versatile Affordable Advanced Turbine Engine (VAATE) program and industry efforts to focus turbine propulsion technology on national needs. The program plan reflects the technology base support for VAATE activity applicable to global responsive strike, capable unmanned warfighting, tactical and global mobility, responsive space lift, and persistent Intelligence, Surveillance, and Reconnaissance (ISR). A portion of this project supports adaptive cycle technologies. This effort develops component technology for an adaptive cycle engine architecture that provides optimized performance/fuel efficiency for widely varying mission needs. A portion of the project supports the Energy Conservation-Assured Fuels Initiative. This effort identifies, and evaluates technologies that enable the use of domestic fuel sources for military energy needs.

(U) B. Accomplishments/Planned Program (\$ in Millions)

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) MAJOR THRUST: Develop core turbofan/turbojet engine components (i.e., compressors, combustors, and high-pressure turbines) for fighters, bombers, sustained supersonic/hypersonic cruise vehicles, and transports. Identify, and evaluate technologies that enable the use of domestic fuel sources for military energy needs. Develop advanced concepts, designs, design rules, and computational tools to support component research and rig testing of components for an adaptive cycle engine. Develop advanced concepts, designs, design rules, and computational tools to support research and rig testing of component technologies to substantially improve specific fuel consumption by increasing overall pressure ratio and turbine rotor inlet temperature; by improving component efficiencies; and by reducing cooling air and pressure losses. Note: Increased funding in FY 2008 and out due to emphasis on increased fuel efficiency, adaptive cycle technologies, and highly efficient embedded turbine engines.	20.839	33.267	65.828
(U) In FY 2007: Developed and applied advanced modeling and simulation rules and tools for advanced components. Incorporated advanced materials into innovative designs and analyzed Ceramic Matrix Composite (CMC) turbine blades, turbine vanes, and turbine rear frame. Designed and analyzed tiled turbine airfoil technology to reduce cooling flow and increase life. Designed and demonstrated a very short, high efficiency afterburner concept. Conducted rig tests and design optimization of effective, durable, radiation barrier coatings to reduce the radiant heat loads on hot section components. Designed, fabricated, and rig tested fan/radial compressor internal aerodynamics, large radius rotating air seals, a low profile annular combustor, and a large-scale casting of fan/radial compressor.			

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

02 Applied Research

PE NUMBER AND TITLE

0602203F Aerospace Propulsion

PROJECT NUMBER AND TITLE

3066 Turbine Engine Technology

(U) **B. Accomplishments/Planned Program (\$ in Millions)**FY 2007FY 2008FY 2009

- (U) In FY 2008: Continue to develop and apply advanced modeling and simulation rules and tools for advanced components. Develop and optimize novel dual fuel burner. Determine suitability of latest Titanium Aluminide materials for Mach 4 compressor application. Develop and apply advanced modeling and simulation rules and tools to significantly improve component efficiencies, enabling reduced fuel consumption in emerging and future gas turbine propulsion systems. Develop and apply advanced modeling and simulation rules and tools to initiate definition and design of lightweight, simple, adaptive cycle features. Develop and apply advanced modeling and simulation rules and tools to initiate definition and design of an efficient, wide-flow range compressor. Initiate rig testing of lightweight, simple, adaptive cycle features, an efficient, wide-flow range compressor, an efficient, high temperature turbine capable of operating over large swings in required work, and an efficient, lightweight, LO-compatible exhaust system. Develop and apply advanced modeling and simulation rules and tools to initiate definition and design of an efficient, very high pressure ratio compressor and associated thermal management features that will offer a step change improvement in engine Specific Fuel Consumption (SFC).
- (U) In FY 2009: Continue to develop and apply advanced modeling and simulation rules and tools for advanced components. Conduct rig testing of advanced high pressure turbine vane and blade nano-laminate thermal barrier coating (TBC) applied. Begin to develop computational fluid dynamics methodology for analyzing turbine flows. Begin to develop CMC lifing models. Conduct bench and rig tests for validation of components with significantly improved efficiency. Continue rig testing of lightweight, simple, adaptive cycle features, an efficient, wide-flow range compressor, an efficient, high temperature turbine capable of operating over large swings in required work, and an efficient, lightweight, LO-compatible exhaust system. Fabricate and rig test an efficient, very high pressure ratio compressor and associated thermal management features that will offer a step change improvement in engine SFC.
- (U) MAJOR THRUST: Develop turbofan/turbojet engine components (i.e., fans, low pressure turbines, engine controls, exhaust nozzles, and integration technologies) for turbofan/turbojet engines for fighters, bombers, sustained supersonic strike and hypersonic cruise vehicles, and transports.
- (U) In FY 2007: Identified and quantified sources of variability and uncertainty affecting turbine blade durability performance (oxidation, creep, thermal material fatigue, high cycle fatigue, etc.). Applied advanced materials systems to innovative designs to determine wear reduction, improve load capacity, and increase temperature capability of five centi-stokes oil and to assess aerodynamics, operability, aeromechanics, and acoustic characteristics of a counter-rotating fan-on-blade (FLADE) concept. Conducted design optimization for turbine blade microcircuit cooling. Tested pilot and fuel injection concepts in a single-flameholder rig to evaluate fundamental capabilities.
- (U) In FY 2008: Continue to develop and apply advanced modeling and simulation rules and tools for advanced

12.975

12.283

15.799

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

02 Applied Research

PE NUMBER AND TITLE

0602203F Aerospace Propulsion

PROJECT NUMBER AND TITLE

3066 Turbine Engine Technology

(U) B. Accomplishments/Planned Program (\$ in Millions)	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
components. Conduct risk reduction testing of variable bypass ratio fan concept. Develop and rig test reheat augmentor technology to significantly decrease burning length. Design and fabricate an advanced lightweight, variable area exhaust nozzle.			
(U) In FY 2009: Continue to develop and apply advanced modeling and simulation rules and tools for advanced components. Develop durable damping/erosion coating systems. Conduct rig testing of advanced fan design for application to a variable cycle engine concept.			
(U) MAJOR THRUST: Develop limited life engine components for missile and unmanned air vehicle applications, including long-range supersonic and hypersonic vehicles. These efforts enable engines with reduced cost, reduced fuel consumption, and increased specific thrust, thereby greatly expanding the operating envelopes of missiles and unmanned vehicles.	3.932	4.094	5.266
(U) In FY 2007: Rig tested a slinger-fed, dual-fuel CRC. Developed and applied advanced modeling and simulation rules and tools for advanced components (i.e., high cycle fatigue, computational fluid dynamics, cycle analyses, propulsion system models, component life models, probabilistic models, etc.). Rig tested a fuel-cooled turbine. Designed and analyzed a five-stage forward swept compressor.			
(U) In FY 2008: Utilize data from high speed turbine engine testing of a wide-range, lightweight carbon-carbon variable area exhaust nozzle and a compact, carbon-carbon ramburner to update and validate advanced modeling and simulation rules and tools.			
(U) In FY 2009: Utilize data from high speed turbine engine testing of a fuel cooled turbine and a slinger-fed, dual-fuel CRC to update and validate advanced modeling and simulation rules and tools.			
(U) MAJOR THRUST: Develop components for turboshaft/turboprop and small turbofan engines for trainers, rotorcraft, special operations aircraft, and theater transports.	1.573	1.535	0.878
(U) In FY 2007: Developed and applied advanced modeling and simulation rules and tools for advanced components. Applied advanced materials systems to innovative designs and analyze a nano-laminate thermal barrier coating. Developed new and innovative design concepts and conducted bench and rig tests for validation of a high heat release combustor design and an advanced forward swept, centrifugal compressor design.			
(U) In FY 2008: Develop new and innovative design concepts and conduct bench and rig tests for validation of a mixed flow turbine design.			
(U) In FY 2009: Utilize data from efficient small scale engine testing of an advanced forward swept, centrifugal compressor, and a silicon nitride mixed flow turbine to update and validate advanced modeling and simulation rules and tools.			

UNCLASSIFIED

Exhibit R-2a, RDT&E Project Justification		DATE February 2008		
BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE		
02 Applied Research	0602203F Aerospace Propulsion	3066 Turbine Engine Technology		
(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u>		<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) CONGRESSIONAL ADD: VAATE TMC FLADE Technology Demonstration (formerly VAATE-Titanium Matrix Composites).		1.079	0.000	0.000
(U) In FY 2007: Developed Titanium Matrix Composites for advanced turbine engine components.				
(U) In FY 2008: Not Applicable.				
(U) In FY 2009: Not Applicable.				
(U) CONGRESSIONAL ADD: Active Combustion Control System for Military Aircraft.		1.766	0.000	0.000
(U) In FY 2007: Developed advanced Active Combustion Control System (ACCS) components for use in ongoing and future engine development programs.				
(U) In FY 2008: Not Applicable.				
(U) In FY 2009: Not Applicable.				
(U) CONGRESSIONAL ADD: Advanced Affordability Assurance Tools for the Versatile Affordable Advanced Turbine Engine (VAATE) Initiative.		0.981	0.000	0.000
(U) In FY 2007: Developed state-of-the-art computer software tools that will estimate development, production, and maintenance costs for advanced technology turbine engines.				
(U) In FY 2008: Not Applicable.				
(U) In FY 2009: Not Applicable.				
(U) CONGRESSIONAL ADD: Intelligent Engine Technology Development for UAVs.		1.374	0.000	0.000
(U) In FY 2007: Developed turbine engine life management software to reduce overall engine maintenance costs.				
(U) In FY 2008: Not Applicable.				
(U) In FY 2009: Not Applicable.				
(U) CONGRESSIONAL ADD: Active Combustion Control Systems for Military Aircraft.		3.826	3.478	0.000
(U) In FY 2007: Developed advanced active combustion control system components for use in ongoing and future engine development programs.				
(U) In FY 2008: Continue to develop Active Combustion Control Systems for military aircraft.				
(U) In FY 2009: Not Applicable.				
(U) CONGRESSIONAL ADD: VDVP for UAV/UCAV Aircraft Engines		0.000	1.590	

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602203F Aerospace Propulsion	PROJECT NUMBER AND TITLE 3066 Turbine Engine Technology
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(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) In FY 2007: Not Applicable.			
(U) In FY 2008: Conduct research and development on variable displacement vane pumps for UAV and UCAV engines.			
(U) In FY 2009: Not Applicable.			
(U) Total Cost	48.345	56.247	87.771

(U) <u>C. Other Program Funding Summary (\$ in Millions)</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to</u>	<u>Total Cost</u>
	<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Complete</u>	
(U) Related Materials:									
(U) PE 0601102F, Defense Research Sciences.									
(U) PE 0602102F, Materials.									
(U) PE 0603216F, Aerospace Propulsion and Power Technology.									
(U) PE 0602122N, Aircraft Technology.									
(U) PE 0603210N, Aircraft Propulsion.									
(U) PE 0603003A, Aviation Advanced Technology.									
(U) This project has been coordinated through the Reliance 21 process to harmonize efforts and eliminate duplication.									
(U) <u>D. Acquisition Strategy</u>									
Not Applicable.									

Exhibit R-2a, RDT&E Project Justification

DATE
February 2008

BUDGET ACTIVITY 02 Applied Research				PE NUMBER AND TITLE 0602203F Aerospace Propulsion			PROJECT NUMBER AND TITLE 3145 Aerospace Power Technology		
Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
3145 Aerospace Power Technology	43.560	44.201	29.280	29.588	29.798	31.534	31.889	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

- (U) **A. Mission Description and Budget Item Justification**
 This project develops electrical and thermal management technologies for military aerospace applications. Power component technologies are developed to increase reliability, maintainability, commonality, affordability, and supportability of aircraft and flight line equipment. Research is conducted in energy storage and hybrid power system technologies to enable special purpose applications. Electrical power and thermal management technologies enable all future military directed energy weapon systems. This project supports development of electrical power and thermal management component and systems suitable for applications to legacy and future aircraft platforms including strike and mobility concepts. Lightweight power systems suitable for other aerospace applications are also developed.
- | | | | |
|--|----------------|----------------|----------------|
| (U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u> | <u>FY 2007</u> | <u>FY 2008</u> | <u>FY 2009</u> |
| (U) MAJOR THRUST: Develop electrical power and thermal management component and subsystem technologies for manned and unmanned aircraft systems. These technologies improve aircraft range, self-sufficiency, reliability, maintainability, and supportability, while reducing life cycle costs and enabling new capabilities. Develop hybrid electrical power and thermal management, including energy conversion/storage, components and subsystem technologies for special purpose applications enabling long endurance missions. Note: Funding increasing in FY 2008 and on due to Air Force emphasis on developing technologies to address thermal management issues of current and emerging aircraft and UAVs. | 11.185 | 16.518 | 23.717 |
| (U) In FY 2007: Fabricated and characterized next generation solid state lithium-based thin film cells. Completed testing of an advanced switched reluctance machine controller. Completed preliminary aircraft thermal management studies and identified high efficiency design candidates. | | | |
| (U) In FY 2008: Develop and design high efficiency, high power, high temperature power electrical components. Develop and test air vehicle electromagnetic and radio frequency effects immune components. Design and fabricate thermal management components and subsystems. Initiate studies, modeling and simulation, and develop preliminary designs for energy harvesting and energy dense, long endurance battery, and fuel cell components and subsystems. Develop and test rechargeable/refuelable, lightweight, energy dense, high power hybrid battery, fuel cell and power management components and subsystems. | | | |
| (U) In FY 2009: Fabricate, integrate, and test high efficiency, high power, wide temperature range power electrical components. Initiate integration and test air vehicle electromagnetic and radio frequency effects immune components. Integrate and test thermal management components and subsystems. | | | |
| (U) MAJOR THRUST: Develop electrical power and thermal management, energy conversion/storage and power conditioning components, and subsystem technologies for aerospace applications. Note: In FY 2007, this activity | 4.120 | 0.000 | 0.000 |

UNCLASSIFIED

Exhibit R-2a, RDT&E Project Justification		DATE February 2008		
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602203F Aerospace Propulsion	PROJECT NUMBER AND TITLE 3145 Aerospace Power Technology		
<u>B. Accomplishments/Planned Program (\$ in Millions)</u>		<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U)	will be completed.			
(U)	In FY 2007: Completed scale-up, modeling efforts and flight tests of ten kW spray cooling technology.			
(U)	In FY 2008: Not Applicable.			
(U)	In FY 2009: Not Applicable.			
(U)				
(U)	MAJOR THRUST: Develop lightweight electrical power and thermal management component and subsystem technologies with low volume displacement to enable delivery of high power for operation of directed energy weapons. Note: In FY 2009, this thrust is reduced due to higher AF priorities.	14.127	14.070	1.171
(U)	In FY 2007: Designed high rate lithium-ion (liquid) battery system for directed energy applications. Completed fabrication and begin testing proof-of-concept superconducting generator.			
(U)	In FY 2008: Develop and initiate design of a flight-weight superconducting generator, high rate charge/discharge energy storage and high voltage/current components and subsystems. Develop concept designs for superconducting multimegawatt generator.			
(U)	In FY 2009: Investigate high-rate thermal energy storage for directed energy applications.			
(U)				
(U)	MAJOR THRUST: Develop hybrid electrical power and thermal management, including energy conversion/storage, components and subsystem technologies for special purpose applications enabling long endurance missions. Note: In FY 2009, efforts in this thrust are broken out from previous thrust to better address future increased emphasis on component development in support of electric hybrid special programs.	0.000	0.000	4.392
(U)	In FY 2007: Not Applicable.			
(U)	In FY 2008: Not Applicable.			
(U)	In FY 2009: Integrate and test thermal management components and subsystems. Integrate and initiate subsystems test of flight-weight, efficient, energy harvesting, hybrid battery and fuel cell components.			
(U)				
(U)	CONGRESSIONAL ADD: High Flux ESC System with TES for Military High Energy Laser.	1.079	0.000	0.000
(U)	In FY 2007: Developed evaporative spray cooling techniques for cooling high heat flux tactical lasers.			
(U)	In FY 2008: Not Applicable.			
(U)	In FY 2009: Not Applicable.			
(U)				
(U)	CONGRESSIONAL ADD: Affordable Lightweight Power Supply Development.	0.981	0.000	0.000
(U)	In FY 2007: Developed alternative high performance electrolytes and low-cost membrane electrode assemblies (MEA's), which are capable of operating at high temperatures, zero or reduced humidities and which enable			

UNCLASSIFIED

Exhibit R-2a, RDT&E Project Justification		DATE February 2008		
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602203F Aerospace Propulsion	PROJECT NUMBER AND TITLE 3145 Aerospace Power Technology		
B. Accomplishments/Planned Program (\$ in Millions)		<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
decreased system complexity and improved utilization of high energy fuels.				
(U)	In FY 2008: Not Applicable.			
(U)	In FY 2009: Not Applicable.			
(U)				
(U)	CONGRESSIONAL ADD: MEPS (Multimegawatt Electric Power System) Thermal Management.	1.275	0.000	0.000
(U)	In FY 2007: Developed a multimegawatt electric power system.			
(U)	In FY 2008: Not Applicable.			
(U)	In FY 2009: Not Applicable.			
(U)				
(U)	CONGRESSIONAL ADD: Chemical Hydride Power System (formerly Portable Power Solution Employing Chemical Hydrides).	2.453	0.000	0.000
(U)	In FY 2007: Further developed the technologies necessary to improve the reliability and compactness of chemical hydride replacement cartridges for Airmen portable power systems.			
(U)	In FY 2008: Not Applicable.			
(U)	In FY 2009: Not Applicable.			
(U)				
(U)	CONGRESSIONAL ADD: Advanced Energy Technology for Munitions - Dominator Program.	1.275	0.000	0.000
(U)	In FY 2007: Developed a compact, flight weight solid oxide fuel cell based power system for the Area Dominator munition.			
(U)	In FY 2008: Not Applicable.			
(U)	In FY 2009: Not Applicable.			
(U)				
(U)	CONGRESSIONAL ADD: Military Purpose Electrolyte Supported Fuel Cells.	0.981	0.000	0.000
(U)	In FY 2007: Developed high power dense advanced solid oxide fuel cell stack technology for UAV applications. Specific objectives included stack scale-up, internal reformation development, and system modeling.			
(U)	In FY 2008: Not Applicable.			
(U)	In FY 2009: Not Applicable.			
(U)				
(U)	CONGRESSIONAL ADD: Manufacturing of High Energy Superior Lithium Battery Technology.	5.103	5.962	0.000
(U)	In FY 2007: Developed the Superior Lithium Polymer Battery (SLPB) technology for a 5, 28 and 270 VDC advanced military aircraft battery with a goal cycle life equal to 5000 cycles at 80 percent Depth of Discharge.			
(U)	In FY 2008: Develop and design equipment and processes for domestic production of SLPB batteries and develop			

UNCLASSIFIED

Exhibit R-2a, RDT&E Project Justification		DATE February 2008		
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602203F Aerospace Propulsion	PROJECT NUMBER AND TITLE 3145 Aerospace Power Technology		
		<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u>				
appropriate anode, cathode and electrolyte materials for prototype production of cells and batteries.				
(U) In FY 2009: Not Applicable.				
(U)				
(U) CONGRESSIONAL ADD: Integrated Electrical Starter/Generator.		0.981	1.988	0.000
(U) In FY 2007: Developed technologies necessary to raise the technology readiness level of integral starter/generators.				
Efforts included a detailed design of a production-configuration Inverter-Converter Controllers (ICCs).				
(U) In FY 2008: Continue detailed design and development to increase the technology readiness level (TRL) of				
lightweight, compact, high temperature starter generator and Inverter-Converter Controllers (ICCs).				
(U) In FY 2009: Not Applicable.				
(U)				
(U) CONGRESSIONAL ADD: Advanced Fuel Cell Based Power System for Small UAVs		0.000	0.795	0.000
(U) In FY 2007: Not Applicable.				
(U) In FY 2008: Develop power systems for small/micro UAV systems. Examine mirco UAV systems requirements to				
determine the size, weight and power requirements needed to power these small aircraft. Perform feasibility studies				
and initial design of fuel cell systems to meet specifications resulting from the requirements study				
(U) In FY 2009: Not Applicable.				
(U)				
(U) CONGRESSIONAL ADD: Modified F-22 Maintneance-Free Nickel Cadmium Aircraft Batteries for the F-16		0.000	1.391	0.000
(U) In FY 2007: Not Applicable.				
(U) In FY 2008: Develop modifications of the cell designs, materials and electronics in the F-22 sealed Nickel-Cadmium				
battery for application in the F-16 aircraft.				
(U) In FY 2009: Not Applicable.				
(U)				
(U) CONGRESSIONAL ADD: THEMA- Thermal and Energy Management for Aerospace		0.000	3.477	0.000
(U) In FY 2007: Not Applicable.				
(U) In FY 2008: Conduct research to advance the state of the art of thermal and energy management technologies for				
aerospace applications.				
(U) In FY 2009: Not Applicable.				
(U) Total Cost		43.560	44.201	29.280

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

02 Applied Research

PE NUMBER AND TITLE

0602203F Aerospace Propulsion

PROJECT NUMBER AND TITLE

3145 Aerospace Power Technology

(U) **C. Other Program Funding Summary (\$ in Millions)**

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to</u>	<u>Total Cost</u>
	<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Complete</u>	

- (U) Related Activities:
- (U) PE 0601102F, Defense Research Sciences.
- (U) PE 0602102F, Aerospace Flight Dynamics.
- (U) PE 0602605F, Directed Energy Technology.
- (U) PE 0602805F, Dual Use Science and Technology.
- (U) PE 0603605F, Advanced Weapon Technology.
- (U) PE 0603216F, Aerospace Propulsion and Power Technology.
- (U) This project has been coordinated through the Reliance 21 process to harmonize efforts and eliminate duplication.
- (U) **D. Acquisition Strategy**
Not Applicable.

Exhibit R-2a, RDT&E Project Justification

DATE
February 2008

BUDGET ACTIVITY 02 Applied Research				PE NUMBER AND TITLE 0602203F Aerospace Propulsion			PROJECT NUMBER AND TITLE 33SP Space Rocket Component Tech		
Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
33SP Space Rocket Component Tech	56.623	53.477	48.258	49.014	49.188	48.468	49.486	0.000	0.000
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

Note: In FY 2007, efforts were transferred from PE 0602500F, Multi-Disciplinary Space Technology, Project 5026, Rocket Propulsion Component Tech, and Project 5027, High Speed Airbreathing Propulsion Technologies, to this Project in order to more effectively manage and provide oversight of the efforts. In FY 2007, Project 3012, Advanced Propulsion Technology, absorbed the efforts of a thrust from Project 33SP, Space Rocket Component Technology, in order to more effectively manage cooperative Combined Cycle Engine (CCE) developments.

(U) A. Mission Description and Budget Item Justification

This project develops advances in rocket propulsion technologies for space access, space maneuver, tactical and ballistic missiles. Analytical and experimental areas of emphasis are propellants, propellant management, combustion, rocket material applications, Technology for Sustainment of Strategic Systems (TSSS), and novel space propulsion concepts. Technologies of interest will improve reliability, performance, survivability, affordability, and environmental compatibility of future space and missile launch subsystems. Technologies are developed to reduce the weight and cost of components using new materials and improved designs and manufacturing techniques. All efforts in this project contribute to the Integrated High Payoff Rocket Propulsion Technology (IHRPT) program, a joint Department of Defense, NASA, and industry effort to focus rocket propulsion technology on national needs. Technologies developed under this program enable capabilities of interest to both the Department of Defense and the NASA. Efforts include modeling and simulation, proof of concept tests of critical components, advanced component development, and ground-based tests.

(U) B. Accomplishments/Planned Program (\$ in Millions)

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) MAJOR THRUST: Develop, characterize, and test advanced hydrocarbons, energetics, solid propellant ingredients, and reduced-toxicity monopropellants to increase space launch payload capability and refine new propellants synthesis methods. Efforts include evaluation and development of reduced-toxicity ionic salt, high-energy-density oxidizers, nano-materials, catalyst, and polymeric binders; development of supporting computational tools; determining optimized paths for incorporating these materials into propellants; and for selected propellants perform laboratory and demonstrator engine evaluations. Efforts seek monopropellants with performance equivalent to bipropellants that reduce the cost of space access and space operations. Phases are referring to the IHRPT program phases.	3.346	4.186	4.826
(U) In FY 2007: Downselected and scaled-up promising high energy-density materials candidates. Evaluated scaled-up propellants in advanced combustion devices to determine materials compatibility and performance to include supporting large-scale motor tests. Completed scale-up of candidate ionic liquids. Explored and developed ionic liquids. Advanced concepts work moved to another thrust.			
(U) In FY 2008: Initiate evaluation and development of potential hydrocarbon fuel additives to improve performance of kerosene. Continue downselect process and continue scaling-up promising high energy-density materials candidates. Develop new high energy-density, high nitrogen ingredients. Develop proof of concept for new computational code			

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

02 Applied Research

PE NUMBER AND TITLE

0602203F Aerospace Propulsion

PROJECT NUMBER AND TITLE

33SP Space Rocket Component Tech

(U) **B. Accomplishments/Planned Program (\$ in Millions)**FY 2007FY 2008FY 2009

to predict molecular properties of propellant ingredients. Evaluate scaled-up propellants in advanced combustion devices to determine materials compatibility and performance to include supporting large-scale motor tests. Continue exploration and development of ionic liquids.

- (U) In FY 2009: Continue evaluation and development of potential hydrocarbon fuel additives to improve performance of kerosene. Continue downselect process and continue scaling-up promising high energy-density materials candidates. Continue development and characterization of high nitrogen ingredients. Evaluate scaled-up propellants in advanced combustion devices to determine materials compatibility and performance to include supporting large-scale motor tests. Continue exploration and development of ionic liquids meeting Phase III goals. Initiate scale up of promising ionic liquids for further characterization. Continue proof of concept for new computational code to predict molecular properties.

(U)

- (U) MAJOR THRUST: Develop advanced liquid engine combustion technology for improved performance, while preserving chamber lifetime and reliability needs for engine uses in heavy lift space vehicles. Efforts include modeling and analyzing advanced propulsion concepts with enhanced performance and reliability such as aerovehicles and potential launch systems.

7.647

7.909

7.239

- (U) In FY 2007: Characterized, studied, and evaluated shear coaxial injector performance to ensure chamber/injector compatibility and prevent damage to upper stage engines. Developed, analyzed, and transitioned advanced combustion device technology, including injectors and chambers suitable for advanced synthetic hydrocarbon fuels capable of meeting or exceeding goals. Developed improved understanding of fundamental combustion and fluid flow/heat transfer processes leading to new methodologies for thermal management, scaling, and combustion instabilities in hydrocarbon fueled liquid rocket engines, reducing the need for conducting large numbers of costly full-scale component and engine tests. Developed, scaled-up, and transitioned new energetic advanced hydrocarbon fuels and additives for rocket propulsion, including space storable high energy, non-toxic fuels. Continued validation and verification of advanced multi-phase modeling and simulation (M&S) capabilities. Conducted proof-of-concept measurements of promising advanced propulsion concepts. developed more complex and realistic computational models of these concepts, and continued system trade studies to evaluate potential return on investment.

- (U) In FY 2008: Characterize, study, and evaluate shear coaxial injector performance to ensure chamber/injector compatibility and prevent damage to upper stage engines. Develop, analyze, and transition advanced combustion device technology, including injectors and chambers suitable for advanced synthetic hydrocarbon fuels capable of meeting or exceeding the Phase III goals. Develop improved understanding of fundamental combustion and fluid flow/heat transfer processes leading to new methodologies for thermal management, scaling, and combustion

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

02 Applied Research

PE NUMBER AND TITLE

0602203F Aerospace Propulsion

PROJECT NUMBER AND TITLE

33SP Space Rocket Component Tech

(U) **B. Accomplishments/Planned Program (\$ in Millions)**FY 2007FY 2008FY 2009

instabilities in hydrocarbon fueled liquid rocket engines, reducing the need for conducting large numbers of costly full-scale component and engine tests. Complete scale-up and transition new energetic advanced hydrocarbon fuels and additives for rocket propulsion, including space storable high energy, non-toxic fuels. Conduct validation and verification of advanced multi-phase M&S capabilities. Perform pre-selection of most promising advanced propulsion concepts; apply realistic computational models to optimize performance. Continue and refine experimental demonstrations of proof-of-concepts, continue development of realistic computational models. Continue system trade studies with improved performance models to evaluate potential return on investment.

- (U) In FY 2009: Characterize, study, and evaluate shear injector performance to ensure chamber/injector compatibility and prevent damage to engines. Develop, analyze, and transition advanced combustion device technology, including injectors and chambers. Develop improved understanding of fundamental combustion and fluid flow/heat transfer processes leading to new methodologies for thermal management, scaling, and combustion instabilities in hydrocarbon fueled liquid rocket engines, reducing the need for conducting large numbers of costly full-scale component and engine tests. Evaluate novel nozzle cooling channels for use with hydrocarbon fuels in the high heat flux test rig. Conduct validation and verification of advanced M&S capabilities. Perform pre-selection of most promising advanced propulsion concepts; apply realistic computational models to optimize performance. Continue and refine experimental demonstrations of proof-of-concepts, continue development of realistic computational models. Continue system trade studies with improved performance models to evaluate potential return on investment.

(U)

- (U) MAJOR THRUST: Develop advanced material applications for lightweight components and material property enhancements for use in advanced combustion devices and propulsion systems for current and future rocket propulsion systems.

5.257

6.048

6.756

- (U) In FY 2007: Developed new advanced ablative components using hybrid polymers. Characterized and finalized processing parameters of new nano-reinforced high temperature polymers and scale-up processing of carbon-carbon materials. Developed new advanced materials for use with high-energy propellants. Explored using nanocomposites for liquid rocket engine components and optimize processing technology using multifunctional nanomaterials.

- (U) In FY 2008: Continue developing new advanced ablative components using hybrid polymers. Continue to characterize and finalize processing parameters of new nano-reinforced high temperature polymers and scale-up processing of carbon-carbon materials. Continue developing new advanced materials for use with high-energy propellants. Continue to explore using nanocomposites for liquid rocket engine components and optimize processing technology using multifunctional nanomaterials. Evaluate new class of hydrophobic and oleophobic materials.

Exhibit R-2a, RDT&E Project Justification		DATE February 2008		
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602203F Aerospace Propulsion	PROJECT NUMBER AND TITLE 33SP Space Rocket Component Tech		
(U) B. Accomplishments/Planned Program (\$ in Millions)		<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) In FY 2009: Continue developing new advanced ablative components using hybrid polymers. Continue to characterize and finalize processing parameters of new nano-reinforced high temperature polymers and scale-up processing of carbon-carbon materials. Continue developing new advanced materials for use with high-energy propellants. Continue to explore using nanocomposites for liquid rocket engine components and optimize processing technology using multifunctional nanomaterials. Continue to characterize and understand the mechanisms behind a new class of hydrophobic and oleophobic materials.				
(U) MAJOR THRUST: Develop advanced liquid engine technologies for improved performance, while increasing life and reliability needs for engine uses in expendable and reusable launch vehicles.		24.374	22.331	23.646
(U) In FY 2007: Conducted advance modeling and simulation tool development for advanced cryogenic liquid rocket upper stage technologies. Developed advanced cryogenic upper stage technologies-turbopumps and thrust chambers. Evaluated third set of potential hydrocarbon fuels and adjust/modify/develop fuel characterization test rig. Completed development of second concept for lightweight nozzles for liquid rocket engines. Started hydrocarbon boost technology development for future spacelift concepts including materials scale-up efforts to improve life and weight of the liquid engine components.				
(U) In FY 2008: Complete advance modeling and simulation tool development for advanced cryogenic liquid rocket upper stage technologies. Continue enabling hydrocarbon boost technology development for future spacelift concepts. Initiate engine health monitoring effort supporting the hydrocarbon boost technology development effort. Also initiate efforts developing hydrocarbon engine technologies using fuels other than kerosene.				
(U) In FY 2009: Continue enabling hydrocarbon boost technology development for future spacelift concepts. Develop engine health monitoring technologies supporting the hydrocarbon boost technology development effort. Develop advanced hydrocarbon engine technologies using fuels other than kerosene.				
(U) MAJOR THRUST: Develop solar electric, solar thermal, chemical, and advanced propulsion technologies for stationkeeping, repositioning, and orbit transfer for large communication satellites, microsatellites, and satellite constellations. Phases are referring to the IHPRPT program phases.		6.691	6.048	5.791
(U) In FY 2007: Conducted Hall thruster development efforts. Evaluated plasma thrusters for microsatellites propulsion systems. Initiated scale-up testing monopropellants. Initiated assessment of advanced chemical propulsion technology developments for satellite thrusters. Initiated development of advanced multi-mode chemical-electric propulsion concepts for satellites.				
(U) In FY 2008: Continue Hall thruster development efforts. Continue evaluating plasma thrusters for microsatellites propulsion systems. Continue scale-up testing additional monopropellants. Continue assessment of advanced				

UNCLASSIFIED

Exhibit R-2a, RDT&E Project Justification		DATE February 2008		
BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE		
02 Applied Research	0602203F Aerospace Propulsion	33SP Space Rocket Component Tech		
(U) B. Accomplishments/Planned Program (\$ in Millions)		<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
chemical propulsion technology developments for satellite thrusters. Continue development of advanced multi-mode chemical-electric propulsion concepts for satellites. Initiate development of alternative propulsion concepts and associated modeling, simulation, and analysis tools to augment or replace Hall Thrusters in the future.				
(U) In FY 2009: Continue Hall thruster development efforts. Continue evaluating plasma thrusters for microsatellites propulsion systems. Continue scale-up testing additional monopropellants, evaluate advanced ignition schemes and chamber concepts. Continue assessment of advanced chemical propulsion technology developments for satellite thrusters, begin component developments. Continue development of advanced multi-mode chemical-electric propulsion concepts for satellites, down-select to single design concept, and begin component developments.				
(U) MAJOR THRUST: Conduct assessments, design trades, and simulations to integrate combined cycle engines (CCEs) and advanced cycle airbreathing hypersonic propulsion technologies in support of the development of affordable, on-demand access to space vehicles to meet future warfighter needs. Note: In FY 2008, this effort transferred within this PE to Project 623012, Advanced Propulsion Technologies, to consolidate and better manage this cooperative CCE effort.		0.478	0.000	0.000
(U) In FY 2007: Conducted assessments, system design trades, and simulations to integrate combined cycle engines (CCEs) and advanced cycle airbreathing hypersonic propulsion technologies in support of the development of affordable, on-demand access to space vehicles to meet future warfighter needs.				
(U) In FY 2008: Not Applicable.				
(U) In FY 2009: Not Applicable.				
(U) CONGRESSIONAL ADD: Advanced Liquid Rocket Booster Technology.				
(U) In FY 2007: Developed hydrocarbon boost rocket engine technologies for the Air Force.		1.374	0.000	0.000
(U) In FY 2008: Not Applicable.				
(U) In FY 2009: Not Applicable.				
(U) CONGRESSIONAL ADD: Engineering Tool Improvement Program (ETIP). Note: In FY 2007, this add was titled Engineering Tool Improvement Program (ETIP) and transferred from PE 0602500F, Multi-Disciplinary Space Technology, Project 5026, Rocket Propulsion Component Technology to better manage development efforts.				
(U) In FY 2007: Developed advanced rocket engine modeling, simulation, and analysis tools for propulsion and integrated them into seamless suite of tools for scientists and engineers to use in developing advanced propulsion technologies.		2.747	0.000	0.000
(U) In FY 2008: Not Applicable.				

UNCLASSIFIED

Exhibit R-2a, RDT&E Project Justification		DATE February 2008		
BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE		
02 Applied Research	0602203F Aerospace Propulsion	33SP Space Rocket Component Tech		
(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u>		<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) In FY 2009: Not Applicable.				
(U) CONGRESSIONAL ADD: Methane Second Stage Rocket Engine.		1.570	0.995	0.000
(U) In FY 2007: Developed liquid oxygen, liquid methane pressure fed second stage rocket engine technologies for the Air Force.				
(U) In FY 2008: Scale-up liquid oxygen, liquid methane pressure fed second stage rocket engine technologies for the Air Force.				
(U) In FY 2009: Not Applicable.				
(U) CONGRESSIONAL ADD: Advanced Vehicle and Propulsion Center.		3.139	1.589	0.000
(U) In FY 2007: Performed technical support and analysis for the Prompt Global Strike Analysis of Alternatives (AoA). Conducted facility upgrades to support upcoming testing which support planning efforts for Land-based Strategic Deterrent and Operationally Responsive Spacelift activities.				
(U) In FY 2008: Refine analytical tools to help assess feasibility and cost benefit of using common boosters/engines across multiple launch platforms. Continue model developments that will support Prompt Global Strike and future ballistic missile development efforts.				
(U) In FY 2009: Not Applicable.				
(U) CONGRESSIONAL ADD: Hydrocarbon Boost Technology Demonstrator.		0.000	1.193	0.000
(U) In FY 2007: Not Applicable.				
(U) In FY 2008: Funds will be used to accelerate development of technologies for highly operable and reusable spacelift.				
(U) In FY 2009: Not Applicable.				
(U) CONGRESSIONAL ADD: Integrated Propulsion Analysis Tool (IPAT).		0.000	1.589	0.000
(U) In FY 2007: Not Applicable.				
(U) In FY 2008: Increase fidelity of rocket engine analysis and assessment tools and broaden application to advanced concepts being considered by the Air Force.				
(U) In FY 2009: Not Applicable.				
(U) CONGRESSIONAL ADD: Development and Testing of Advanced Paraffin-Based Hybrid Rockets for Space Applications.		0.000	1.589	0.000
(U) In FY 2007: Not Applicable.				

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

02 Applied Research

PE NUMBER AND TITLE

0602203F Aerospace Propulsion

PROJECT NUMBER AND TITLE

33SP Space Rocket Component Tech

(U) **B. Accomplishments/Planned Program (\$ in Millions)**

FY 2007

FY 2008

FY 2009

(U) In FY 2008: Scale-up of hybrid rocket technologies and characterize for potential application to space applications.

(U) In FY 2009: Not Applicable.

(U) Total Cost

56.623

53.477

48.258

(U) **C. Other Program Funding Summary (\$ in Millions)**

FY 2007

FY 2008

FY 2009

FY 2010

FY 2011

FY 2012

FY 2013

Cost to

Total Cost

Actual

Estimate

Estimate

Estimate

Estimate

Estimate

Estimate

Complete

(U) Not Applicable.

(U) **D. Acquisition Strategy**

Not Applicable

Exhibit R-2a, RDT&E Project Justification

DATE
February 2008

BUDGET ACTIVITY 02 Applied Research				PE NUMBER AND TITLE 0602203F Aerospace Propulsion			PROJECT NUMBER AND TITLE 4847 Rocket Propulsion Technology		
Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
4847 Rocket Propulsion Technology	18.516	10.651	9.188	10.702	7.511	11.762	12.073	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

- (U) **A. Mission Description and Budget Item Justification**
 This project develops technologies for the sustainment of strategic systems (including solid boost/missile propulsion, post boost control, aging and surveillance efforts). Technologies of interest will improve reliability, performance, survivability, affordability, and environmental compatibility of these systems. Technologies are being accomplished in two phases and are developed to reduce the weight by 15 percent (Phase I)/20 percent (Phase II) and cost of components 25 percent (Phase I)/35 percent (Phase II) through the use of new materials and improving designs and manufacturing techniques. Aging and surveillance efforts could reduce lifetime prediction uncertainties for individual motors by 50 percent, enabling motor replacement for cause. All efforts in this project are part of the Technology for the Sustainment of Strategic Systems program and support the Integrated High Payoff Rocket Propulsion Technology program.
- | | | | |
|--|----------------|----------------|----------------|
| (U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u> | <u>FY 2007</u> | <u>FY 2008</u> | <u>FY 2009</u> |
| (U) MAJOR THRUST: Develop missile propulsion and boost technologies for tactical and ballistic missile systems. Efforts support the Technology for the Sustainment of Strategic Systems program. Note: Decreased funding in FY 2008 and out due to post boost control system component technology maturation and effort completions. | 11.611 | 8.201 | 4.962 |
- (U) In FY 2007: Initiated component development and risk reduction efforts for the Missile Propulsion demonstration. Verified development of rapid densification nozzle technology using improved strategic propellants for future ballistic missiles to enhance performance and weight. Demonstrated low-cost, high temperature, non-erosive, lightweight coated carbon-carbon, ceramic and hybrid polymer components for solid rocket motors. Developed advanced tactical propulsion technologies. Formulated and characterized new propellant formulations using new fuels and oxidizers developed over the last couple of years for the next phase of advanced solid propulsion. Conducted sub-scale tests to characterize and validate physics in rocket motor environments and incorporate into modeling and simulation tool developments for solid rocket motors to be used in developing components for the Missile Propulsion Demonstration.
- (U) In FY 2008: Continue component development and risk reduction efforts for the Missile Propulsion demonstration. Conduct sub-scale testing of rapid densification nozzle technology using improved strategic propellants for future ballistic missiles to enhance performance and weight. Continue demonstrating low-cost, high temperature, non-erosive, lightweight coated carbon-carbon, ceramic and hybrid polymer components for solid rocket motors. Complete modeling, simulation, and analysis tool development efforts. Continue development of advanced tactical propulsion technologies.
- (U) In FY 2009: Continue component development and risk reduction efforts for the Missile Propulsion demonstration. Use physics based modeling, simulation, and analysis tools to design and analyze sub-scale components to help verify suitability of those technologies for use in Missile Propulsion demonstration. Complete verification

UNCLASSIFIED

Exhibit R-2a, RDT&E Project Justification		DATE February 2008		
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602203F Aerospace Propulsion	PROJECT NUMBER AND TITLE 4847 Rocket Propulsion Technology		
(U) B. Accomplishments/Planned Program (\$ in Millions)		<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
development of rapid densification nozzle technology using improved strategic propellants for future ballistic missiles to enhance performance and weight. Continue demonstrating low-cost, high temperature, non-erosive, lightweight coated carbon-carbon, ceramic and hybrid polymer components for solid rocket motors. Continue development of advanced tactical propulsion technologies.				
(U) MAJOR THRUST: Develop missile propulsion technologies and aging and surveillance technologies for ballistic missiles. Efforts support the Technology for the Sustainment of Strategic Systems program.		3.275	2.450	4.226
(U) In FY 2007: Conducted advanced service life prediction technology program developing and applying existing and advanced sensors that can be embedded or attached to solid rocket motors and the aging and surveillance models and tools that can translate and integrate the sensor data into existing aging and surveillance tool suite.				
(U) In FY 2008: Continue advanced service life prediction technology program developing and applying existing and advanced sensors that can be embedded or attached to solid rocket motors and the aging and surveillance models and tools that can translate and integrate the sensor data into existing aging and surveillance tool suite.				
(U) In FY 2009: Complete advanced service life prediction technology program developing and applying existing and advanced sensors that can be embedded or attached to solid rocket motors and the aging and surveillance models and tools that can translate and integrate the sensor data into existing aging and surveillance tool suite. Begin efforts to integrate advanced aging and surveillance technologies into demonstrations to validate and verify efforts to reduce uncertainties and accurately model motor behavior.				
(U) CONGRESSIONAL ADD: Aerospace Lab Equipment Upgrade.		0.981	0.000	0.000
(U) In FY 2007: Upgraded/augmented existing university facilities/capabilities to train future aerospace engineers.				
(U) In FY 2008: Not Applicable.				
(U) In FY 2009: Not Applicable.				
(U) CONGRESSIONAL ADD: Advanced Vortex Hybrid Propulsion System.		1.668	0.000	0.000
(U) In FY 2007: Developed small launch vehicle size engines that utilize vortex combustion processes to generate improved performance and/or operability. Tasks included developments in propellant storage tanks as well as the engine designs. Engine concepts examined included LOx/Propane vortex cold-wall chamber as well as vortex hybrid designs.				
(U) In FY 2008: Not Applicable.				
(U) In FY 2009: Not Applicable.				
(U)				

UNCLASSIFIED

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602203F Aerospace Propulsion	PROJECT NUMBER AND TITLE 4847 Rocket Propulsion Technology
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(U) B. Accomplishments/Planned Program (\$ in Millions)	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) CONGRESSIONAL ADD: Solid Boost Propulsion Technology for the Sustainment of Strategic Systems.	0.981	0.000	0.000
(U) In FY 2007: Developed technologies that aid in the sustainment of strategic solid rocket motors.			
(U) In FY 2008: Not Applicable.			
(U) In FY 2009: Not Applicable.			
(U) Total Cost	18.516	10.651	9.188

(U) C. Other Program Funding Summary (\$ in Millions)	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to</u>	<u>Total Cost</u>
	<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Complete</u>	
(U) Related Activities:									
(U) PE 0601102F, Defense Research Sciences.									
(U) PE 0602114N, Power Projection Applied Research.									
(U) PE 0602303A, Missile Technology.									
(U) PE 0602500F, Multi-Disciplinary Space Tech.									
(U) PE 0603311F, Ballistic Missile Technology.									
(U) PE 0603401F, Advanced Spacecraft Technology.									
(U) This project has been coordinated through the Reliance 21 process to harmonize efforts and eliminate duplication.									
(U) D. Acquisition Strategy									
Not Applicable.									

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PE NUMBER: 0602204F
 PE TITLE: Aerospace Sensors

Exhibit R-2, RDT&E Budget Item Justification	DATE February 2008
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BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602204F Aerospace Sensors
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Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
Total Program Element (PE) Cost	130.517	121.242	109.048	104.557	112.890	112.671	115.159	Continuing	TBD
2002 Electronic Component Technology	25.409	24.922	26.489	25.731	29.486	38.475	39.034	Continuing	TBD
2003 EO Sensors & Countermeasures Tech	21.668	26.503	16.539	14.959	15.893	22.300	22.850	Continuing	TBD
44SP Space Sensors	8.644	10.176	8.914	9.537	10.177	9.723	9.967	Continuing	TBD
4916 Electromagnetic Tech	21.064	14.217	15.929	14.639	13.889	0.000	0.000	Continuing	TBD
6095 Sensor Fusion Technology	20.262	19.801	18.348	16.144	17.448	17.609	18.008	Continuing	TBD
7622 RF Sensors & Countermeasures Tech	33.470	25.623	22.829	23.547	25.997	24.564	25.300	Continuing	TBD

Note: In FY 2007, efforts were transferred from PE 0602500F, Multidisciplinary Space Technology, Project 5028, Space Sensors, Photonics and RF Processors, and Project 5029, Space Sensor and CM Technology, to Project 44SP, Space Sensors, in order to more effectively manage and provide oversight of the efforts. In FY 2012, efforts in Project 4916, Electromagnetic Technology, will transfer to Project 2002, Electronic Component Technology, and Project 2003, EO Sensors & Countermeasures Technology, as a result of Base Realignment And Closure law.

(U) A. Mission Description and Budget Item Justification

This program develops the technology base for Air Force aerospace sensors and electronic combat. Advances in aerospace sensors are required to increase combat effectiveness by providing "anytime, anywhere" surveillance, reconnaissance, precision targeting, and electronic warfare capabilities. To achieve this progress, this program pursues simultaneous advances in: 1) generating, controlling, receiving, and processing electronic and photonic signals for radio frequency (RF) sensor aerospace applications; 2) electro-optical (EO) aerospace sensor technologies for a variety of offensive and defensive uses; 3) radio frequency antennas and associated electronics for airborne and space surveillance, together with active and passive electro-optical sensors; 4) technologies to manage and fuse on-board sensor information for timely, comprehensive situational awareness; and 5) technology for reliable, all-weather surveillance, reconnaissance, and precision strike radio frequency sensors and electronic combat systems. Note: In FY 2008, Congress added \$5.0 million for the Super-Resolution Sensor System; \$3.2 million for the Optically Pumped Atomic Laser; \$2.4 million for the Low Voltage, Wideband Electro-Optic Polymer Modulator; \$1.0 million for the Center for Advanced Sensor and Communication Antennas; \$0.8 million for Optikey Optical Maximum Entropy Verification; and \$1.6 million for Sensor Fusion. This program is in Budget Activity 2, Applied Research, since it develops and determines the technical feasibility and military utility of evolutionary and revolutionary sensor, electronics, and electronic combat technologies.

Exhibit R-2, RDT&E Budget Item Justification

DATE

February 2008

BUDGET ACTIVITY

02 Applied Research

PE NUMBER AND TITLE

0602204F Aerospace Sensors

(U) **B. Program Change Summary (\$ in Millions)**

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) Previous President's Budget	133.235	108.055	103.739
(U) Current PBR/President's Budget	130.517	121.242	109.048
(U) Total Adjustments	-2.718	13.187	
(U) Congressional Program Reductions		-0.043	
Congressional Rescissions		-0.770	
Congressional Increases		14.000	
Reprogrammings	-1.220		
SBIR/STTR Transfer	-1.498		
(U) <u>Significant Program Changes:</u>			
Not Applicable.			

C. Performance Metrics
Under Development.

Exhibit R-2a, RDT&E Project Justification

DATE
February 2008

BUDGET ACTIVITY 02 Applied Research				PE NUMBER AND TITLE 0602204F Aerospace Sensors			PROJECT NUMBER AND TITLE 2002 Electronic Component Technology		
Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
2002 Electronic Component Technology	25.409	24.922	26.489	25.731	29.486	38.475	39.034	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

Note: In FY 2012, efforts in this project transferred from Project 4916, Electromagnetic Technology, as a result of Base Realignment And Closure law.

(U) A. Mission Description and Budget Item Justification

This project focuses on generating, controlling, receiving, and processing electronic signals for radio-frequency sensor aerospace applications. The enabling technologies developed under this project will be used for intelligence, surveillance, reconnaissance, electronic warfare, battlespace access, and precision engagement capabilities. The technologies developed include: exploratory device concepts, solid state power devices and amplifiers; low noise and signal control components; photonic components; high-temperature electronics; signal control and distribution; signal processing; multi-function monolithic integrated circuits; high-speed analog-to-digital and digital-to-analog mixed mode integrated circuits; reconfigurable electronics; power distribution; multi-chip modules; and high density packaging and interconnect technologies. This project also designs, develops, fabricates, and evaluates techniques for integrating combinations of these electronic component technologies. The project aims to demonstrate significantly improved military sensors of smaller size, lower weight, lower cost, lower power dissipation, higher reliability, and improved performance. The device and component technology developments under this project are military unique; they are based on Air Force and other Department of Defense weapon systems requirements in the areas of radar, communications, electronic warfare, navigation, and smart weapons.

(U) B. Accomplishments/Planned Program (\$ in Millions)

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) MAJOR THRUST: Develop compact, affordable, multi-function receiver, exciter, and phased array components for communications, Global Positioning System, radar, electronic warfare, intelligence, surveillance, and reconnaissance sensors. Develop advanced aperture subsystems that support affordable and scalable antenna arrays as well as enable efficient wideband multi-function sensors for radar, electronic warfare, and communications. Develop receiver and exciter subsystem technologies that enable compact, affordable, multi-function, multi-beam radar and electronic warfare systems. Develop metamaterials for conformal arrays. Note: In FY 2009, this increase in funding is due to greater emphasis on metamaterials.	7.585	4.811	11.434
(U) In FY 2007: Developed scalable panel demonstration with multiple panel communication and metrology. Designed and demonstrated a distributed receiver/exciter architecture for advanced multifunction systems used in radar and electronic warfare sensors for intelligence, surveillance, reconnaissance, and battlespace access capabilities.			
(U) In FY 2008: Develop integrated wideband multi-channel phased array sub-array with digital receiver and exciter architecture for future multi-intelligence electronic warfare and radar applications. Finish demonstration of distributed receiver/exciter architecture for advanced multi-function systems used in radar and electronic warfare sensors.			
(U) In FY 2009: Demonstrate integrated wideband subarray for future multi-intelligence electronic warfare and radar applications. Design and develop digital receiver components to enable full digital receiver and exciter capabilities			

Exhibit R-2a, RDT&E Project Justification		DATE February 2008		
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602204F Aerospace Sensors	PROJECT NUMBER AND TITLE 2002 Electronic Component Technology		
(U) B. Accomplishments/Planned Program (\$ in Millions)		<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
per transmit/receive site to enable future software-controlled phased arrays. Develop new hardware to exploit emerging metamaterials for compact radiating sensor applications including conformal array antennas and electronics based upon complex media. Evaluate the potential for highly-integrated electronics and apertures using low electromagnetic interference integrated devices and circuits through the use of metamaterials as three-dimensional electronic building blocks including laboratory prototyping of electrically small, compact radiating elements.				
(U) MAJOR THRUST: Develop new microelectronic component technologies for radar, electronic warfare, and communications to support intelligence, surveillance, reconnaissance, precision strike, and battlespace access capabilities using advances in material research and microelectronic fabrication techniques.		3.776	6.378	2.692
(U) In FY 2007: Demonstrated integrated photonic microsystems. Developed electronics modeling and assessment techniques. Developed high performance radio-frequency circuits on lightweight and flexible substrates using advanced semiconducting materials and devices.				
(U) In FY 2008: Fabricate and perform lab testing to investigate physical and chemical properties of microcircuits under operating conditions to understand operating lifetime-limiting changes in structure. Continue development of electronics modeling and assessment techniques. Develop flexible and visually-transparent radio-frequency electronics.				
(U) In FY 2009: Continue fabrication and lab testing to investigate physical and chemical properties of microelectronics to develop models to predict failure modes and lifetimes. Further refine electronics modeling and assessment techniques. Demonstrate flexible and visually-transparent radio-frequency electronics.				
(U) MAJOR THRUST: Develop integration and assembly technologies for high-performance aerospace phased array sensors. Design and model photonic component technologies for radio-frequency distribution and signal processing. Develop electro-optical devices for next-generation warfighter applications.		3.913	3.251	4.699
(U) In FY 2007: Designed and developed radio-frequency modulation components to enable low-loss wideband radio-frequency links and arbitrary electro-optical waveform generation. Initiated development of vertical external cavity surface emitting lasers as compact, efficient, high-brightness sources. Initiated development of fiber-optics and optical components for high-power mid-infrared applications.				
(U) In FY 2008: Demonstrate photonic radio-frequency modulation components for radio-frequency links and arbitrary electro-optical waveform generation. Continue development of vertical external cavity surface emitting lasers as compact, efficient, high-brightness sources. Continue development of fiber-optics and optical components for				

UNCLASSIFIED

Exhibit R-2a, RDT&E Project Justification		DATE February 2008		
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602204F Aerospace Sensors	PROJECT NUMBER AND TITLE 2002 Electronic Component Technology		
<u>B. Accomplishments/Planned Program (\$ in Millions)</u>		<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) high-power mid-infrared applications.				
(U) In FY 2009: Continue development of vertical external cavity surface emitting lasers as compact, efficient, high-brightness sources. Complete development of fiber-optics and optical components for high-power mid-infrared applications. Develop ultra-stable, tunable, mode-locked lasers to enable highly integrated optical waveform generation.				
(U) MAJOR THRUST: Develop signal control and low power consumption components and techniques to reduce both power loss and power consumption for future radar, electronic warfare, and intelligence, surveillance, and reconnaissance sensors. Develop and integrate adaptable circuit technologies which utilize dynamic elements and low-loss signal control for multi-function radar and electronic warfare sensors used for intelligence, surveillance, reconnaissance, and battlespace access capabilities. Develop wideband (multi-octave) component technologies for multi-function radio frequency apertures used in radar and electronic warfare sensor systems.		4.714	3.820	5.388
(U) In FY 2007: Developed and demonstrated adaptable microcircuits for multi-function applications. Characterized and transitioned reliable wideband power amplifiers for multifunction radar and electronic warfare sensor applications. Characterized high-reliability Gallium Nitride-based circuits for millimeter-wave and Q-band applications.				
(U) In FY 2008: Develop and demonstrate adaptable microcircuits for multi-function sensors. Emphasize emerging electronic approaches for energy-starved circuit applications.				
(U) In FY 2009: Develop tunable and reconfigurable wideband amplifiers for use in multi-function radar and electronic warfare sensors. Emphasize emerging electronics approaches for energy-starved circuit applications.				
(U) MAJOR THRUST: Refine materials and processes for two-dimensional and three-dimensional device interconnects and component protection from the environment. Develop and demonstrate innovative radio-frequency component technology that lowers system cost through reduction of design costs, part count, chip size, production costs, and integration costs.		1.977	3.331	1.138
(U) In FY 2007: Designed and implemented military-specific radio-frequency components using advanced circuit design techniques and the latest commercial foundry advances. Characterized and performed trade-space analysis with respect to traditional radio-frequency component technologies.				
(U) In FY 2008: Investigate microcircuit integration modeling and simulation tools to enable two-dimensional and three-dimensional electronics.				
(U) In FY 2009: Develop and demonstrate highly integrated phase control components for use in wideband				

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY
02 Applied Research

PE NUMBER AND TITLE
0602204F Aerospace Sensors

PROJECT NUMBER AND TITLE
2002 Electronic Component Technology

(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
multi-function sensors.			
(U) MAJOR THRUST: Evaluate the integrated tool suite in the modeling, simulation, design, and characterization environment for mixed-signal (digital, radio-frequency, microwave, etc.) component development in both advanced and emerging electronic component technologies.	2.049	3.331	1.138
(U) In FY 2007: Designed and modeled next-generation wideband gap devices for high power, high temperature, and broadband multi-function systems.			
(U) In FY 2008: Continue design and refinement of models for next-generation high-power components that operate under extreme conditions and enable multi-function sensors.			
(U) In FY 2009: Demonstrate closed-loop characterization of performance-driven component and device design, fabrication, and characterization with first-pass success.			
(U) CONGRESSIONAL ADD: 3-D Packaging Technology for High Speed RF Communications.	1.395	0.000	0.000
(U) In FY 2007: Conducted Congressionally-directed effort for 3-D Packaging Technology for High Speed RF Communications.			
(U) In FY 2008: Not Applicable.			
(U) In FY 2009: Not Applicable.			
(U) Total Cost	25.409	24.922	26.489

(U) <u>C. Other Program Funding Summary (\$ in Millions)</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to</u>	<u>Total Cost</u>
	<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Complete</u>	
(U) Related Activities:									
(U) PE 0602500F, Multi-Disciplinary Space Technology.									
(U) PE 0603203F, Advanced Aerospace Sensors.									
(U) PE 0603270F, Electronic Combat Technology.									
(U) This project has been coordinated through the									

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

02 Applied Research

PE NUMBER AND TITLE

0602204F Aerospace Sensors

PROJECT NUMBER AND TITLE

2002 Electronic Component
Technology(U) **C. Other Program Funding Summary (\$ in Millions)**

Reliance 21 process to
harmonize efforts and eliminate
duplication.

(U) **D. Acquisition Strategy**

Not Applicable.

Exhibit R-2a, RDT&E Project Justification

DATE
February 2008

BUDGET ACTIVITY 02 Applied Research				PE NUMBER AND TITLE 0602204F Aerospace Sensors			PROJECT NUMBER AND TITLE 2003 EO Sensors & Countermeasures Tech			
Cost (\$ in Millions)		FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
2003	EO Sensors & Countermeasures Tech	21.668	26.503	16.539	14.959	15.893	22.300	22.850	Continuing	TBD
Quantity of RDT&E Articles		0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project determines the technical feasibility of advanced electro-optical aerospace sensor technologies for a variety of offensive and defensive uses. The sensor technologies under development range from the ultraviolet through the infrared portion of the spectrum. Related efforts include improvements in avionics integration, digital processing, analysis tools, and sensor architectures. One of the project's main goals is to improve electro-optical and related technologies for the detection, tracking, and identification of non-cooperative and difficult targets, such as those obscured by camouflage. This project also develops the passive and active hyperspectral imaging sensors and algorithms needed to enable precision targeting in severe weather. These technologies are critical to future aerospace surveillance and targeting. Other project goals include advanced electro-optical threat warning and countermeasures.

(U) B. Accomplishments/Planned Program (\$ in Millions)

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) MAJOR THRUST: Develop technology for non-cooperative detection and identification of airborne and ground-based targets.	2.720	2.386	2.884
(U) In FY 2007: Performed off-board cued ground- and air-based testing and demonstration of advanced combat identification systems with multi-spectral, polarization-based target re-acquisition and active electro-optical interrogation for combat identification including three-dimensional imaging and vibration sensing. Developed hybrid focal planes and read-out electronics capable of simultaneous multi-discriminant sensing. Began demonstration of electro-optical and infrared system architectures for layered sensing based on multiple platform types for deep penetration and continuous area coverage.			
(U) In FY 2008: Perform phenomenology experiments for multi-discriminant active/passive sensing and perform sensor concept modeling. Collect signature data for target discrimination and shape extraction using passive multispectral and polarimetric sensing techniques. Characterize the performance of a long-wave hyperspectral sensor for performing identification of gaseous targets. Demonstrate hybrid focal planes and read-out electronics for simultaneous multi-discriminant active and passive sensing, and develop image processing techniques for sensor data enhancement.			
(U) In FY 2009: Perform sensor concept demonstrations for multi-discriminant active and passive sensing and quantify expected system performance. Characterize target discrimination and shape extraction performance using passive multispectral and polarimetric sensing techniques. Continue demonstration of hybrid focal planes and read-out electronics for simultaneous multi-discriminant active and passive sensing, and refine image processing techniques for sensor data enhancement. Perform trade-off studies for long range target identification using passive and active techniques, including polarimetric discrimination and synthetic aperture laser radar.			

UNCLASSIFIED

Exhibit R-2a, RDT&E Project Justification		DATE February 2008		
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602204F Aerospace Sensors	PROJECT NUMBER AND TITLE 2003 EO Sensors & Countermeasures Tech		
(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	
(U)				
(U) MAJOR THRUST: Develop optical transmitter technology capable of sensing multiple target characteristics for robust non-cooperative target identification.	7.185	6.702	5.307	
(U) In FY 2007: Continued development and testing of optical transmitter technologies including waveforms capable of sensing multiple target characteristics for robust non-cooperative target identification. Continued laboratory and field tests and utility analysis of multi-function pulsed vibration sensing and imaging system and evaluated performance for long-range combat identification. Performed flight data collections for pulsed gated imager and vibration combat identification sensor. Completed testing of breadboard active multi-spectral transmitter and evaluated performance for both hard and extended targets. Continued flight-capable, long-range, multi-function brassboard sensor development. Utilized flight test platform to support testing of long range air-to-air and air-to-ground systems under development. Continued collection of simultaneous passive and multifunction active sensing phenomenology data in airborne environment for difficult target detection analysis including diverse background characterization.				
(U) In FY 2008: Extend development and testing of optical transmitter technologies for non-cooperative target identification to increased standoff ranges. Explore optical discriminants for long range identification including shape, polarization, and vibration using real-beam and synthetic aperture sensing techniques. develop a sparse aperture testbed supporting spatial synthesis imaging. Develop advanced models to support phenomenology-driven sensor trade studies with both active and passive sensors. Perform tower and flight collections to validate system modeling results. Explore enabling sensor components to support extended range operation.				
(U) In FY 2009: Continue development and testing of optical transmitter technologies for non-cooperative target identification at long standoff ranges. Perform multi-function signature collections for long-range identification including shape, polarization, and vibration using real-beam and synthetic aperture sensing techniques. Develop optimal system concepts using advanced active and passive sensor models. Continue tower and flight collections to quantify expected performance. Develop enabling sensor components for a long-range demonstration system.				
(U)				
(U) MAJOR THRUST: Develop innovative techniques and components to target difficult objects in battlefield environments.	3.465	3.679	4.725	
(U) In FY 2007: Continued development and began demonstration of techniques and components to target difficult objects in degraded atmospheric conditions. Integrated and evaluated weather and obscurant penetration concepts into system-level tests. Demonstrated utility of non-mechanical beam steering for advanced multimode sensor applications including precision pointing, focusing, and wavefront correction. Continued development and				

Exhibit R-2a, RDT&E Project Justification		DATE February 2008
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602204F Aerospace Sensors	PROJECT NUMBER AND TITLE 2003 EO Sensors & Countermeasures Tech

(U) B. Accomplishments/Planned Program (\$ in Millions)	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
demonstrations of combined electro-optical/radio-frequency apertures including preliminary sensor configurations. Continued analysis and evaluation of specialized multifunction laser radar for detection and characterization of difficult targets. Explored implementation of advanced architectures for advanced electro-optical unmanned aerial vehicle-based systems to find, fix and identify difficult targets in difficult environments including the urban environment. Incorporated advanced passive and multifunction active sensing methods to exploit all salient target and background phenomenologies. Continued target phenomenology investigations.			
(U) In FY 2008: Extend development of techniques for targeting difficult objects in dynamic urban environments. Develop passive infrared components and techniques for continuous surveillance of broad areas with detection and tracking of dynamic targets and events. Continue development of non-mechanical beam steering for both passive and active sensors. Explore passive and active laser detection and range-sensing phenomenology techniques for capturing robust spectral, spatial, polarimetric, and radiometric signatures for moving target identification and track association in dense target areas.			
(U) In FY 2009: Continue development of techniques for targeting difficult objects in dynamic urban environments. Perform concept demonstrations of continuous passive infrared surveillance of broad areas with detection and tracking of dynamic targets and events. Develop sensor concept designs for optimizing revisit rate and perform design trade-off experiments. Develop concepts for close-in sensing from unmanned aerial vehicles or small unmanned aerial vehicles in difficult environments. Investigate small unmanned aerial vehicle applications of non-mechanical beam steering for pointing and stabilization. Perform spectral, spatial, polarimetric, and radiometric signature collection experiments using laboratory passive and active laser detection and ranging sensors for moving target identification and track association in dense target areas.			
(U) MAJOR THRUST: Develop countermeasure technologies for use against infrared- and electro-optical guided missiles threats.	1.941	2.646	2.893
(U) In FY 2007: Continued evaluation of countermeasure techniques to defeat first-generation infrared-imaging missile seekers. Initiated development of second-generation infrared imaging missile seeker models and simulations for countermeasure technique development. Continued exploitation of advanced infrared missiles and infrared acquisition sensors for countermeasure technique updates and refinement. Conducted laboratory assessments of active-sensing technology to evaluate capabilities against multi-band infrared sensors.			
(U) In FY 2008: Continue development of second-generation infrared-imaging missile seeker models and simulations for countermeasure technique development. Continue exploitation of advanced infrared missiles and infrared acquisition sensors for countermeasure technique updates and refinement. Initiate identification of discriminants for			

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Exhibit R-2a, RDT&E Project Justification		DATE February 2008		
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602204F Aerospace Sensors	PROJECT NUMBER AND TITLE 2003 EO Sensors & Countermeasures Tech		
(U) B. Accomplishments/Planned Program (\$ in Millions)		<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
specific identification of new electro-optical sensors and missile threats.				
(U) In FY 2009: Evaluate countermeasure techniques to defeat second-generation infrared-imaging missile seekers. Develop new countermeasure technique updates and refinement applicable to legacy systems. Continue identification of discriminants for specific identification of new electro-optical sensors and missile threats.				
(U) MAJOR THRUST: Develop aerospace missile and laser warning technologies to accurately cue countermeasures.		0.679	0.557	0.730
(U) In FY 2007: Continued developing laser warning sensor concepts for unmanned aerial vehicles and night vision goggles. Continued developing new laser warning sensor technologies to address ultra-short and tunable laser threats. Initiated development of an advanced laser warning concept for integration into tactical aircraft.				
(U) In FY 2008: Continue developing new laser warning sensor technologies to address ultra-short and tunable laser threats. Identify methods to increase focal plane array dynamic range for precise characterization of low- and high-power laser threats.				
(U) In FY 2009: Continue developing new laser warning sensor technologies to address ultra-short and tunable laser threats. Identify clutter suppression techniques to increase signal to noise and improve detection ranges in urban operations. Evaluate algorithms to optimize detection and declaration ranges.				
(U) CONGRESSIONAL ADD: WBI LADAR Development and Demonstration		1.992	0.000	0.000
(U) In FY 2007: Conducted Congressionally-directed effort for WBI LADAR Development and Demonstration.				
(U) In FY 2008: Not Applicable.				
(U) In FY 2009: Not Applicable.				
(U) CONGRESSIONAL ADD: Super-Resolution Sensor System.		1.694	4.968	0.000
(U) In FY 2007: Conducted Congressionally-directed effort for the Super-Resolution Sensor System.				
(U) In FY 2008: Conduct Congressionally-directed effort for the Super-Resolution Sensor System.				
(U) In FY 2009: Not Applicable.				
(U) CONGRESSSIONAL ADD: Optically Pumped Atomic Laser (OPAL).		1.992	3.180	0.000
(U) In FY 2007: Conducted Congressionally-directed effort for the OPAL.				
(U) In FY 2008: Conduct Congressionally-directed effort for the OPAL.				
(U) In FY 2009: Not Applicable.				
(U)				

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602204F Aerospace Sensors	PROJECT NUMBER AND TITLE 2003 EO Sensors & Countermeasures Tech
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(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) CONGRESSIONAL ADD: Low Voltage, Wideband Electro-Optic Polymer Modulator	0.000	2.385	0.000
(U) In FY 2007: Not Applicable.			
(U) In FY 2008: Conduct Congressionally-directed effort for the Low Voltage, Wideband Electro-Optic Polymer Modulator.			
(U) In FY 2009: Not Applicable.			
(U) Total Cost	21.668	26.503	16.539

(U) <u>C. Other Program Funding Summary (\$ in Millions)</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to</u>	<u>Total Cost</u>
	<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Complete</u>	
(U) Related Activities:									
(U) PE 0602500F, Multi-Disciplinary Space Technology.									
(U) PE 0603253F, Advanced Sensor Integration.									
(U) PE 0602301E, Intelligence System Program.									
(U) This project has been coordinated through the Reliance 21 process to harmonize efforts and eliminate duplication.									

(U) **D. Acquisition Strategy**
Not Applicable.

Exhibit R-2a, RDT&E Project Justification

DATE
February 2008

BUDGET ACTIVITY 02 Applied Research				PE NUMBER AND TITLE 0602204F Aerospace Sensors			PROJECT NUMBER AND TITLE 44SP Space Sensors		
Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
44SP Space Sensors	8.644	10.176	8.914	9.537	10.177	9.723	9.967	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

Note: In FY 2007, efforts were transferred from PE 0602500F, Multi-Disciplinary Space Technology, Project 5028, Space Sensors, Photonics, and RF Processors and Project 5029, Space Sensor and CM Technology, in order to more effectively manage and provide oversight of the efforts.

(U) A. Mission Description and Budget Item Justification

This project focuses on developing methods of generating, controlling, receiving, transmitting, and processing electronic, photonic, optical, and opto-electronic (mixed) signals for radio-frequency space sensor applications. The enabling technologies will be used for intelligence, surveillance, reconnaissance, electronic warfare, and precision engagement sensors based in space. This project develops the baseline technologies required to manage and perform on-board space sensor information fusion for timely and comprehensive communications and situational awareness. Through modeling and simulation, this project develops and evaluates innovative electromagnetic and electronic countermeasures for space applications. This project aims to demonstrate significantly improved military space sensors of smaller size, lower weight, lower cost, lower power dissipation, higher reliability, and improved performance. This project also develops and assesses multi-dimensional adaptive techniques in radar technology for affordable and reliable space surveillance and reconnaissance systems.

(U) B. Accomplishments/Planned Program (\$ in Millions)

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) MAJOR THRUST: Develop hybrid space-based sensor solutions and reduce associated technology risks. Investigate hardware and software implementation approaches for the needs of responsive space and of sensing difficult targets from space. Develop space-qualified precision time, position, and velocity sensors capable of operating in jamming environments while enabling multiple-platform sensor-to-warfighter operations. Note: In FY 2007, space-based sensor platform technology efforts, previously performed under other major thrusts in the project, were placed here to show emphasis.	3.878	3.102	2.965
(U) In FY 2007: Initiated identification and development of specific techniques and technologies to further expand the capabilities of space-based sensor platforms.			
(U) In FY 2008: Define specific responsive space sensor functional capabilities and implementation assessments. Model size-, weight-, and power-restricted precision time, position, and velocity sensor techniques for space-based applications. Develop a constructive systems engineering model to assess space-based assured reference techniques in terms of measures of performance and warfighter utility.			
(U) In FY 2009: Experimentally assess responsive space "plug-and-play" satellite implementation concept. Design size-, weight-, and power-restricted precision time, position, and velocity sensor techniques for space-based applications. Demonstrate constructive systems engineering model to assess space-based assured reference techniques in terms of measures of performance and warfighter utility.			
(U) MAJOR THRUST: Develop advanced active phased array antenna subsystems to meet the unique requirements of	2.164	3.384	1.954

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

02 Applied Research

PE NUMBER AND TITLE

0602204F Aerospace Sensors

PROJECT NUMBER AND TITLE

44SP Space Sensors

(U) B. Accomplishments/Planned Program (\$ in Millions)	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
affordable space-based sensing including restrictions on mass, size, and power. Utilize advanced materials, to demonstrate low-mass, low-cost, reliable, and scalable apertures. Develop multi-band and multi-beam forming technologies. Address technologies for antenna array operations in dynamic sensor networks. Supports intelligence, surveillance, and reconnaissance capabilities.			
(U) In FY 2007: Demonstrated low-mass scalable tiles and panels with advanced thermal management and improved efficiency for active components.			
(U) In FY 2008: Develop sub-array-level digital beam-forming and low-cost L-band antenna panels.			
(U) In FY 2009: Experimentally assess enhanced antenna signal interference compatibility capability.			
(U)			
(U) MAJOR THRUST: Study adaptive processing techniques for large, multi-mission, space-based conformal arrays to meet the stringent demands of wide-area coverage, target detection, and target tracking in severe clutter and interference environments.	1.693	1.523	1.652
(U) In FY 2007: Developed adaptive processing techniques suitable for implementation on space-qualified computing architectures for multi-intelligence, surveillance, and reconnaissance sensing from space-based platforms. Developed signal processing methods and novel adaptive transmit and receive techniques for a space surveillance platform.			
(U) In FY 2008: Evaluate adaptive transmit and receive techniques for surface moving target indication from space under a variety of tactical scenarios and interference environments.			
(U) In FY 2009: Integrate developed algorithms, waveforms, and space platform scenarios into a surveillance network of sensors.			
(U)			
(U) MAJOR THRUST: Develop advanced component technology for space-based sensors that focuses on improving performance and reducing size, mass, and power. Investigate pre-space qualification issues associated with newer component technologies to ensure more rapid and accurate transitions. Supports intelligence, surveillance, and reconnaissance capabilities.	0.909	0.905	1.084
(U) In FY 2007: Developed and modeled an initial reduced-power architecture for large-area antennas.			
(U) In FY 2008: Validate new low-cost radio-frequency sub-assembly technology compatibility for space qualification. Evaluate plastic packaging, liquid crystal polymer packages, and flexible radio-frequency boards.			
(U) In FY 2009: Develop compact tunable filters for interference signal rejection in dense signal environments.			
(U)			
(U) MAJOR THRUST: Develop sensor technologies to achieve highly accurate and robust navigation performance for hypersonic air vehicles in prompt global strike applications. Note: This work is an outgrowth of other efforts within	0.000	1.262	1.259

R-1 Line Item No. 12

Page-14 of 31

Project 44SP

Exhibit R-2a (PE 0602204F)

Exhibit R-2a, RDT&E Project Justification	DATE February 2008
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BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602204F Aerospace Sensors	PROJECT NUMBER AND TITLE 44SP Space Sensors
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(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
this Project.			
(U) In FY 2007: Not Applicable.			
(U) In FY 2008: Model hypersonic air vehicle plasma characteristics, platform trajectories, and highly accurate and robust navigation techniques for space-based applications. Develop a constructive systems engineering model to assess hypersonic navigation techniques in terms of measures of performance and warfighter utility.			
(U) In FY 2009: Design a radio-frequency hardware-in-the-loop testbed to implement hypersonic air vehicle plasma characteristics, platform trajectories, and highly accurate and robust navigation techniques for space-based applications. Continue developing a constructive systems engineering model to assess hypersonic navigation techniques in terms of measures of performance and warfighter utility.			
(U) Total Cost	8.644	10.176	8.914

(U) <u>C. Other Program Funding Summary (\$ in Millions)</u>		<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to</u>	<u>Total Cost</u>
		<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Complete</u>	<u>Total Cost</u>
(U) Related Activities:										
(U) PE 0602500F, Multi-Disciplinary Space Tech.										
(U) PE 0603203F, Advanced Aerospace Sensors.										
(U) PE 0603500F, Multi-Disciplinary Adv Dev Space Tech.										
(U) This project has been coordinated through the Reliance 21 process to harmonize efforts and eliminate duplication.										
(U) <u>D. Acquisition Strategy</u>										
Not Applicable.										

Exhibit R-2a, RDT&E Project Justification

DATE
February 2008

BUDGET ACTIVITY 02 Applied Research				PE NUMBER AND TITLE 0602204F Aerospace Sensors			PROJECT NUMBER AND TITLE 4916 Electromagnetic Tech		
Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
4916 Electromagnetic Tech	21.064	14.217	15.929	14.639	13.889	0.000	0.000	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

Note: In FY 2012, efforts in this project will transfer to Project 2002, Electronic Component Technology, and Project 2003, EO Sensors & Countermeasures Technology, as a result of Base Realignment And Closure law.

(U) A. Mission Description and Budget Item Justification

This project develops technologies for sensor systems that cover the electromagnetic spectrum from radio-frequency to electro-optical. It develops radio-frequency antennas and associated electronics for airborne and space-based surveillance. It also investigates radio-frequency scattering phenomenology for applications in ground and air moving target indicators in extremely cluttered environments. The project develops active and passive electro-optical sensors for use in concert with radio-frequency sensors. It develops low-cost active sensors that use reliable high-performance solid state components for target detection and identification and missile threat warning. The project also develops passive multi-dimensional sensors to improve battlefield awareness and identify threats at long-range.

(U) B. Accomplishments/Planned Program (\$ in Millions)

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) MAJOR THRUST: Investigate detection of difficult airborne and ground-based targets in clutter from airborne or space-based surveillance platforms.	3.516	3.106	3.336
(U) In FY 2007: Developed integration techniques for multiple platforms, combining electromagnetic target and clutter physics models with signal processing for improved target detection.			
(U) In FY 2008: Develop techniques for fully-adaptive sensing and processing, combining electromagnetic phenomenology, cognitive algorithms, and signal processing pertaining to waveform-diverse sensing and distributed sensing.			
(U) In FY 2009: Develop analytical and computationally-efficient tools for multi-sensor integration for target detection, tracking, and classification in a knowledge-aided framework, exploiting physics-based and data-dependent electromagnetic models of targets and clutter.			
(U) MAJOR THRUST: Design and develop antennas for airborne and space-based surveillance.	3.724	3.309	3.552
(U) In FY 2007: Developed nonlinear embedded algorithms that enhance dynamic range and bandwidth of digital beam-forming hardware, enabling the use of lower cost hardware. Demonstrated the integration of microwave-integrated circuits into low-cost three-dimensional micro-electrical/mechanical systems-manufactured radio-frequency structures designed for a miniature seeker radar. Analyzed and developed digital beam-forming architectures for conformal phased array antennas for future air-to-air radar system applications.			
(U) In FY 2008: Integrate optimal algorithms with mixed circuit radio-frequency wide-band beam-forming hardware to demonstrate lower cost lightweight sensor platforms. Demonstrate low-cost miniature seeker hardware. Transition newly-developed digital beam-forming architectures to new airborne radar platforms.			

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

02 Applied Research

PE NUMBER AND TITLE

0602204F Aerospace Sensors

PROJECT NUMBER AND TITLE

4916 Electromagnetic Tech

(U) B. Accomplishments/Planned Program (\$ in Millions)	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) In FY 2009: Develop new low-cost digital beam-forming techniques for miniature unmanned aerial vehicles. Integrate new detection algorithm with low-cost seeker hardware. Integrate and test new conformal digital beam-forming phased array antennas on airborne radar platforms.			
(U) MAJOR THRUST: Design and develop new electro-optical techniques and components for detecting and identifying concealed targets.	3.238	2.706	2.904
(U) In FY 2007: Developed Zinc Oxide, Aluminum Nitride, and Gallium Nitride semiconductors for high-power, high-temperature electro-optical applications. Developed single-crystal Gallium Nitride substrates for use in detection of biological agents in clouds and in harsh battlefield environments. Developed laser detection and ranging techniques to extend range of agent and target detection. Developed Zinc Oxide, Gallium Nitride, and Aluminum Nitride-based avalanche photodiodes for increased range and detection sensitivity and for non-line-of-sight covert communications.			
(U) In FY 2008: Develop new focal plane array materials and avalanche photo-detector device technologies to enhance autonomous munitions, staring focal plane arrays, and target identification and tracking applications. Develop two-dimensional pixel-based electronic control circuits for enhanced imaging. Integrate these focal plane arrays with the electronic control circuits for a compact three-dimensional focal plane array capability.			
(U) In FY 2009: Develop new quasi-phase-matched materials, such as Gallium Phosphate, and techniques for efficient optical sources in mid- and long-wave infrared applications. New materials systems will be developed to enable conversion from pump wavelengths between 1 and 2 microns. Continue testing of integrated focal plane arrays.			
(U) MAJOR THRUST: Develop hardware and software for passive multi-dimensional sensing in the thermal infrared spectral wavelength range at high frame rates. Develop metamaterials for conformal arrays. Note: In FY 2009, this increase in funding is due to greater emphasis on metamaterials.	3.613	3.308	6.137
(U) In FY 2007: Continued evaluation of the cross dispersion prism-based sensor system performance. Expanded evaluation of the cross dispersion prism-based sensor system to field testing various assets of interest for target validation and false alarm reduction. Continued the design and development of micro-lens multispectral sensor for real-time threat warning and battle damage assessment. Evaluated micro-lens multispectral sensor performance for real time threat warning and battle damage assessment.			
(U) In FY 2008: Perform critical technical assessments and field tests of hyperspectral electro-optical sensors developed in prior years. Evaluate the potential of sensing rapidly changing electro-optical spectra from hot battlefield events (for example, rocket propelled grenades, mortars, man-portable air defense systems, and muzzle flash). Use results of collections to define small portable systems that can be fielded to provide rapid tactical information to			

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

02 Applied Research

PE NUMBER AND TITLE

0602204F Aerospace Sensors

PROJECT NUMBER AND TITLE

4916 Electromagnetic Tech

(U) B. Accomplishments/Planned Program (\$ in Millions)	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) commanders about the location and type of weapons being fired at friendly forces. Perform initial testing on a new hyperspectral approach to finding and identifying toxic gas clouds.			
(U) In FY 2009: Develop new electro-optical sensor hardware for detecting chemical, biological, radioactive, nuclear, or high explosive weapons using spectral and hyperspectral intelligence. Perform initial testing to assess sensor detection and identification viability and initiate plan for transition. Continue development of hyperspectral and multispectral sensors and create a small, deployable instrument suitable for moving into transition with an advanced technology demonstrator. Initiate utility assessment of hyperspectral sensors for collecting data at millisecond sample rates for space-based applications. Develop new hardware to exploit emerging meta- materials for compact radiating sensor applications including conformal array antennas and electronics based upon complex media. Assess the viability of obtaining metamaterial properties consistent with the demonstration of highly integrated subsystems based upon radio frequency integrated circuit applications to enable small, highly directional antenna element device drivers.			
(U) CONGRESSIONAL ADD: Phased Array Antenna Control Computer.	0.996	0.000	0.000
(U) In FY 2007: Conducted Congressionally-directed effort for the Phased Array Antenna Control Computer.			
(U) In FY 2008: Not Applicable.			
(U) In FY 2009: Not Applicable.			
(U) CONGRESSIONAL ADD: Compact Ultra-sensitive Optical Receiver for Smart and Loitering Standoff Weapons.	1.992	0.000	0.000
(U) In FY 2007: Conducted Congressionally-directed effort for a Compact Ultra-sensitive Optical Receiver for Smart and Loitering Standoff Weapons.			
(U) In FY 2008: Not Applicable.			
(U) In FY 2009: Not Applicable.			
(U) CONGRESSIONAL ADD: Hanscom AFB Collaboration on Meta-Materials and Conformal Antenna Technologies.	0.996	0.000	0.000
(U) In FY 2007: Conducted Congressionally-directed effort for the Hanscom AFB Collaboration on Meta-Materials and Conformal Antenna Technologies.			
(U) In FY 2008: Not Applicable.			
(U) In FY 2009: Not Applicable.			
(U) CONGRESSIONAL ADD: Wideband Digital Airborne Electronic Sensing Array.	1.395	0.000	0.000
(U) In FY 2007: Conducted Congressionally-directed efforts for the Wideband Digital Airborne Electronic Sensing			

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602204F Aerospace Sensors	PROJECT NUMBER AND TITLE 4916 Electromagnetic Tech
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(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
Array.			
(U) In FY 2008: Not Applicable.			
(U) In FY 2009: Not Applicable.			
(U)			
(U) CONGRESSIONAL ADD: Center for Advanced Sensor and Communication Antennas.	1.594	0.993	0.000
(U) In FY 2007: Conducted Congressionally-directed effort for the Center for Advanced Sensor and Communication Antennas.			
(U) In FY 2008: Conduct Congressionally-directed effort for the Center for Advanced Sensor and Communication Antennas.			
(U) In FY 2009: Not Applicable.			
(U)			
(U) CONGRESSIONAL ADD: Optikey Optical Maximum Entropy Verification.	0.000	0.795	0.000
(U) In FY 2007: Not Applicable.			
(U) In FY 2008: Conduct Congressionally-directed effort for Optikey Optical Maximum Entropy Verification.			
(U) In FY 2009: Not Applicable.			
(U)			
(U) Total Cost	21.064	14.217	15.929

(U) <u>C. Other Program Funding Summary (\$ in Millions)</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to</u>	<u>Total Cost</u>
	<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Complete</u>	
(U) Related Activities:									
(U) PE 0602500F, Multi-Disciplinary Space Technology.									
(U) PE 0602702F, Command Control and Communications.									
(U) This project has been coordinated through the Reliance 21 process to harmonize efforts and eliminate duplication.									

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

02 Applied Research

PE NUMBER AND TITLE

0602204F Aerospace Sensors

PROJECT NUMBER AND TITLE

4916 Electromagnetic Tech

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification

DATE
February 2008

BUDGET ACTIVITY 02 Applied Research				PE NUMBER AND TITLE 0602204F Aerospace Sensors			PROJECT NUMBER AND TITLE 6095 Sensor Fusion Technology		
Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
6095 Sensor Fusion Technology	20.262	19.801	18.348	16.144	17.448	17.609	18.008	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project develops the technologies required to perform management and fusion of sensor information for timely and comprehensive situational awareness, automatic target recognition, integrated fire control, and bomb damage assessment. This project determines the feasibility of technologies and concepts for fire control that help to precisely locate, identify, and target airborne and surface targets. The project emphasizes finding reduced-signature targets and targets of opportunity. It will enable new covert tactics for successful air-to-air and air-to-surface strikes.

(U) B. Accomplishments/Planned Program (\$ in Millions)

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) MAJOR THRUST: Develop and assess single and multi-sensor automatic target recognition and sensor fusion algorithms for rapidly finding, tracking, and targeting mobile targets.	2.427	1.508	2.195
(U) In FY 2007: Continued to develop improved processing of, and image formation from, synthetic aperture radar data from research and development data collections. Continued development of synthetic data generation tools to augment and enhance collected research, development, and operational data sets. Continued laboratory tests and assessment of multi-sensor and sensor fusion algorithms for automated exploitation and weapon delivery systems. Completed initial automatic target recognition performance evaluation theory for radar automatic target recognition technology. Continued automatic target recognition performance evaluation theory for electro-optical and multiple sensor automatic target recognition technologies. Laboratory tested the first multi-sensor automatic target recognition performance prediction model. Continued assessment methods and measures for moving target tracking and identification approaches using multiple sensor types. Continued development of analysis methods and measures for assessing automated exploitation and rapid response systems proposed for post-conflict force protection, stability, and security operations.			
(U) In FY 2008: Continue to develop improved processing of, and image formation from, synthetic aperture radar data from research and development data collections. Continue to develop image and data formation and processing of electro-optical, infrared, and hyper-spectral imagery data from research and development data collections. Continue development of multi-sensor and multi-frequency synthetic data generation tools to augment and enhance collected research, development, and operational data sets. Continue laboratory tests and assessment of multi-sensor and sensor fusion algorithms for automated exploitation and weapon delivery systems. Enhance automatic target recognition performance evaluation theory for radar automatic target recognition technology and continue for electro-optical and multiple-sensor automatic target recognition technologies. Continue assessment methods and measures for moving target tracking and identification approaches using multiple sensor types. Continue development of analysis methods and measures for assessing automated exploitation and rapid response systems			

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

02 Applied Research

PE NUMBER AND TITLE

0602204F Aerospace Sensors

PROJECT NUMBER AND TITLE

6095 Sensor Fusion Technology

(U) B. Accomplishments/Planned Program (\$ in Millions)	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
proposed for post-conflict force protection, stability, and security operations.			
(U) In FY 2009: Assess the processing of, and image formation from, synthetic aperture radar, electro-optical, infrared, and hyper-spectral imagery data from research and development data collections taking advantage of disparate phenomenology to improve automatic target recognition detection, classification, and identification performance. Develop and validate multi-sensor and multi-frequency synthetic data generation tools required to augment and enhance collected research, development, and operational data sets. Initiate development of tools and technology supporting other phenomenological features that heretofore have not been exploited. Continue laboratory tests and assessment of multi-sensor and sensor fusion algorithms for automated exploitation and weapon delivery systems. Enhance automatic target recognition performance evaluation theory for radar automatic target recognition technology and continue for electro-optical and multiple-sensor automatic target recognition technologies. Continue assessment methods and measures for moving target tracking and identification approaches using multiple sensor types. Continue development of analysis methods and measures for assessing automated exploitation and rapid response systems proposed for post-conflict force protection, stability, and security operations.			
(U) MAJOR THRUST: Develop, evaluate, and demonstrate target signature models to support automatic target recognition and sensor fusion algorithm development and testing for reconnaissance and strike mission applications.	3.416	3.897	5.477
(U) In FY 2007: Continued to mature target signature models for signature exploitation of radio-frequency sensors, electro-optical multi-spectral systems, and signals intelligence sensors. Continued to develop signatures, algorithms, and modeling support for multiple radio-frequency and electro-optical phenomenology automatic target recognition of tactical ground targets. Continued to generate synthetic air and ground target signatures with sufficient fidelity to support automatic recognition of targets in operationally realistic mission environments. Demonstrated a synthetic-scene data generation capability for radio-frequency scenes and continue development of an electro-optical scene capability applicable to large-area reconnaissance coverage. Continued investigation of model-driven spectral signal processing and exploitation techniques. Continued development of automatic target recognition algorithm-driven radio-frequency sensor design, new modes of operation for existing sensors, and signal processing and exploitation for high-diversity data.			
(U) In FY 2008: Develop and validate target signature models for signature exploitation of radio-frequency sensors, electro-optical multi-spectral systems, and signals intelligence sensors. Develop signatures, algorithms, and modeling support for multiple radio-frequency and electro-optical phenomenology automatic target recognition of tactical ground targets, including civilian vehicles. Continue to generate synthetic air and ground target signatures with sufficient fidelity to support automatic recognition of targets in operationally realistic mission environments. Continue demonstration of a synthetic-scene data generation capability for radio-frequency scenes and continue			

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

02 Applied Research

PE NUMBER AND TITLE

0602204F Aerospace Sensors

PROJECT NUMBER AND TITLE

6095 Sensor Fusion Technology

(U) B. Accomplishments/Planned Program (\$ in Millions)	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
development of an electro-optical scene capability applicable to large-area reconnaissance coverage. Continue investigation of model-driven spectral signal processing and exploitation techniques. Measure performance of initial automatic target recognition algorithm-driven radio-frequency sensor design, new modes of operation for existing sensors, and signal processing and exploitation for high-diversity data.			
(U) In FY 2009: Continue to mature target signature models for signature exploitation of radio-frequency sensors, electro-optical multi-spectral systems, and signals intelligence sensors. Continue to develop signatures, algorithms, and modeling support for multiple radio-frequency and electro-optical phenomenology automatic target recognition of tactical ground targets. Initiate the development of signatures, algorithms, target modeling, and phenomenological modeling of other phenomenological features that heretofore have not been exploited. Continue to generate synthetic air and ground target signatures with sufficient fidelity to support automatic recognition of targets in operationally realistic mission environments. Continue demonstration of a synthetic-scene data generation capability for radio-frequency scenes and continue development of an electro-optical scene capability applicable to large area reconnaissance coverage. Continue investigation of model-driven spectral signal processing and exploitation techniques. Continue development of automatic target recognition algorithm-driven radio-frequency sensor design, new modes of operation for existing sensors, and signal processing and exploitation for high-diversity data.			
(U) MAJOR THRUST: Develop and demonstrate enabling automatic target recognition, sensor management, and sensor fusion technologies for target detection, tracking, and identification in intelligence, surveillance, reconnaissance, and combat identification applications.	13.323	10.405	8.102
(U) In FY 2007: Continued fusion of exploitable radar, electro-optical, infrared, laser detection and ranging, and hyper-spectral features for target detection, tracking, and identification with sensor management techniques. Continued evaluation of physics-based techniques for target detection and identification for intelligence, surveillance, reconnaissance, and combat identification applications. Continued development of technology that will capitalize on precision time, position, attitude, and velocity sensor data to enable improved geo-location capabilities for future distributed-time and distributed-platform sensing. Investigated pixel-level registration techniques. Continued development of capabilities to represent and utilize sensor parameters and errors, along with other uncertainty reference information, for improved fused geo-location accuracy. Continued research of bio-inspired automatic target recognition for robustness. Continued automatic target recognition, sensor management, and sensor fusion research for urban intelligence, surveillance, and reconnaissance from small unmanned aerial vehicles.			
(U) In FY 2008: Develop and validate a fusion capability of exploitable radar, electro-optical, infrared, laser detection and ranging, and hyperspectral features for target detection, tracking, and identification with sensor management			

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

02 Applied Research

PE NUMBER AND TITLE

0602204F Aerospace Sensors

PROJECT NUMBER AND TITLE

6095 Sensor Fusion Technology

(U) **B. Accomplishments/Planned Program (\$ in Millions)**FY 2007FY 2008FY 2009

techniques. Evaluate physics-based techniques for target detection and identification for intelligence, surveillance, and reconnaissance and combat identification applications. Initiate development of automated battle space behavior analysis. Continue development and initiate assessment of technology that will capitalize on precision time, position, attitude, and velocity sensor data to enable improved geo-location capabilities for future distributed time and distributed platform sensing. Continue development of multi-sensor pixel level registration techniques. Continue development of capabilities to represent and utilize sensor parameters and errors, along with other uncertainty reference information, for improved fused geo-location accuracy. Continue research of bio-inspired automatic target recognition for robustness. Extend automatic target recognition, sensor management, and sensor fusion research for urban intelligence, surveillance, and reconnaissance from small unmanned aerial vehicles to include civilian objects of interest.

- (U) In FY 2009: Complete initial fusion capability for radar, electro-optical, infrared, laser detection and ranging, and hyper-spectral features for target detection, tracking, and identification with sensor management techniques. Evaluate and improve of physics-based techniques for target detection and identification for intelligence, surveillance, and reconnaissance and combat identification applications. Continue development and initiate evaluation of automated battle space behavior analysis. Continue development of technology that will capitalize on precision time, position, attitude, and velocity sensor data to enable improved geo-location capabilities for future distributed time and distributed platform sensing, and initiate its inclusion into fusion functions. Complete and evaluate multi-sensor, pixel-level registration techniques. Continue development of capabilities to represent and utilize sensor parameters and errors, along with other uncertainty reference information, for improved fused geo-location accuracy. Continue research of bio-inspired automatic target recognition for robustness and initiate evaluation of these techniques for urban applications. Evaluate automatic target recognition, sensor management, and sensor fusion research for urban intelligence, surveillance, and reconnaissance from small unmanned aerial vehicles.

(U)

- (U) MAJOR THRUST: Develop fundamental technical methods required for algorithm performance models, automatic target recognition driven sensing, layered sensing and other sensing and exploitation technologies impacted by automatic target recognition capabilities. Note: This work is an outgrowth of other work within this project.

0.000

2.402

2.574

- (U) In FY 2007: Not Applicable.

- (U) In FY 2008: Assess the state-of-the-art in automatic target recognition predictive methods. Determine exploitation and sensing technologies that require the integration of automatic target recognition techniques. Develop fundamental automatic target recognition approaches for various subcomponents.

- (U) In FY 2009: Evaluate new innovations in automatic target recognition-related technologies. Continue development

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

02 Applied Research

PE NUMBER AND TITLE

0602204F Aerospace Sensors

PROJECT NUMBER AND TITLE

6095 Sensor Fusion Technology

(U) B. Accomplishments/Planned Program (\$ in Millions)	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) of fundamental automatic target recognition approaches for subcomponents. Begin development of an integrated, unified automatic target recognition methodology, building upon the various automatic target recognition subcomponent efforts.			
(U) (U) MAJOR THRUST: Develop, evaluate, and demonstrate distributed trusted multi-layered sensing architectures for persistent sensing and decision support within air, space, and cyber application domains			
(U) (U) In FY 2007: Not Applicable.			
(U) (U) In FY 2008: Develop new technologies and methodologies for defining adaptive architectures for distributed trusted collaborative heterogeneous sensor systems and semantic sensor networks. Develop new techniques for system of systems sensor engineering and analysis. Initiate development of new techniques for sensor network situation awareness and predictive analytics to optimize object driven, self-organizing collaborative sensor systems for multi-layered sensing.			
(U) (U) In FY 2009: Continue to development of new technologies and methodologies for defining adaptive architectures for distributed trusted collaborative heterogeneous sensor systems and semantic sensor networks. Continue to develop new techniques for system of systems sensor engineering and analysis. Continue to develop new techniques for sensor network situation awareness and predictive analytics to optimize object driven, self-organizing collaborative sensor systems for multi-layered sensing. Initiate research into sensor network science to identify critical areas and technologies needed for next generation semantic sensor networks.			
(U) CONGRESSIONAL ADD: Advanced Sensor Aided Vigilance Technologies.	1.096	0.000	0.000
(U) In FY 2007: Conducted Congressionally-directed effort for Advanced Sensor Aided Vigilance Technologies.			
(U) In FY 2008: Not Applicable.			
(U) In FY 2009: Not Applicable.			
(U) CONGRESSIONAL ADD: Sensor Fusion.	0.000	1.589	0.000
(U) In FY 2007: Not Applicable.			
(U) In FY 2008: Conduct Congressionally-directed effort for Sensor Fusion.			
(U) In FY 2009: Not Applicable.			
(U) Total Cost	20.262	19.801	18.348

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY
02 Applied Research

PE NUMBER AND TITLE
0602204F Aerospace Sensors

PROJECT NUMBER AND TITLE
6095 Sensor Fusion Technology

(U) **C. Other Program Funding Summary (\$ in Millions)**

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to</u>	<u>Total Cost</u>
	<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Complete</u>	

- (U) Related Activities:
- (U) PE 0602500F, Multi-Disciplinary Space Technology.
- (U) PE 0603203F, Advanced Aerospace Sensors.
- (U) PE 0602602F, Conventional Munitions.
- (U) PE 0603270F, Electronic Combat Technology.
- (U) PE 0603226E, Experimental Evaluation of Major Innovative Technologies.
- (U) PE 0603762E, Sensor and Guidance Technology.
- (U) This project has been coordinated through the Reliance 21 process to harmonize efforts and eliminate duplication.
- (U) **D. Acquisition Strategy**
Not Applicable.

Exhibit R-2a, RDT&E Project Justification

DATE
February 2008

BUDGET ACTIVITY 02 Applied Research				PE NUMBER AND TITLE 0602204F Aerospace Sensors			PROJECT NUMBER AND TITLE 7622 RF Sensors & Countermeasures Tech			
Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total	
7622 RF Sensors & Countermeasures Tech	33.470	25.623	22.829	23.547	25.997	24.564	25.300	Continuing	TBD	
Quantity of RDT&E Articles	0	0	0	0	0	0	0			

(U) A. Mission Description and Budget Item Justification

This project develops and assesses affordable, reliable, all-weather radio-frequency sensing concepts for aerospace applications covering the range of radar sensors including intelligence, surveillance, reconnaissance, and fire control, both active and passive. This project also develops and evaluates technology for intelligence, surveillance, reconnaissance, fire control radar, electronic combat, and integrated radar and electronic combat systems. It emphasizes the detecting and tracking of surface and airborne targets with radio-frequency signatures that are difficult to detect due to reduced radar cross-sections, concealment and camouflage measures, severe clutter, or heavy jamming. Techniques exploited include the use of multiple radio-frequency phenomenologies, multi-dimensional adaptive processing, advanced waveforms, and knowledge aided processing techniques. This project also develops the radio-frequency warning and countermeasure technology for advanced electronic combat applications. Specifically, it develops techniques and technologies to detect and counter the links and sensors of threat air defense systems and hostile command and control networks. The project also exploits emerging technologies and components to provide increased capability for offensive and defensive radio-frequency sensors, including radar warning, radio-frequency electronic combat, and electronic intelligence applications.

(U) B. Accomplishments/Planned Program (\$ in Millions)

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) MAJOR THRUST: Develop advanced waveforms for achieving transmit adaptivity and simultaneous multi-mode operations to improve interference rejection, self-protection, and target identification by exploiting diversity in frequency, delay, polarization, modulation, and coding. Develop technologies and techniques to provide significant size, weight, and power reductions in radio-frequency sensors compatible with severely constrained unmanned aerial platforms. Develop technology to enable affordable upgrades to radio-frequency signal receivers. Note: Funding drops in FY 2008 and FY 2009 due to reduced multiple-intelligence advanced radar sensor technology development efforts.	17.770	16.480	6.375
(U) In FY 2007: Developed and evaluated advanced digital receiver and exciter technologies for electronic security and radar applications that support multiple degree-of-freedom adaptivity. Developed and evaluated advanced signal processing concepts that seamlessly integrate with receiver technologies to support increased levels of adaptivity for operation in complex signal environments. Continued development to reduce size, weight, and power in radio-frequency sensors compatible with severely constrained unmanned aerial platforms. Refined innovative techniques to provide concurrent radio-frequency radar and electronic warfare with electro-optical compatibility on a single platform. Determined system-level multi-intelligence trades through integrated radar and electronic warfare modeling, simulation, and analysis.			
(U) In FY 2008: Develop and evaluate advanced mode-control concepts to provide concurrent multi-function radio-frequency radar and electronic warfare compatibility on a single platform. Develop integrated radio-frequency			

Exhibit R-2a, RDT&E Project Justification		DATE February 2008		
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602204F Aerospace Sensors	PROJECT NUMBER AND TITLE 7622 RF Sensors & Countermeasures Tech		
(U) B. Accomplishments/Planned Program (\$ in Millions)		<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) (radar and electronic warfare) and electro-optical modeling, simulation, and analysis capabilities to address broader system-level multi-intelligence trades. Develop advanced digital receiver techniques for adaptive electronic security for passive multi-mode platform operations. Continue development and evaluation of advanced digital receiver and exciter technologies for electronic security and radar applications that support multiple degrees-of-freedom adaptivity. Continue development and evaluation of advanced digital receiver signal processing concepts and techniques for adaptive operation in complex signal environments. Perform digital receiver simulation, modeling and analysis for electronic security scenarios in modern signal environments. Refine reductions in size, weight, and power in radio-frequency sensors compatible with severely constrained unmanned aerial platforms.				
(U) In FY 2009: Continue to develop and evaluate advanced mode-control concepts to provide concurrent radio-frequency radar and electronic warfare with electro-optical compatibility on a single platform. Define approaches allowing the simultaneous design and development of sensors and their back-end exploitation functions. Develop advanced electronic security digital receiver concepts and techniques for spatial and temporal adaptivity to overcome limitations to precision emitter parameterization in complex environments. Continue development and evaluation of advanced adaptive digital receiver and exciter technologies for electronic security, radar and, passive multi-mode applications. Continue digital receiver simulation, modeling, and analysis for electronic security scenarios in modern signal environments. Continue to refine reductions in size, weight, and power in radio-frequency sensors compatible with severely constrained unmanned aerial platforms.				
(U) MAJOR THRUST: Develop robust, ultra-wide-bandwidth antenna technology for use in operational and future aerospace platform electronic apertures. Develop innovative technologies and architectures for extremely wide-band apertures to provide more functionality on a set of platforms. Assess next-generation applied radio-frequency aperture technology. Note: Funding drops in FY 2008 due to completion of wide-band aperture development.		4.260	0.831	1.735
(U) In FY 2007: Fabricated and tested thin-profile wide-band receiver array. Extended array to accommodate transmit function. Evaluated performance of directional wideband array transmitter. Completed fabrication and test of compact wideband direction-finding antenna for close-in sensing.				
(U) In FY 2008: Integrate compact digital receiver and exciter to thin-profile array.				
(U) In FY 2009: Laboratory demonstration and testing of thin-profile array with integrated receiver and exciter.				
(U) MAJOR THRUST: Develop multi-function radio-frequency-sensing concepts and radio-frequency transformational element-level arrays for concurrent multi-mode operation.		2.756	1.277	3.747
(U) In FY 2007: Designed autonomous constellation of active and passive air, space, and ground sensor techniques for				

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY
02 Applied ResearchPE NUMBER AND TITLE
0602204F Aerospace SensorsPROJECT NUMBER AND TITLE
**7622 RF Sensors & Countermeasures
Tech**

(U) B. Accomplishments/Planned Program (\$ in Millions)	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
close-in sensing applications using distant sources of opportunity. Performed systems-engineering analysis of concurrent operation to determine multi-mode array performance. Initiated technology development of critical subsystems for element-level multi-mode digital beam forming.			
(U) In FY 2008: Develop autonomous constellation of active and passive air, space, and ground sensor techniques for close-in sensing applications using distant sources of opportunity. Design and develop panel technology for multi-mode array to demonstrate concurrent operation.			
(U) In FY 2009: Demonstrate autonomous constellation of active and passive air, space, and ground sensor techniques for close-in sensing applications using distant sources of opportunity. Demonstrate and test multi-mode array with element-level digital beam forming.			
(U) MAJOR THRUST: Develop digital radio-frequency receiver and exciter technology to support digital beam forming.	3.583	2.341	2.991
(U) In FY 2007: Demonstrated receiver and exciter technologies that support digital beam-forming functionality for advanced electronic support and radar sensor systems. Performed laboratory integration and demonstration of reduced size, weight, and power receiver and exciter technologies that support multi-function radio-frequency sensor concepts.			
(U) In FY 2008: Develop subsystem engineering, simulation, and characterization technologies for integrated wideband radio-frequency aperture, wideband receiver/exciter, and digital beam-forming signal processing.			
(U) In FY 2009: Demonstrate advanced wideband radio-frequency aperture and wideband receiver and exciter with digital beam-forming signal processing subsystem to validate subsystem engineering, simulation, and characterization technologies.			
(U) MAJOR THRUST: Develop advanced waveforms for achieving transmit adaptivity and simultaneous multi-mode operation to improve interference rejection, self-protection, and target identification by exploiting diversity in frequency, delay, polarization, modulation, and coding. Develop multi-platform, multi-mission radar-adaptive processing algorithms that improve detection and location performance for advanced cruise missiles, air-, and ground-based targets in severe clutter and jamming environments.	4.105	4.694	7.981
(U) In FY 2007: Developed optimal waveforms for multi-sensor and multi-mode radar. Developed advanced radar signal processing algorithms that are suitable for multi-sensor and multi-mode operation. Evaluated wideband radar signal processing techniques for moving target indicator surveillance platforms. Evaluated distributed processing technology for next-generation deep-reach target detection and tracking.			

Exhibit R-2a, RDT&E Project Justification

DATE
February 2008

BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602204F Aerospace Sensors	PROJECT NUMBER AND TITLE 7622 RF Sensors & Countermeasures Tech
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(U) B. Accomplishments/Planned Program (\$ in Millions)	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) In FY 2008: Evaluate distributed processing technology for next-generation deep-reach target detection and tracking. Utilize high-fidelity simulation tools. Plan for future experiments.			
(U) In FY 2009: Initiate and conduct experiments to demonstrate the advantages and performance improvements of adaptive transmit waveforms, new distributed sensor receive processing techniques, and distributed sensing for multi-band, multi-platform, and shared aperture applications.			
(U) CONGRESSIONAL ADD: Sensor Network Technology.	0.996	0.000	0.000
(U) In FY 2007: Conducted Congressionally-directed effort for Sensor Network Technology.			
(U) In FY 2008: Not Applicable.			
(U) In FY 2009: Not Applicable.			
(U) Total Cost	33.470	25.623	22.829

(U) C. Other Program Funding Summary (\$ in Millions)	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to</u>	<u>Total Cost</u>
	<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Complete</u>	
(U) Related Activities:									
(U) PE 0602500F, Multi-Disciplinary Space Technology.									
(U) PE 0603203F, Advanced Aerospace Sensors.									
(U) PE 0603253F, Advanced Avionics Integration.									
(U) PE 0602782A, Command, Control, Communications Technology.									
(U) PE 0602232N, Navy C3 Technology.									
(U) PE 0603792N, Advanced Technology Transition.									
(U) This project has been coordinated through the									

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

02 Applied Research

PE NUMBER AND TITLE

0602204F Aerospace Sensors

PROJECT NUMBER AND TITLE

**7622 RF Sensors & Countermeasures
Tech****(U) C. Other Program Funding Summary (\$ in Millions)**

Reliance 21 process to
harmonize efforts and eliminate
duplication.

(U) D. Acquisition Strategy

Not Applicable.

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PE NUMBER: 0602601F
 PE TITLE: Space Technology

Exhibit R-2, RDT&E Budget Item Justification	DATE February 2008
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BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602601F Space Technology
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Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
Total Program Element (PE) Cost	101.316	128.397	117.519	104.647	114.942	114.797	113.866	Continuing	TBD
1010 Space Survivability & Surveillance	48.497	48.773	47.528	45.905	46.313	44.269	44.345	Continuing	TBD
4846 Spacecraft Payload Technologies	15.027	26.380	21.470	19.471	19.592	22.075	22.005	Continuing	TBD
5018 Spacecraft Protection Technology	1.798	2.532	6.257	6.927	7.994	6.194	5.178	Continuing	TBD
8809 Spacecraft Vehicle Technologies	35.994	50.712	42.264	32.344	41.043	42.259	42.338	Continuing	TBD

Note: Funds for the FY 2008 Congressionally-directed Center for Solar Electricity and Hydrogen in the amount of \$2.4 million were moved from PE 0602203F, Aerospace Propulsion, Project 6233SP, to this PE for execution.

(U) A. Mission Description and Budget Item Justification

This PE focuses on four major areas. First, space environmental protection develops technologies to understand, mitigate, and exploit effects of weather and geophysics environments on the design and operation of Air Force systems. Second, spacecraft payload technologies improve satellite payload operations by investigating advanced component and subsystem capabilities. Third, spacecraft protection develops technologies for protecting U.S. space assets in potential hostile settings. The last major area, spacecraft vehicles, focuses on spacecraft platform, payload, and control technologies, and their interactions. Note: In FY 2008, Congress added \$2.0M for Advanced Modular Avionics for Operationally Responsive Space Use, \$2.0M for Multicontinuum Technology for Space Structures, \$0.5M for Mission Design and Analysis Tool, \$0.35M for Shielding Rocket Payloads, \$1.6M for Deployable Structure Systems for Space, \$1.6M for Field Programmable Gate Arrays, \$3.2M for High-frequency Active Auroral Research Program (HAARP), \$1.6M for Microsatellite Target System, \$2.4M for Nuclear Test Seismic Research, and \$2.0M for Reconfigurable Electronics and Non-Volatile Memory Research. This program is in Budget Activity 2, Applied Research, since it develops and determines the technical feasibility and military utility of evolutionary and revolutionary space technologies.

(U) B. Program Change Summary (\$ in Millions)

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) Previous President's Budget	103.472	109.566	106.755
(U) Current PBR/President's Budget	101.316	128.397	117.519
(U) Total Adjustments	-2.156	18.831	
(U) Congressional Program Reductions		-0.013	
Congressional Rescissions		-0.806	
Congressional Increases		17.250	
Reprogrammings	-0.672	2.400	
SBIR/STTR Transfer	-1.484		

(U) Significant Program Changes:

Changes to this PE since the Previous President's Budget are due to higher Air Force priorities.

Exhibit R-2, RDT&E Budget Item Justification

DATE

February 2008

BUDGET ACTIVITY

02 Applied Research

PE NUMBER AND TITLE

0602601F Space Technology

C. Performance Metrics
(U) Under Development.

Exhibit R-2a, RDT&E Project Justification

DATE
February 2008

BUDGET ACTIVITY 02 Applied Research				PE NUMBER AND TITLE 0602601F Space Technology			PROJECT NUMBER AND TITLE 1010 Space Survivability & Surveillance		
Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
1010 Space Survivability & Surveillance	48.497	48.773	47.528	45.905	46.313	44.269	44.345	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project develops the technologies to exploit the space environment for warfighter's future capabilities. The project focuses on characterizing and forecasting the battlespace environment for realistic space system design, modeling, and simulation, as well as the battlespace environment's effect on space systems' performance. It includes technologies to specify and forecast the environment from "mud to sun" for planning operations and ensuring uninterrupted system performance, optimize space-based surveillance operations, and allow the opportunity to mitigate or exploit the space environment for both offensive and defensive operations. Finally, this project includes the seismic research program that supports national requirements for monitoring nuclear explosions.

(U) B. Accomplishments/Planned Program (\$ in Millions)

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) MAJOR THRUST: Develop technologies for specifying, monitoring, predicting, and controlling space environmental conditions hazardous to Department of Defense (DoD) operational space systems in order to improve performance, reduce cost, and increase operational lifetimes.	5.071	6.810	8.892
(U) In FY 2007: Developed energetic electron data assimilation models for real-time situational awareness by coupling to dynamic radiation belt model to provide data-driven specification and forecast capability. Coupled radiation belt model to global geospace environment models to increase accuracy and lead time. Completed initial predictive model of solar explosive events, including flares, bursts, and coronal mass ejections. Developed concepts for active beam and wave probes of radiation belt dynamics.			
(U) In FY 2008: Complete detailed analysis of Solar Mass Ejection Imager. Compile specifications and guidance for operational heliospheric imager. Initiate measurement of interplanetary magnetic fields using wide-field radio array. Initiate development of magnetic reconnection model to study solar flare initiation and energy storage. Initiate program to test and evaluate empirical flare prediction models based on synoptic data from Air Force and national observatory assets. Complete development of energetic electron data assimilation models for real-time situational awareness by coupling to dynamic radiation belt model to provide data-driven specification and forecast capability. Continue coupling of radiation belt model to global geospace environment models to increase accuracy and lead time. Validate models for ionospheric penetration by very low frequency (VLF) electromagnetic waves and their injection into the magnetosphere.			
(U) In FY 2009: Continue measurement of interplanetary magnetic fields using wide-field radio array. Complete Spiral 1 magnetic reconnection model to study solar flare initiation and energy storage. Continue program to test and evaluate empirical flare prediction models based on synoptic data from Air Force and national observatory assets. Complete coupling of radiation belt model to global geospace environment models to increase accuracy and lead			

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

02 Applied Research

PE NUMBER AND TITLE

0602601F Space Technology

PROJECT NUMBER AND TITLE

1010 Space Survivability & Surveillance

(U) **B. Accomplishments/Planned Program (\$ in Millions)**FY 2007FY 2008FY 2009

time. Utilize three-dimensional global radiation belt diffusion models to simulate ultimate global effect of wave-particle interactions from VLF electromagnetic wave power injected in narrow altitude slices of radiation belts. Validate models for virtual VLF electromagnetic wave generation in the ionosphere and global transport and power distribution.

(U)

(U) MAJOR THRUST: Develop spectral signature libraries, target detection techniques, and decision aids for application to space-based surveillance, laser weapons, and countermeasure systems, including detection of low-observable targets, and targets and space-based resident space object characterization.

16.131

13.531

14.496

(U) In FY 2007: Demonstrated technologies for space-based detection, identification, and characterization for resident space object characterization, environmental monitoring, and missile warning/defense. Developed super-resolution techniques for space-based resident space objects for space situational awareness. Transitioned initial validated spectral processing and exploitation algorithms and related signature databases to appropriate users. With available thermal spectral sensors, validated nighttime spectral processing algorithms and related signature databases for specific environments. Transferred sensor technologies and architecture concepts to acquisition and operational commands as appropriate. Refined real-time hypertemporal processing algorithms; and determined additional optimal parameters for operational system. Developed third generation (model) hypertemporal sensor for space. Transitioned improved stratospheric clear air turbulence forecast models to Air Force Weather Agency. Addressed technology requirements for transition of operational decision aids for airborne lasers, tactical high-energy laser systems, and laser communication systems.

(U) In FY 2008: Finalize real-time hypertemporal (HT) processing algorithms with optimal parameters for space-based missile launch detection. Continue development of third-generation brassboard HT sensor for space-based missile launch detection. Begin feasibility study of HT applications for technical intelligence from ground, air, and space-based platforms. Use satellite tracking test bed and Air Force Maui Optical and Supercomputing tracking telescopes to demonstrate Space Situational Awareness (SSA) capability of HT sensors and validate the utility of this technique to obtain operational and health status of resident space objects. Other advanced sensors of spectral, polarimetric and temporal capabilities are considered in the down selection phase and tested with ground systems as needed. Complete analysis of space data on real world detections of resident space objects with multiple band thermal infrared, visible, and ultraviolet and develop models of sensor performance to evaluate capability of space-based sensors. Utilize planned space demonstrations to validate spectral theater surveillance and area search missions and supporting models. Continue transition of spectral image processing and exploitation algorithms and related signature databases to government users. Begin investigation of spectral applications for material

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

02 Applied Research

PE NUMBER AND TITLE

0602601F Space Technology

PROJECT NUMBER AND TITLE

1010 Space Survivability & Surveillance

(U) **B. Accomplishments/Planned Program (\$ in Millions)**FY 2007FY 2008FY 2009

identification in support of military chemical/biological weapons detection and identification in the thermal infrared and other bands.

- (U) In FY 2009: Finalize brassboard HT sensor for space-based missile launch detection. Incorporate latest real-time HT processing algorithms into sensor platform. Transition brassboard sensor and algorithms to customer for space-based missile launch detection. Test feasibility of HT applications for technical intelligence from ground, air, and space-based platforms. Define the requirements and the optimum configuration of a space-based HT sensor. Develop end-to-end simulation capability, based on the sensor performance models, to assist acquisition community and space operator community in trade space analyses of sensors or sensor suites. The emphasis is on the capabilities to derive information and intelligence about space objects with signals in all bands and all temporal regimes. Continue investigation of spectral applications for material identification in support of military chemical/biological weapons detection and identification in the thermal infrared and other bands. Complete transition of spectral image processing and exploitation algorithms and related signature databases to government users. Complete analysis and documentation of military utility of planned space demonstrations of spectral theater surveillance and area search missions. Complete validation of hyperspectral models.

(U)

- (U) MAJOR THRUST: Develop artificial intelligence techniques, forecasting tools, and sensors for improved ionospheric specification and forecasting, including communications/navigation outage forecasting (C/NOFS), space-based geolocation demonstrations, and determination and prediction of radar degradation.

6.181

7.020

7.515

- (U) In FY 2007: Performed metric tests of C/NOFS scintillation forecasting system. Integrated C/NOFS results into ionospheric specification and forecasting algorithms and models for enhanced military utility of scintillation warning system. Investigated coupled solar-magnetospheric-ionospheric-thermospheric models to improve forecast lead times for radar operations, and communications/navigation outages. Developed portable ionospheric sensor suite for measuring total electron content and communications/navigation scintillation.

- (U) In FY 2008: Expand high-latitude data collection to initiate a high-latitude scintillation warning system. Investigate the impact of convection of scintillations to higher latitudes on Ultra High Frequency communication and Global Positioning System (GPS) navigation systems. Investigate HF induced artificial scintillation generation using the High-frequency Active Auroral Research Program (HAARP). Develop portable ionospheric sensor suite for measuring total electron content and communications/navigation scintillation. Initiate space radar data collection for ionosphere compensation study. Develop scintillation mitigation technology by using metal-oxide space cloud. Develop techniques of analyzing GPS radio occultation data acquired by C/NOFS and Constellation Observing System for Meteorology, Ionosphere and Climate (COSMIC) satellites. Begin incorporation of Kalman filter

Exhibit R-2a, RDT&E Project Justification		DATE February 2008		
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602601F Space Technology	PROJECT NUMBER AND TITLE 1010 Space Survivability & Surveillance		
(U) B. Accomplishments/Planned Program (\$ in Millions)		<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
ionospheric model into forecast models and ionospheric warfighter impact products. Conduct statistical analysis of neutral density to improve accuracy of empirical neutral density models for specifying and forecasting neutral density during geomagnetic storms. Implement algorithm to assess impacts of penetration electric fields on generation of equatorial irregularities.				
(U) In FY 2009: Investigate solar activity on enhancement of L-band scintillations to assess the support of the scintillation database and tools to military communication and navigation systems. Measure total electron content and scintillations over the African subcontinent for better defining the equatorial scintillation and GPS error environment in the middle-eastern region. Demonstrate scintillation mitigation technology using metal-oxide space cloud. Deliver ionospheric compensation technique with wide-band radio-frequency waves. Improve modeling techniques for specifying high temporal resolution of neutral density and satellite drag to achieve predictive space situation awareness. Improve empirical and neutral density model based on Atmospheric Density Specification experiment data and develop physics-based model of the neutral composition, wind, and density. Continue transition of physics-based 3-D model of equatorial plasma bubbles into warfighter products and transition of ionospheric Kalman filter operational models into equatorial models.				
(U)				
(U) MAJOR THRUST: Develop High-frequency Active Auroral Research Program site transmitting and diagnostic instrument infrastructure.		9.596	9.070	9.841
(U) In FY 2007: Validated performance of 3.6 megawatt transmitting array in Extremely Low Frequency/Very Low Frequency (ELF/VLF) wave generation and optical emissions research programs.				
(U) In FY 2008: Conduct experimental research with the 3.6 megawatt transmitting array to develop techniques to increase the efficiency of ELF/VLF wave generated in space and initiate research to characterize their interactions with charged particles in the earth's radiation belts.				
(U) In FY 2009: Continue research to characterize wave-particle interactions and wave amplification effects in space and their potential application to mitigate charged particle effects on space systems and operations.				
(U)				
(U) MAJOR THRUST: Develop basic seismic technologies to support national requirements for monitoring nuclear explosions with special focus on regional distances less than 2,000 kilometers from the sensors.		7.099	6.777	6.784
(U) In FY 2007: Updated seismic codes for operational use. Developed hypothesis test results into potential discrimination and yield estimation techniques, while addressing unresolved hypothesis issues for seismic energy partition, magnitudes, and source physics. Incorporated seismic energy partition effects into implications for local and regional seismic wave propagation. Developed efforts on seismic calibration; seismic detection, location, and				

UNCLASSIFIED

Exhibit R-2a, RDT&E Project Justification		DATE February 2008		
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602601F Space Technology	PROJECT NUMBER AND TITLE 1010 Space Survivability & Surveillance		
		<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) B. Accomplishments/Planned Program (\$ in Millions)				
discrimination; and observational studies of seismic wave propagation, including propagation in Eurasia. Assessed future directions based on results obtained so far.				
(U) In FY 2008: Test and incorporate new research methods for automated processing of increasing numbers of seismic events. Develop long-period regional seismic discrimination, while examining challenges in high-frequency regional discrimination. Continue efforts on seismic calibration; seismic detection, location, and discrimination; and observational studies of seismic wave propagation, including propagation in Eurasia. Conduct comprehensive studies to transition the program to meet emerging local seismic monitoring requirements. Design and conduct theoretical, laboratory, and field studies to support local monitoring.				
(U) In FY 2009: Flyoff different techniques for automated processing of increasing numbers of seismic events. Conduct detailed research on causes of challenges in high-frequency regional discrimination. Further continue efforts on seismic calibration; seismic detection, location, and discrimination; and observational studies of seismic wave propagation, including propagation in Eurasia. Continue to conduct detailed studies of particular challenge areas in local seismic monitoring. Refine design and conduct theoretical, laboratory, and field studies to support local monitoring.				
(U)	CONGRESSIONAL ADD: USAF Center for National Security Research - Signature.	1.277	0.000	0.000
(U)	In FY 2007: Conducted Congressionally-directed effort for USAF National Security Research - Signature.			
(U)	In FY 2008: Not Applicable.			
(U)	In FY 2009: Not Applicable.			
(U)	CONGRESSIONAL ADD: High-frequency Active Auroral Research Program.	3.142	3.180	0.000
(U)	In FY 2007: Conducted Congressionally-directed effort for HAARP.			
(U)	In FY 2008: Conduct Congressionally-directed effort for HAARP.			
(U)	In FY 2009: Not Applicable.			
(U)	CONGRESSIONAL ADD: Nuclear Test Seismic Research	0.000	2.385	0.000
(U)	In FY 2007: Not Applicable.			
(U)	In FY 2008: Conduct Congressionally-directed effort for Nuclear Test Seismic Research.			
(U)	In FY 2009: Not Applicable.			
(U)	Total Cost	48.497	48.773	47.528

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY
02 Applied Research

PE NUMBER AND TITLE
0602601F Space Technology

PROJECT NUMBER AND TITLE
1010 Space Survivability & Surveillance

(U) **C. Other Program Funding Summary (\$ in Millions)**

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to</u>	<u>Total Cost</u>
	<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Complete</u>	

- (U) Related Activities:
- (U) PE 0305111F, Weather Systems.
- (U) PE 0305160F, Defense Meteorological Satellite Program.
- (U) PE 0601102F, Defense Research Sciences.
- (U) PE 0602204F, Aerospace Sensors.
- (U) PE 0603401F, Advanced Spacecraft Technology.
- (U) This project has been coordinated through the Reliance 21 process to harmonize efforts and eliminate duplication.
- (U) **D. Acquisition Strategy**
Not Applicable.

Exhibit R-2a, RDT&E Project Justification

DATE
February 2008

BUDGET ACTIVITY 02 Applied Research				PE NUMBER AND TITLE 0602601F Space Technology			PROJECT NUMBER AND TITLE 4846 Spacecraft Payload Technologies		
Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
4846 Spacecraft Payload Technologies	15.027	26.380	21.470	19.471	19.592	22.075	22.005	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

Note: Funds for the FY 2007, Congressionally-directed Space-Qualified Common Data Link in the amount of \$2.2 million were moved from this Project to PE 0602702F, Command, Control and Communications, Project 6266SP, for execution.

(U) A. Mission Description and Budget Item Justification

This project develops advanced technologies that enhance spacecraft payload operations by improving component and subsystem capabilities. The project focuses on four primary areas: (1) development of advanced, space-qualified, survivable electronics, and electronics packaging technologies; (2) development of advanced space data generation and exploitation technologies, including infrared, Fourier Transform hyperspectral imaging, polarimetric sensing, and satellite antenna subsystem technologies; (3) development of high-fidelity space simulation models that support space-based surveillance and space asset protection research and development for the warfighter; and (4) development of advanced networking, radio frequency, and laser communications technologies to support next generation satellite communication systems.

(U) B. Accomplishments/Planned Program (\$ in Millions)

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) MAJOR THRUST: Develop advanced infrared device technologies for space applications that enable hardened space detector arrays with improved detection, to perform acquisition, tracking, and discrimination of space objects such as decoys, satellites, and warheads throughout their trajectory.	2.773	4.139	5.458
(U) In FY 2007: Pursued detector response tunability. Completed assessment of quantum interference towards amplification of incoming weak signals. Studied radiation damage of very long wavelength and visible focal plane arrays (FPAs). Pursued long-wave infrared (LWIR) superlattice defect reduction and passivation optimization.			
(U) In FY 2008: Continue investigating spectral agility. Begin investigating field-enhancement technologies. Demonstrate a three-layer single pixel polarimeter. Continue LWIR superlattice defect reduction and passivation optimization.			
(U) In FY 2009: Continue investigating spectral agility. Demonstrate tuning from 15 to 20 microns in 1 micron increments. Continue investigating field enhancement technologies. Demonstrate amplification using quantum interference and demonstrate enhancement using plasmons. Continue investigating the single pixel polarimeter. Demonstrate improved LWIR superlattice detector and assess very long-wave infrared feasibility.			
(U) MAJOR THRUST: Develop spectral sensing and data exploitation methodologies for military imaging and remote sensing applications.	0.762	1.130	1.328
(U) In FY 2007: Completed validation of polarimetric scene and signature modeling capability, comparing simulated data to measured field data. Completed initial polarimetric database of materials for use in signature and scene			

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY
02 Applied ResearchPE NUMBER AND TITLE
0602601F Space TechnologyPROJECT NUMBER AND TITLE
**4846 Spacecraft Payload
Technologies**

(U) B. Accomplishments/Planned Program (\$ in Millions)	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
modeling. Defined concepts for polarimetric or multi-band imaging sensors for space-based space surveillance applications.			
(U) In FY 2008: Begin development of a predictive model for advanced imaging concepts. Using the physics-based models, develop an end-to-end capability to predict the performance, benefit, and cost of various sensors for Intelligence, Surveillance, and Reconnaissance (ISR) and SSA applications.			
(U) In FY 2009: Complete the development and begin the validation of a predictive model for advanced imaging. Validate against laboratory and available field data of ISR and SSA missions. Make improvements to the simulation capability to improve accuracy and usability of the model. Utilize the prediction capability to develop concepts for purpose built sensors for SSA.			
(U)			
(U) MAJOR THRUST: Develop technologies for space-based payload components such as low power, high performance, radiation-hardened electronic devices, micro-electro-mechanical system devices, and advanced electronics packaging for next generation high performance space electronics.	2.424	3.682	4.410
(U) In FY 2007: Completed study of dynamics of phase change materials, and of their interactions with pertinent technological materials. Explored use of polymers in reconfigurable electronics. Studied alternative dielectrics for advanced electronics, especially the nitrated oxides. Collaborated with the Air Force Research Laboratory Materials Directorate on nanotechnology. Researched radiation effects mitigation schemes using best commercial practices in design and manufacturing to identify new methods for creating radiation hardened, long-lifetime, commodity and custom mixed signal microcircuits for next generation space and missile systems. Evaluated devices using advanced hardening techniques to determine robustness and compatibility with state of the art design and fabrication technology. Developed morphable electronic panels suitable for demonstration in a relevant environment.			
(U) In FY 2008: Initiate capabilities to the current Satellite Design Automation software to evolve a logical sequence to form a "push-button toolflow" satellite builder. Initiate radiation-harden space sensor interface modules allocating standardized data messages protocols from sensors for ease device control of sensors and actuators.			
(U) In FY 2009: Complete capabilities to the current Satellite Design Automation software to evolve a logical sequence to form a "push-button toolflow" satellite builder. Demonstrate radiation-harden space sensor interface modules allocating standardized data messages protocols from sensors for ease device control of sensors and actuators.			
(U)			
(U) MAJOR THRUST: Develop modeling, simulation, and analysis tools for space-based surveillance systems, rendezvous and proximity operations, optical/infrared imaging space systems, distributed satellite architecture, and space control payloads. Note: In FY 2008, increase in funding is due to acceleration of the development of	2.190	6.387	3.027

Exhibit R-2a, RDT&E Project Justification		DATE February 2008		
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602601F Space Technology	PROJECT NUMBER AND TITLE 4846 Spacecraft Payload Technologies		
(U) B. Accomplishments/Planned Program (\$ in Millions)		<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
engineering and military utility models for space superiority analysis of space situational awareness and defensive counterspace technologies.				
(U) In FY 2007: Supported autonomous and responsive space flight experiments with simulations and data validation. Extended the simulation architecture to feed engineering-level data to mission/campaign models. Readied the simulation architecture to support flight experiment simulation and data validation for experiments on space situational awareness and tactical surveillance.				
(U) In FY 2008: Complete support of autonomous and responsive space flight experiments with simulations and data validation. Complete extension of the simulation architecture to feed engineering-level data to mission/campaign models. Begin to develop engineering and military utility models for space superiority analysis of space situational awareness and defensive counterspace technologies.				
(U) In FY 2009: Continue to develop engineering and military utility models for space superiority analysis of space situational awareness and defensive counterspace technologies.				
(U) MAJOR THRUST: Develop technologies for multi-access laser communications terminals. Assess the maturity of single access terminal components and their applicability to a multi-access terminal design.		4.816	7.464	7.247
(U) In FY 2007: Finished verification of standards of multiple airborne intelligence, surveillance and reconnaissance and space asset feeds into a single optical data path. Performed system testing using laboratory testbed.				
(U) In FY 2008: Begin integration of single-access laser communications terminal components into multi-access laser communications terminal.				
(U) In FY 2009: Complete integration of single-access laser communications terminal components into multi-access laser communications terminal.				
(U) CONGRESSIONAL ADD: Nanoscale Microelectronic Circuit Technology Development.		1.080	0.000	0.000
(U) In FY 2007: Conducted Congressionally-directed effort for Nanoscale Microelectronic Circuit Technology Development.				
(U) In FY 2008: Not Applicable.				
(U) In FY 2009: Not Applicable.				
(U) CONGRESSIONAL ADD: Field Programmable Gate Arrays.		0.982	1.590	0.000
(U) In FY 2007: Conducted Congressionally-directed effort for Field Programmable Gate Arrays.				
(U) In FY 2008: Conduct Congressionally-directed effort for Field Programmable Gate Arrays.				

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY
02 Applied Research

PE NUMBER AND TITLE
0602601F Space Technology

PROJECT NUMBER AND TITLE
4846 Spacecraft Payload Technologies

(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) In FY 2009: Not Applicable.			
(U) CONGRESSIONAL ADD: Reconfigurable Electronic and Non-Volatile Memory Research.	0.000	1.988	0.000
(U) In FY 2007: Not Applicable.			
(U) In FY 2008: Conduct Congressionally-directed effort for Reconfigurable Electronic and Non-Volatile Memory Research.			
(U) In FY 2009: Not Applicable.			
(U) Total Cost	15.027	26.380	21.470

(U) <u>C. Other Program Funding Summary (\$ in Millions)</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to</u>	<u>Total Cost</u>
	<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Complete</u>	
(U) Related Activities:									
(U) PE 0603401F, Advanced Spacecraft Technology.									
(U) This project has been coordinated through the Reliance 21 process to harmonize efforts and eliminate duplication.									
(U) <u>D. Acquisition Strategy</u>									
Not Applicable.									

Exhibit R-2a, RDT&E Project Justification

DATE
February 2008

BUDGET ACTIVITY 02 Applied Research				PE NUMBER AND TITLE 0602601F Space Technology			PROJECT NUMBER AND TITLE 5018 Spacecraft Protection Technology			
Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total	
5018 Spacecraft Protection Technology	1.798	2.532	6.257	6.927	7.994	6.194	5.178	Continuing	TBD	
Quantity of RDT&E Articles	0	0	0	0	0	0	0			

(U) A. Mission Description and Budget Item Justification

This project develops the technologies for protecting U.S. space assets in potential hostile environments to assure continued space system operation without performance loss in support of warfighter requirements. The project focuses on identifying and assessing spacecraft system vulnerabilities, developing threat warning technologies, and developing technologies to mitigate the effects of both intentional and unintentional threats.

(U) B. Accomplishments/Planned Program (\$ in Millions)

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) MAJOR THRUST: Develop key satellite threat warning technologies and tools for high value satellite asset defense. Note: In FY 2009, increase in funding is due to increased emphasis on defensive counterspace technologies.	0.791	1.020	2.810
(U) In FY 2007: Conducted sensor testing and analysis. Identified technology transition opportunities.			
(U) In FY 2008: Continue to conduct sensor space flight experiment and analysis. Identify technology transition opportunities and provide associated engineering designs and concepts.			
(U) In FY 2009: Transfer an active and/or passive threat warning sensor for detection of a direct assent or co-orbital vehicle and transition these engineering designs.			
(U) MAJOR THRUST: Develop high value space asset defensive capabilities. Note: In FY 2009, increase in funding is due to increased emphasis on defensive counterspace technologies.	0.513	0.864	1.657
(U) In FY 2007: Conducted defensive technology space demonstration and analysis. Identified technology transfer opportunities.			
(U) In FY 2008: Develop space experiment using onboard systems or develop proof of concept space experiment to validate concept and multiple use technology.			
(U) In FY 2009: Identify two technology options that provide defensive capability for incorporation into geosynchronous orbit/low earth orbit satellites and complete engineering designs.			
(U) MAJOR THRUST: Develop techniques to exploit existing on-board inherent satellite resources, satellite-as-a-sensor, and self-aware satellite technologies as a first-line threat detection system. Note: In FY 2009, increase in funding is due to increased emphasis on defensive counterspace technologies.	0.494	0.648	1.790
(U) In FY 2007: Conducted defensive technology space demonstration and analysis. Identified technology transfer opportunities.			
(U) In FY 2008: Transition technology to other compatible space systems for multiple uses.			

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY
02 Applied Research

PE NUMBER AND TITLE
0602601F Space Technology

PROJECT NUMBER AND TITLE
5018 Spacecraft Protection
Technology

(U) **B. Accomplishments/Planned Program (\$ in Millions)**

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) In FY 2009: Identify technology transition opportunities and provide engineering designs to potential users.			
(U) Total Cost	1.798	2.532	6.257

(U) **C. Other Program Funding Summary (\$ in Millions)**

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to</u>	<u>Total Cost</u>
	<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Complete</u>	
(U) PE 0603401F, Advanced Spacecraft Technology.									
(U) This project has been coordinated through the Reliance 21 process to harmonize efforts and eliminate duplication.									

(U) **D. Acquisition Strategy**

Not Applicable.

Exhibit R-2a, RDT&E Project Justification

DATE
February 2008

BUDGET ACTIVITY 02 Applied Research				PE NUMBER AND TITLE 0602601F Space Technology			PROJECT NUMBER AND TITLE 8809 Spacecraft Vehicle Technologies		
Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
8809 Spacecraft Vehicle Technologies	35.994	50.712	42.264	32.344	41.043	42.259	42.338	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

Note: Funds for the FY 2008 Congressionally-directed funds for the Center for Solar Electricity and Hydrogen in the amount of \$2.4 million were moved from PE 0602203F, Aerospace Propulsion, Project 6233SP, to this Project, for execution.

(U) A. Mission Description and Budget Item Justification

This project focuses on seven major space technology areas: spacecraft platforms (e.g., structures, controls, power, and thermal management); space-based payloads (e.g., survivable electronics); satellite control (e.g., software for autonomous distributed satellite formation flying, signal processing, and control); modeling and simulation of space-based systems; satellite protection technologies (e.g., space environment effects, debris prediction, and threat warning/attack reporting); microsatellite technologies; and space experiments of maturing technologies for space qualification.

(U) B. Accomplishments/Planned Program (\$ in Millions)

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) MAJOR THRUST: Develop technologies for advanced space platform subsystems such as cryocoolers, compact, high efficiency solar power cells and arrays, and innovative power generation concepts.	3.109	4.406	4.266
(U) In FY 2007: Developed component-based system model of pulse tube cryocoolers for parametric optimization of cryocooler system design. Designed an ultra low-temperature (10 degrees Kelvin), low mass and high efficiency advanced engineering model cryocooler. Transitioned optimal design methodologies to cryocooler industry. Demonstrated greater than 33% efficient solar cell using either lattice mismatch or five- or six- junction solar cell technology. Developed a greater than 12% efficient thin-film solar cell on a polymer substrate at least 20 square centimeters in area.			
(U) In FY 2008: Continue to refine and validate cryocooler component and system models with experimental data. Complete theoretical model of multistage cooler energy flows. Continue to investigate thermodynamic loss mechanisms in regenerative cycle cryocoolers through computational fluid dynamics models. Complete definition and begin procurement technology development design work for improved short-wavelength infrared/medium-wavelength infrared (SWIR/MWIR) cryocooler application needs for missile launch detection and technical intelligence missions. Develop advanced concept solar cells traceable to efficiencies greater than 40%.			
(U) In FY 2009: Further refine and validate cryocooler component and system models with experimental data. Continue to investigate thermodynamic loss mechanisms in regenerative cycle cryocoolers through computational fluid dynamics models. Complete design work for improved SWIR/MWIR cryocooler application for missile launch detection and technical intelligence mission systems. Complete engineering demonstration of advanced array for thin-film solar cells scaleable to greater than 100 kw.			
(U)			

UNCLASSIFIED

Exhibit R-2a, RDT&E Project Justification		DATE February 2008		
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602601F Space Technology	PROJECT NUMBER AND TITLE 8809 Spacecraft Vehicle Technologies		
(U) B. Accomplishments/Planned Program (\$ in Millions)		<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) MAJOR THRUST: Develop technologies for advanced space platform structures such as structural controls for vibration suppression, multi-functional structures, deployable large aperture optical arrays, and lightweight composite satellite and launch vehicle structures. Note: In FY 2008 and out, increase in funding is due to increased emphasis on spacecraft structures.		6.078	10.567	14.639
(U) In FY 2007: Characterized thermal protection structural performance in reentry environment. Developed autonomy concepts to support defensive/protection actions by spacecraft.				
(U) In FY 2008: Complete characterization of thermal protection structural performance. Provide autonomy concepts to support defensive/protection actions by spacecraft. Begin development of multifunctional structural hardware concepts for space situational awareness, such as structural health monitoring, light occultation by nearby objects, and detection of RF emissions. Initiate development of system-level architectures for large precision deployable structures. Commence development of advanced estimation algorithms for better local situational awareness using existing and next-generation hardware, such as star-trackers for object detection, characterization, and tracking.				
(U) In FY 2009: Continue development of multifunctional structural hardware concepts for space situational awareness, such as structural health monitoring, light occultation by nearby objects, and detection of RF emissions. Continue development of system-level architectures for large precision deployable structures. Continue development of advanced estimation algorithms for better local situational awareness using existing and next-generation hardware, such as star-trackers for object detection, characterization, and tracking.				
(U) MAJOR THRUST: Develop flight experiments to address key scientific and technological problems in order to improve the capabilities of existing operational space systems and to enable new transformational space capabilities. Note: Funding changes are due to launch preparation activities and higher Air Force priorities.		15.333	25.355	23.359
(U) In FY 2007: Completed Critical Design Review for all payloads to freeze all designs and authorize fabrication of all flight hardware. Completed fabrication of integrated spacecraft core including structure and electronics. Delivered individual experiment payloads and prepared to assemble, integrate, and test with the core spacecraft.				
(U) In FY 2008: Complete delivery of all spacecraft payloads. Complete spacecraft assembly, integration and test. Train mission operations team for on-orbit activities. Prepare science teams for on-orbit operations using simulated data to certify the dissemination and analysis process.				
(U) In FY 2009: Prepare spacecraft for launch. Complete all spacecraft to launch vehicle interface analysis and approval. Launch spacecraft and commence with Mission Operations.				
(U) CONGRESSIONAL ADD: Integrated Control for Autonomous Space Systems (ICASS).		1.571	0.000	0.000

UNCLASSIFIED

Exhibit R-2a, RDT&E Project Justification		DATE February 2008		
BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE		
02 Applied Research	0602601F Space Technology	8809 Spacecraft Vehicle Technologies		
(U) B. Accomplishments/Planned Program (\$ in Millions)		<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) In FY 2007: Conducted Congressionally-directed effort for ICASS.				
(U) In FY 2008: Not Applicable.				
(U) In FY 2009: Not Applicable.				
(U)				
(U) CONGRESSIONAL ADD: Elastic Memory Composites (EMC).		0.982	0.000	0.000
(U) In FY 2007: Conducted Congressionally-directed effort for Elastic Memory Composites.				
(U) In FY 2008: Not Applicable.				
(U) In FY 2009: Not Applicable.				
(U)				
(U) CONGRESSIONAL ADD: Deployable Structures Experiment.		1.080	0.000	0.000
(U) In FY 2007: Conducted Congressionally-directed effort for Deployable Structures Experiment.				
(U) In FY 2008: Not Applicable.				
(U) In FY 2008: Not Applicable.				
(U)				
(U) CONGRESSIONAL ADD: Flexible CIGS Solar Cells on Silicone Substrates for Spacecraft.		0.982	0.000	0.000
(U) In FY 2007: Conducted Congressionally-directed effort for Flexible CIGS Solar Cells on Silicone Substrates for Spacecraft.				
(U) In FY 2008: Not Applicable.				
(U) In FY 2008: Not Applicable.				
(U)				
(U) CONGRESSIONAL ADD: Joint Micro Power Initiative.		0.982	0.000	0.000
(U) In FY 2007: Conducted Congressionally-directed effort for Joint Micro Power Initiative.				
(U) In FY 2008: Not Applicable.				
(U) In FY 2009: Not Applicable.				
(U)				
(U) CONGRESSIONAL ADD: Three Dimensional Deployable Structure Systems for Space.		1.080	0.000	0.000
(U) In FY 2007: Conducted Congressionally-directed effort for Three Dimensional Deployable Structure Systems for Space.				
(U) In FY 2008: Not Applicable.				
(U) In FY 2009: Not Applicable.				
(U)				

UNCLASSIFIED

Exhibit R-2a, RDT&E Project Justification		DATE February 2008		
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602601F Space Technology	PROJECT NUMBER AND TITLE 8809 Spacecraft Vehicle Technologies		
(U) B. Accomplishments/Planned Program (\$ in Millions)		<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) CONGRESSIONAL ADD: Lightweight Photovoltaic Electricity and Hydrogen for Portable, On-Demand Power/Center for Solar Electricity and Hydrogen.		3.535	2.384	0.000
(U) In FY 2007: Conducted Congressionally-directed effort for Center for Solar Electricity and Hydrogen.				
(U) In FY 2008: Conduct Congressionally-directed effort for Center for Solar Electricity and Hydrogen.				
(U) In FY 2009: Not Applicable.				
(U)				
(U) CONGRESSIONAL ADD: Multicontinuum Technology for Space Structures.		0.982	1.988	0.000
(U) In FY 2007: Conducted Congressionally-directed effort for Multicontinuum Technology for Space Structures.				
(U) In FY 2008: Conduct Congressionally-directed effort for Multicontinuum Technology for Space Structures.				
(U) In FY 2009: Not Applicable.				
(U)				
(U) CONGRESSIONAL ADD: Shield Rocket Payloads / Shielding Rocket Payloads.		0.280	0.347	0.000
(U) In FY 2007: Conducted Congressionally-directed effort for Shield Rocket Payloads.				
(U) In FY 2008: Conduct Congressionally-directed effort for Shielding Rocket Payloads.				
(U) In FY 2009: Not Applicable.				
(U)				
(U) CONGRESSIONAL ADD: Advanced Modular Avionics for Operationally Responsive Space Use.		0.000	1.988	0.000
(U) In FY 2007: Not Applicable.				
(U) In FY 2008: Conduct Congressionally-directed effort for Advanced Modular Avionics for Operationally Responsive Space Use.				
(U) In FY 2009: Not Applicable.				
(U)				
(U) CONGRESSIONAL ADD: Deployable Structure Systems for Space.		0.000	1.590	0.000
(U) In FY 2007: Not Applicable.				
(U) In FY 2008: Conduct Congressionally-directed effort for Deployable Structure Systems for Space.				
(U) In FY 2009: Not Applicable.				
(U)				
(U) CONGRESSIONAL ADD: Microsatellite Target System.		0.000	1.590	0.000
(U) In FY 2007: Not Applicable.				
(U) In FY 2008: Conduct Congressionally-directed effort for Microsatellite Target System.				
(U) In FY 2009: Not Applicable.				

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602601F Space Technology	PROJECT NUMBER AND TITLE 8809 Spacecraft Vehicle Technologies
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(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) CONGRESSIONAL ADD: Mission Design and Analysis Tool.	0.000	0.497	0.000
(U) In FY 2007: Not Applicable.			
(U) In FY 2008: Conduct Congressionally-directed effort for Mission Design and Analysis Tool.			
(U) In FY 2009: Not Applicable.			
(U) Total Cost	35.994	50.712	42.264

(U) <u>C. Other Program Funding Summary (\$ in Millions)</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to</u>	<u>Total Cost</u>
	<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Complete</u>	
(U) Related Activities:									
(U) PE 0602203F, Aerospace Propulsion.									
(U) PE 0602102F, Materials.									
(U) PE 0603311F, Ballistic Missile Technology.									
(U) PE 0603401F, Advanced Spacecraft Technology.									
(U) This project has been coordinated through the Reliance 21 process to harmonize efforts and eliminate duplication.									
(U) <u>D. Acquisition Strategy</u>									
Not Applicable.									

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UNCLASSIFIED

PE NUMBER: 0602602F
 PE TITLE: Conventional Munitions

Exhibit R-2, RDT&E Budget Item Justification	DATE February 2008
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BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602602F Conventional Munitions
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Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
Total Program Element (PE) Cost	60.150	58.632	55.963	60.781	58.725	56.638	59.159	Continuing	TBD
2068 Advanced Guidance Technology	18.493	17.778	17.982	19.171	19.206	18.354	19.299	Continuing	TBD
2502 Ordnance Technology	41.657	40.854	37.981	41.610	39.519	38.284	39.860	Continuing	TBD

(U) A. Mission Description and Budget Item Justification

This program investigates, develops, and establishes the technical feasibility and military utility of advanced guidance and ordnance technologies for conventional air-launched munitions. The program includes two projects: (1) development of advanced guidance technologies, including seekers, navigation and control, target detection and identification algorithms, and simulation assessments; and (2) development of conventional ordnance technologies, including warheads, fuzes, explosives, munitions integration, and weapon lethality and vulnerability assessments. Note: In FY 2008, Congress added \$1.2 million for Advanced Nanotube Micro-Munition Weapon Technology Initiative. This program is in Budget Activity 2, Applied Research, since it develops and determines the technical feasibility and military utility of evolutionary and revolutionary technologies.

(U) B. Program Change Summary (\$ in Millions)

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) Previous President's Budget	61.868	57.804	56.081
(U) Current PBR/President's Budget	60.150	58.632	55.963
(U) Total Adjustments	-1.718	0.828	
(U) Congressional Program Reductions			
Congressional Rescissions		-0.372	
Congressional Increases		1.200	
Reprogrammings	-0.814		
SBIR/STTR Transfer	-0.904		

(U) Significant Program Changes:

Not Applicable.

C. Performance Metrics

(U) Under Development.

Exhibit R-2a, RDT&E Project Justification

DATE
February 2008

BUDGET ACTIVITY 02 Applied Research				PE NUMBER AND TITLE 0602602F Conventional Munitions			PROJECT NUMBER AND TITLE 2068 Advanced Guidance Technology		
Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
2068 Advanced Guidance Technology	18.493	17.778	17.982	19.171	19.206	18.354	19.299	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

- (U) **A. Mission Description and Budget Item Justification**
 This project investigates, develops, and evaluates conventional munitions advanced guidance technologies to establish technical feasibility and military utility. This project includes development of advanced guidance including terminal seekers, navigation and control, signal and processing algorithms, and guidance and control simulations. Project payoffs include: adverse-weather and autonomous precision guidance capability; increased number of kills per sortie; increased aerospace vehicle survivability; improved reliability and affordability; and improved survivability and effectiveness of conventional weapons.
- (U) **B. Accomplishments/Planned Program (\$ in Millions)**
- | | | | |
|--|----------------|----------------|----------------|
| | <u>FY 2007</u> | <u>FY 2008</u> | <u>FY 2009</u> |
| (U) MAJOR THRUST: Investigate and develop advanced guidance component technologies for adverse weather and autonomous seekers for air-delivered munitions, such as detectors and detector arrays, receiver electronics, signal pre-processing, target recognition, spatial target characteristics, optics, and low-cost beam scanning and shaping technologies. These technologies will enable the development of next generation seekers that will increase a weapon's kill probability, reduce pilot workload, and enhance sortie effectiveness. | 6.712 | 5.621 | 5.080 |
| (U) In FY 2007: Further improved and tested components in laser ranging seeker to provide "single-shot" imaging. Conducted further fabrication of an optical seeker that uses multi-discriminate signatures to improve targeting obscured targets. Used ground test data to further augment the shape signatures in the automatic target acquisition algorithms to add laser multi-discriminate signatures. | | | |
| (U) In FY 2008: Test and demonstrate in a lab environment test components for laser ranging seeker to provide "single shot" imaging at useful ranges. Lab test an optical seeker that uses multi-discriminate signatures to improve targeting of obscured targets. Develop Synthetic Aperture Radar (SAR) system simulation for designing Radar Frequency (RF) seeker technologies analysis. | | | |
| (U) In FY 2009: Laboratory demonstration of test components for laser ranging seeker to profile "single shot" images of useful targets. Test and demonstrate an optical seeker that uses multi-discriminate signatures to improve targeting obscure targets. Refine SAR System simulation. Begin developing a multi mode seeker that provides improved performance in two wavelength bands. | | | |
| (U) MAJOR THRUST: Investigate and develop advanced navigation and control technologies for air-delivered munitions to include nonlinear controllers, biomimetic guidance, clutter rejection modules, detection and segmentation modules, and micro-electromechanical gyros. These technologies will allow a more efficient flight path to target, increase stand off ranges, improve resistance to Global Positioning System (GPS) jamming, and enhance strike aircraft effectiveness and survivability. | 3.800 | 3.300 | 3.455 |

Exhibit R-2a, RDT&E Project Justification		DATE February 2008		
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602602F Conventional Munitions	PROJECT NUMBER AND TITLE 2068 Advanced Guidance Technology		
(U) B. Accomplishments/Planned Program (\$ in Millions)		<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) In FY 2007: Further developed navigation and guidance techniques to autonomously guide cooperative robotic weapons without location information from GPS. Further developed small agile vehicle guidance to avoid obstacles. Applied neuro-physiology of insects to guide small vehicles to moving targets in an urban-like environment. Further evaluated navigation systems within GPS jamming environments.				
(U) In FY 2008: Test navigation and guidance techniques to autonomously guide cooperative robotic weapons without location information from GPS. Continue applying neuro-physiology of insects to guide small vehicles for moving targets in urban like environments. Continue novel evaluating navigation system within GPS jamming environments. Investigate using data links to provide target location updates for precision strike against mobile, time sensitive targets.				
(U) In FY 2009: Continue applying the neuro-physiology of insects to guide small vehicles to moving targets in urban-like environments. Continue evaluating navigation systems within GPS jamming environments. Evaluate utility data links to provide target location updates for precision strike against time sensitive targets. Investigate guidance navigation and control algorithms for engaging high agility, reduced signature targets. Investigate technologies applicable to indoor navigation within facilities.				
(U)				
(U)	MAJOR THRUST: Investigate and develop advanced optical and digital processors and target detection, classification, and identification algorithms for improved seeker performance to allow greater air-delivered weapon autonomy. Continue developing highly innovative concepts and approaches in guidance and control. These seekers will deny an enemy the ability to hide or camouflage a target, while also decreasing aircrew workload.	3.109	3.570	3.851
(U)	In FY 2007: Investigated particular target attributes using biomimetic principles. Developed polarization behavior theory models. Further evaluated contractor developed optic-flow algorithms.			
(U)	In FY 2008: Verify biomimetic models through simulation. Continue developing polarization behavior theory models. Develop an optical flow enhanced seeker.			
(U)	In FY 2009: Continue verifying biomimetic models through simulation and field testing. Verify polarization theory models through simulation. Conduct tests on an optical flow enhanced seeker.			
(U)				
(U)	MAJOR THRUST: Investigate and develop detailed six-degree-of-freedom and hardware-in-the-loop simulations including synthetic aperture radar, automatic target recognition, and biomimetic processing. Technologies also include trajectory optimization algorithm and polarization sensing and models to analyze guided munitions and their components that will enable requirement studies, design iteration and evaluation, and experiment risk reduction. These simulations will shorten development time, reduce development costs, and provide more effective munitions.	4.872	5.287	5.596
(U)	In FY 2007: Further refined the set of interoperable simulations, validating the reusable aspect, to evaluate emerging			

Exhibit R-2a, RDT&E Project Justification	DATE February 2008
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BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602602F Conventional Munitions	PROJECT NUMBER AND TITLE 2068 Advanced Guidance Technology
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(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
munitions technologies. Improved existing multi-spectral phenomenology models and evaluate in a synthetic scene environment. Developed a set of reusable modeling tools to allow munition simulations to be built from standardized components using standard commercial products.			
(U) In FY 2008: Continue refining the set of interoperable simulations, validating the reusable aspects, to evaluate emerging munitions technologies. Update and test multi-spectral phenomenology models and evaluate via synthetic scene simulation. Investigate laser radar (LADAR) scene generation to demonstrate a feasible projection system for hardware-in-the-loop testing.			
(U) In FY 2009: Continue refining the set of interoperable simulations to evaluate emerging munitions technologies. Integrate and test updates for multi-spectral phenomenology models and evaluate updated results via synthetic scene simulation. Continue the investigation of a LADAR scene generation capability for hardware-in-the-loop testing.			
(U) Total Cost	18.493	17.778	17.982

(U) <u>C. Other Program Funding Summary (\$ in Millions)</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to</u>	<u>Total Cost</u>
	<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Complete</u>	
(U) Related Activities:									
(U) PE 0603601F, Conventional Weapons Technology.									
(U) This project has been coordinated through the Reliance 21 process to harmonize efforts and eliminate duplication.									
(U) <u>D. Acquisition Strategy</u> Not Applicable.									

Exhibit R-2a, RDT&E Project Justification

DATE
February 2008

BUDGET ACTIVITY 02 Applied Research				PE NUMBER AND TITLE 0602602F Conventional Munitions			PROJECT NUMBER AND TITLE 2502 Ordnance Technology		
Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
2502 Ordnance Technology	41.657	40.854	37.981	41.610	39.519	38.284	39.860	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

- (U) **A. Mission Description and Budget Item Justification**
 This project investigates, develops, and evaluates conventional ordnance technologies to establish technical feasibility and military utility to include technologies for advanced conventional weapon dispensers, submunitions, safe and arm devices, fuzes, explosives, warheads, and weapon airframe and carriage technology. The project also assesses the lethality and effectiveness of current and planned conventional weapons technology programs and assesses target vulnerability. The payoffs include: improved storage capability and transportation safety of fully assembled weapons; improved warhead and fuze effectiveness; improved submunition dispensing; low-cost airframe/subsystem components and structures; and reduced aerospace vehicle and weapon drag.
- (U) **B. Accomplishments/Planned Program (\$ in Millions)**
- | | | | |
|---|----------------|----------------|----------------|
| | <u>FY 2007</u> | <u>FY 2008</u> | <u>FY 2009</u> |
| (U) MAJOR THRUST: Investigate and develop high fidelity analytical tools, such as computational mechanics models for predicting weapons' effects and assessing target vulnerability. These analysis tools will reduce air-delivered munitions development costs and provide weapons that can generate maximum lethality against a given target class. | 6.700 | 7.810 | 8.582 |
| (U) In FY 2007: Modeled damage to buildings caused by direct weapon effects. Improved methods for predicting damage caused by detonation of penetrating warheads in a variety of materials. Developed a model to predict the vulnerability of protected assets in deep underground facilities. | | | |
| (U) In FY 2008: Continue modeling damage to buildings caused by direct weapon effects. Develop capability to apply first principles computational tools to the design and evaluation of new munitions concepts. Identify high payoff technologies for defeating mobile targets. | | | |
| (U) In FY 2009: Continue modeling damage to buildings caused by direct weapon effects. Continue developing capability to apply first principles computational tools to design and evaluation of new munitions concepts. Continue to identify high payoff technologies for defeating mobile targets. Apply system level analysis tools to identify promising high payoff technologies for defeating mobile targets. | | | |
| (U) MAJOR THRUST: Investigate and develop more efficient, affordable explosives including multi-phase blast explosives, cast and cure high energy composite explosives, and nano-scale metal fuels that provide both higher blast performance and lower ignition sensitivity for air-delivered munitions. These technologies will enable safer, more insensitive to unplanned stimuli, and less expensive explosive fills for inventory and future weapons. | 6.600 | 6.000 | 6.700 |
| (U) In FY 2007: Further developed highly energetic material with twice the power density of conventional explosives by delivering a modeling and simulation capability for enhanced blast materials. Developed energetic liner technology to enhance blast output yet improve the insensitive munition attributes of the weapon system. Demonstrated performance of cast/cure PBX using advanced materials, plasticizers, and formulation techniques. | | | |

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

02 Applied Research

PE NUMBER AND TITLE

0602602F Conventional Munitions

PROJECT NUMBER AND TITLE

2502 Ordnance Technology

(U) B. Accomplishments/Planned Program (\$ in Millions)	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) In FY 2008: Continue developing highly energetic material with twice the power density of conventional explosives by formulating advanced energetic materials. Evaluate the sensitivity and detonation performance and develop design processes for new energetic formulations. Characterize the chemical reaction kinetics of new energetic materials to develop a materials properties database.			
(U) In FY 2009: Continue developing highly energetic material with twice the power density of conventional explosives by characterizing advanced explosive formulations. Evaluate the sensitivity and detonation performance and develop process of new energetic materials. Continue developing a materials properties database characterizing chemical reaction kinetics.			
(U)			
(U) MAJOR THRUST: Investigate and develop advanced fuze technologies for air-delivered munitions, such as commercially available micro-mechanical systems, shock-hardened fuzes, low energy detonators, light activated and modular firing systems for advanced single-point initiation, switches, capacitors, power sources, and safe-arming components. These advanced fuze technologies will enhance lethality through precise selection of burst-height at, above, or below the surface to increase weapon safety and tactical performance, while simultaneously decreasing procurement costs and system supportability requirements.	7.050	5.600	6.000
(U) In FY 2007: Further developed a miniaturized fuze to provide safe and arm, burst point sensor and low power initiator in a four cubic inch package. Further developed a wireless communication system to fuze a hard target munition. Continued to develop a waveform agile fuze to defeat smart jamming devices.			
(U) In FY 2008: Test a miniaturized fuze to provide safe and arm, burst point sensor and low power initiator in a four cubic inch package. Complete static and sled testing of a wireless communication system to fuze a hard target munitions. Complete development of a waveform agile fuze to defeat smart jamming. Begin investigating novel warheads to initiate explosives.			
(U) In FY 2009: Demonstrate a miniature fuze that provides safe and arm, burst point sensor and low power initiator in a four cubic inch package. Continue investigating novel methods to initiate explosives. Begin investigating miniature components to transmit bomb damage information.			
(U)			
(U) MAJOR THRUST: Investigate and develop control and carriage technologies for ordnance packages for advanced air-delivered munitions in order to enhance weapon lethality. Examples of these technologies include high-energy formulations, mass-focus fragmentation, and multi-sensor fuzing. These technologies will increase weapon systems effectiveness by contributing to increased weapon load-out on strike aircraft and enhanced sortie effectiveness. Note: In FY 2007, funds are increased to support Battlefield Air Operations efforts.	13.859	12.152	8.800
(U) In FY 2007: Completed precision time-of-arrival investigation to defeat tunnel blast doors. Further investigated			

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

02 Applied Research

PE NUMBER AND TITLE

0602602F Conventional Munitions

PROJECT NUMBER AND TITLE

2502 Ordnance Technology

(U) B. Accomplishments/Planned Program (\$ in Millions)	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
<p>technologies for miniature cruise missile development. Completed the design studies for loitering, persistent, low-cost multiple-shot munitions. Completed the initial investigation of nanotube reinforced composites to reduce structural weight of weapons. Further miniaturized the attack system to communicate target aim point position from behind enemy lines. Further developed a covert video capability to collect and transmit data to coordinate attack of enemy targets.</p>			
<p>(U) In FY 2008: Finish investigating technologies for miniature cruise missile development. Finish miniaturizing the attack system to communicate target aim point position from behind enemy lines. Field test a covert video distribution capability to collect and transmit data to coordinate attack of enemy targets. Investigate reaction jet control technology to enable dual role air dominance missile technology. Begin to investigate the design of precision guided munitions.</p>			
<p>(U) In FY 2009: Complete development of third spiral of covert video distribution capability and transmit data to coordinate attacks of enemy targets. Continue investigating reaction jet control for dual role area dominance missile technology. Continue investigating the design of precision guided munitions by performing subsystem design trade studies. Conduct research on dispensing technologies for aerospace applications.</p>			
<p>(U) MAJOR THRUST: Investigate and develop advanced warhead kill mechanisms, such as adaptable warhead, directional control and fragmenting ordnance, and application of reactive metals. The investigation includes characterization of the dynamic response of metals and geologic materials, adjustable yield ordnance packages, and distributed multi-point fire set to enhance air-delivered munition lethality. This enhanced lethality supports the development of smaller munitions with effectiveness similar to current inventory weapons with a corresponding increase in aircraft load-out and sortie effectiveness.</p>	7.448	8.100	7.899
<p>(U) In FY 2007: Evaluated selected materials for high-speed penetrating weapons. Further developed focusing kill mechanisms for dual role, dual range missiles. Investigated micro damage technologies to neutralize electronics with small robotic weapons.</p>			
<p>(U) In FY 2008: Continue evaluating selected materials for high-speed penetrating weapons and the hard nose-caps against hard and combination targets. Begin investigating high strength next generation warhead cases with the eventual goal of terradynamic steering. Evaluate shaped charges to defeat medium and heavy armor. Continue investigating micro-damage technologies to neutralize electronics with small robotic weapons. Develop a small high velocity unmanned aerial vehicle (UAV) deliverable with strength to defeat hardened targets. Develop a submunition concept that can penetrate hardened target for agent defeat.</p>			
<p>(U) In FY 2009: Complete evaluation of selected materials for high-speed penetrating weapons and the hard nose-caps against hard and combination targets. Continue investigating high strength next generation warhead cases with the</p>			

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602602F Conventional Munitions	PROJECT NUMBER AND TITLE 2502 Ordnance Technology
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(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
eventual goal of terradynamic steering. Continue evaluation of shaped charges to defeat medium and heavy armor. Continue investigating micro-damage technologies to neutralize electronics with small robotic weapons. Continue developing a small high velocity UAV deliverable with strength to defeat hardened targets. Continue investigating submunition technology that provide agent defeat mechanisms against hardened targets. Begin investigations into new mechanisms for defeating agent defeat targets.			
(U) CONGRESSIONAL ADD: Advanced Nanotube Micro-Munition Weapon Technology Initiative.	0.000	1.192	0.000
(U) In FY 2007: Not Applicable.			
(U) In FY 2008: Conduct Congressionally-directed research for the Advanced Nanotube Micro-Munition Technology Initiative.			
(U) In FY 2009: Not Applicable.			
(U) Total Cost	41.657	40.854	37.981

(U) <u>C. Other Program Funding Summary (\$ in Millions)</u>	<u>FY 2007</u> <u>Actual</u>	<u>FY 2008</u> <u>Estimate</u>	<u>FY 2009</u> <u>Estimate</u>	<u>FY 2010</u> <u>Estimate</u>	<u>FY 2011</u> <u>Estimate</u>	<u>FY 2012</u> <u>Estimate</u>	<u>FY 2013</u> <u>Estimate</u>	<u>Cost to</u> <u>Complete</u>	<u>Total Cost</u>
(U) Related Activities:									
(U) PE 0603601F, Conventional Weapons Technology.									
(U) This project has been coordinated through the Reliance 21 process to harmonize efforts and eliminate duplication.									
(U) <u>D. Acquisition Strategy</u> Not Applicable.									

UNCLASSIFIED

PE NUMBER: 0602605F
 PE TITLE: DIRECTED ENERGY TECHNOLOGY

Exhibit R-2, RDT&E Budget Item Justification	DATE February 2008
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BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602605F DIRECTED ENERGY TECHNOLOGY
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Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
Total Program Element (PE) Cost	48.487	56.915	62.871	90.216	75.717	93.720	99.591	Continuing	TBD
4866 Lasers & Imaging Technology	24.383	35.753	36.633	48.766	42.530	51.926	54.866	Continuing	TBD
4867 Advanced Weapons & Survivability Technology	14.934	16.290	19.964	29.042	20.037	26.627	29.472	Continuing	TBD
55SP Laser and Imaging Space Tech	9.170	4.872	6.274	12.408	13.150	15.167	15.253	Continuing	TBD

Note: In FY 2008, relay mirror technology efforts in Project 55SP, Laser and Imaging Space Technology, transferred to Project 4866, Lasers and Imaging Technology, within this PE in order to more effectively manage the efforts.

(U) A. Mission Description and Budget Item Justification

This program covers research in directed energy technologies, primarily lasers and high power microwaves. In lasers, this research includes moderate to high power lasers (solid state and chemical) and associated optical components and techniques. In advanced weapons, this program examines technologies such as narrowband and wideband high power microwave devices and antennas. Vulnerability/lethality assessments of representative systems are done for both areas. Note: In FY 2008, Congress added \$2.4 million for Ceramics for Next-Generation Tactical Laser Systems. This program is in Budget Activity 2, Applied Research, since it develops and determines the technical feasibility and military utility of evolutionary and revolutionary technologies.

(U) B. Program Change Summary (\$ in Millions)

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) Previous President's Budget	50.019	54.883	53.362
(U) Current PBR/President's Budget	48.487	56.915	62.871
(U) Total Adjustments	-1.532	2.032	
(U) Congressional Program Reductions		-0.005	
Congressional Rescissions		-0.363	
Congressional Increases		2.400	
Reprogrammings	-0.534		
SBIR/STTR Transfer	-0.998		

(U) Significant Program Changes:

Funding was increased in FY 2009 for additional demonstrations leading to an earlier transition of tactical directed energy weapon technologies.

C. Performance Metrics
 Under Development.

Exhibit R-2a, RDT&E Project Justification

DATE
February 2008

BUDGET ACTIVITY 02 Applied Research				PE NUMBER AND TITLE 0602605F DIRECTED ENERGY TECHNOLOGY			PROJECT NUMBER AND TITLE 4866 Lasers & Imaging Technology			
Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total	
4866 Lasers & Imaging Technology	24.383	35.753	36.633	48.766	42.530	51.926	54.866	Continuing	TBD	
Quantity of RDT&E Articles	0	0	0	0	0	0	0			

Note: In FY 2008, relay mirror technology efforts in Project 55SP, Laser and Imaging Space Technology, transferred to Project 4866, Lasers and Imaging Technology, within this PE in order to more effectively manage the efforts.

(U) A. Mission Description and Budget Item Justification

This project explores the technical feasibility of moderate to high power lasers and supporting laser technologies for aircraft protection, force protection, precision engagement, and Global War On Terrorism missions. Develop new technologies, perform physics based modeling, and evaluate new materials that will enable development of: (1) compact, reliable, and affordable laser systems with good beam quality, scalability to high power, and high potential military utility; (2) optical and beam control systems to enhance laser beam propagation and pointing and tracking over long distances in the atmosphere. Emphasis will be on using computer modeling and simulation and laboratory experiments to demonstrate traceability to key concept performance parameters, reliability, affordability, and packaging requirements unique to potential applications. Develop and implement system concept assessment tools supporting the definition of laser system concept performance, military utility and cost trade decisions.

(U) B. Accomplishments/Planned Program (\$ in Millions)

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) MAJOR THRUST: Develop solid state laser technologies for airborne tactical and strategic applications. Technologies include fiber lasers and bulk solid state lasers. Funding was increased in FY 2009 for additional demonstrations leading to an earlier transition of tactical laser weapon technologies.	12.920	15.366	17.903
(U) In FY 2007: Designed and developed laser sources for jamming/damaging optical threats, focusing on increased efficiency and reliability. Performed testing of ultra-short pulse laser sources to evaluate potential applications. Continued development of solutions to aero-optical issues on airborne platforms. Investigated technologies for tactical platform disturbance mitigation. Performed additional lethality assessment studies of various laser concepts in relevant scenarios. Validated vulnerability assessment models. Refined technologies to obtain architectures that are favorable in terms of size, weight, efficiency, affordability, and fieldability for tactical laser weapon applications. Developed the most promising solid state laser technologies for scaling to the weapons class power level. Demonstrated "eye-safe" wavelength solid state laser technology for designator and illuminator applications.			
(U) In FY 2008: Refine laser sources to obtain higher efficiencies and improve ruggedness of designs. Continue development of system-level solutions to aero-optical issues involving airborne tactical laser weapon applications. Perform further lethality assessment studies to assess the effectiveness of the various laser concepts in relevant scenarios. Continue coupon-level and mid-scale demonstration experiments to validate vulnerability assessment models. Continue to scale electric lasers up to the weapons class power level. Refine technologies in effort to obtain suitable parameters in terms of size, weight, efficiency, affordability, reliability, maintainability, supportability,			

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

02 Applied Research

PE NUMBER AND TITLE

0602605F DIRECTED ENERGY
TECHNOLOGY

PROJECT NUMBER AND TITLE

4866 Lasers & Imaging Technology

(U) B. Accomplishments/Planned Program (\$ in Millions)	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
environmental acceptability, and ruggedness for the next-generation applications.			
(U) In FY 2009: Improve design of laser sources for aircraft self-protection. Perform damage/vulnerability tests against real or simulated systems. Use test results to verify models and assess laser effectiveness/system vulnerabilities. Demonstrate system-level beam control solutions to aero-optical issues of tactical laser weapons applications on airborne platforms. Continue to assess the effectiveness of the various laser concepts in relevant scenarios. Continue to scale electric lasers up to the weapons class power level. Pursue higher power "eye-safer" electric laser concepts. Develop architectures that are suitable in terms of size, weight, efficiency, affordability, reliability, maintainability, supportability, environmental acceptability, and ruggedness for the next-generation applications.			
(U) MAJOR THRUST: Develop chemical, gas, and hybrid laser technologies (i.e. new fuel chemistry, fuel regeneration techniques, and nozzle designs) for scalable, high energy laser devices with improved efficiency.	4.735	6.013	5.490
(U) In FY 2007: Continued to investigate scaling of high-performance oxygen generator concepts for airborne laser applications. Evaluated iodine injection schemes for oxygen generators. Evaluated and refined advanced chemical laser technologies demonstrated in FY 2006. Pursued scaling chemical-electric hybrid laser technologies that offer potential for power scaling and component size and weight reduction.			
(U) In FY 2008: Demonstrate enhanced-performance singlet delta oxygen generator coupled with advanced ejector nozzle concepts for airborne laser applications, including advanced fuel chemistries. Continue scaling path demonstrations for electric discharge oxygen-iodine lasers and diode-pumped atomic lasers.			
(U) In FY 2009: Refine high-performance singlet delta oxygen generator and advanced ejector nozzle concepts for airborne laser applications based on results of previous demonstration. Conduct real-world condition demonstrations for enhanced chemical and electric discharge oxygen-iodine lasers and diode-pumped atomic lasers.			
(U) MAJOR THRUST: Develop optical and imaging technologies for advanced beam control, atmospheric compensation, and pointing and tracking for future optical imaging/laser systems. Note: In FY 2008, relay mirror technology efforts previously performed in Project 55SP, Laser and Imaging Space Technology, within this PE were placed here to more effectively manage the efforts. Funding was increased in FY 2009 for additional demonstrations leading to an earlier transition of tactical laser weapon beam control technologies.	4.971	11.989	13.240
(U) In FY 2007: Developed system-level solutions to aero-optical issues involving tactical laser applications on airborne platforms and acquired adaptive optics system for wind tunnel aero-optics disturbance mitigation testing. Investigated technologies for tracking in clutter and tactical platform disturbance mitigation. Developed selected technologies for transition from laboratory to field testing. Investigated advanced adaptive optics techniques.			

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY
02 Applied Research

PE NUMBER AND TITLE
0602605F DIRECTED ENERGY TECHNOLOGY

PROJECT NUMBER AND TITLE
4866 Lasers & Imaging Technology

(U) B. Accomplishments/Planned Program (\$ in Millions)

FY 2007

FY 2008

FY 2009

(U) In FY 2008: Integrate adaptive optics hardware in wind tunnel tests to measure and characterize aero-optical disturbances. Develop and analyze advanced tactical beam control architectures and critical beam control components, such as inertial reference systems and trackers. Begin development of lightweight optics and advanced tracking techniques and technologies. Complete sub-system fabrication in order to conduct a low-power demonstration. Assess alternatives to improve compensation in long horizontal path propagation. Begin demonstrations in real-world conditions technologies to improve pointing stability for tactical lasers. Continue development of advanced adaptive optics techniques. Continue development of silicon carbide fast steering mirror and complete inner gimbals for tactical relay mirror demonstrator.

(U) In FY 2009: Complete demonstration of system-level solutions for aero-optical distortions associated with airborne tactical laser weapons systems in wind-tunnel environment. Implement advanced platform disturbance reduction technologies for an end-to-end field demonstration of precision tactical laser beam control. Demonstrate advanced jitter reduction and improved tracking for tactical lasers. Analyze impact of incorporating high-power solid state laser systems on large aircraft. Select improved compensation techniques for laboratory demonstrations of long horizontal path propagation. Continue development of advanced adaptive optic techniques. Demonstrate adaptive optics on both receive and transmit mirrors of tactical relay mirror demonstrator.

(U) CONGRESSIONAL ADD: Ceramics for Next-Generation Tactical Laser Systems.

1.757

2.385

0.000

(U) In FY 2007: Continued to refine ceramic process and scaled up process to commercial grade. Broadened research effort to secure a domestic source for required nanopowders. Continued to increase size of laser materials with improved thermal, mechanical, and optical performance necessary for use in high energy lasers.

(U) In FY 2008: Continue development of advanced ceramic materials for solid state lasers.

(U) In FY 2009: Not Applicable.

(U) Total Cost

24.383

35.753

36.633

(U) C. Other Program Funding Summary (\$ in Millions)

FY 2007
Actual

FY 2008
Estimate

FY 2009
Estimate

FY 2010
Estimate

FY 2011
Estimate

FY 2012
Estimate

FY 2013
Estimate

Cost to
Complete

Total Cost

(U) Related Activities:

(U) PE 0601108F, High Energy Laser Research Initiatives.

(U) PE 0602890F, High Energy Laser Research.

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

02 Applied Research

PE NUMBER AND TITLE

**0602605F DIRECTED ENERGY
TECHNOLOGY**

PROJECT NUMBER AND TITLE

4866 Lasers & Imaging Technology**(U) C. Other Program Funding Summary (\$ in Millions)**

- (U) PE 0603444F, Maui Space Surveillance System.
- (U) PE 0603605F, Advanced Weapons Technology.
- (U) PE 0603924F, High Energy Laser Advanced Technology Program.
- (U) PE 0602120A, Sensors and Electronic Survivability.
- (U) PE 0602307A, Advanced Weapons Technology.
- (U) PE 0602624A, Weapons and Munitions Technology.
- (U) PE 0603004A, Weapons and Munitions Advanced Technology.
- (U) PE 0602114N, Power Projection Applied Research.
- (U) PE 0602702E, Tactical Technology.
- (U) PE 0603175C, Ballistic Missile Defense Technology.
- (U) PE 0603883C, Ballistic Missile Defense Boost Phase Segment.
- (U) PE 0602651M, Joint Non-Lethal Weapons Applied Research.
- (U) PE 0603651M, Joint Non-Lethal Weapons Technology Development.
- (U) This project has been coordinated through the

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

02 Applied Research

PE NUMBER AND TITLE

0602605F DIRECTED ENERGY
TECHNOLOGY

PROJECT NUMBER AND TITLE

4866 Lasers & Imaging Technology

(U) C. Other Program Funding Summary (\$ in Millions)

Reliance 21 process to
harmonize efforts and eliminate
duplication.

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification

DATE
February 2008

BUDGET ACTIVITY 02 Applied Research				PE NUMBER AND TITLE 0602605F DIRECTED ENERGY TECHNOLOGY			PROJECT NUMBER AND TITLE 4867 Advanced Weapons & Survivability Technology		
Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
4867 Advanced Weapons & Survivability Technology	14.934	16.290	19.964	29.042	20.037	26.627	29.472	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project explores high power microwave (HPM) and other unconventional weapon concepts using innovative technologies. Technologies are developed that support a wide range of Air Force missions such as the potential disruption and degradation of an adversary's electronic infrastructure and military capability. This effect can often be applied covertly with no collateral structural or human damage. Targeted capabilities include local computer and communication systems, as well as large and small air defense and command and control systems. This project also provides for vulnerability assessments of representative U.S. strategic and tactical systems to HPM weapons, HPM weapon technology assessment for specific Air Force missions, and HPM weapon lethality assessments against foreign targets.

(U) B. Accomplishments/Planned Program (\$ in Millions)

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) MAJOR THRUST: Investigate and develop technologies for narrowband and wideband HPM components to support multiple Air Force applications such as the disruption of electronic systems and subsystems.	3.915	4.821	4.445
(U) In FY 2007: Conducted measurements using the compact repetitively pulsed gigawatt-class HPM testbed. Developed a command and control system for the compact airborne platform HPM testbed. Investigated nanotechnology to reduce the HPM source weight and size. Conducted field tests to characterize and to evaluate the wideband testbed. Developed an engineering model of a compact wideband target identification system that can be used to conduct laboratory experiments for applications such as target under trees.			
(U) In FY 2008: Continue testing of the compact repetitively pulsed gigawatt-class HPM demonstration unit. Continue to improve the compact HPM source and conformal antenna such that they can be integrated into an airborne platform. Develop a compact wideband target-under-trees identification unit that can be used to conduct laboratory experiments. Further develop flux trapping technology for compact flux compression generators and perform functional testing. Perform design studies for disk generators to further reduce the size of single shot devices.			
(U) In FY 2009: Enhance the compact repetitively pulsed gigawatt-class HPM testbed. Integrate and demonstrate the conformal antenna and command and control system for the compact HPM testbed. Improve the wideband antenna and high voltage switch and demonstrate the effectiveness during field tests. Develop apparatus capable of correctly delivering gas into interaction region of HPM tubes. Investigate HPM concepts related to cyber warfare and determine new HPM waveforms that can be optimized for a cyber warfare application.			
(U) MAJOR THRUST: Develop and use the ability to assess the effects/lethality of HPM directed energy weapon technologies against representative air and ground systems. Develop and apply sophisticated models to enhance the	4.378	5.315	5.607

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

02 Applied Research

PE NUMBER AND TITLE

0602605F DIRECTED ENERGY
TECHNOLOGY

PROJECT NUMBER AND TITLE

4867 Advanced Weapons &
Survivability Technology

(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
development of HPM and related technology.			
(U) In FY 2007: Predicted susceptibilities of relevant electronic systems based on model and manufacturer. Conducted experiments on the systems to verify model accuracy and compare predictions with experiments. Adjusted models as required. Identified and mitigated platform/system susceptibilities to HPM. Refined battle damage assessment capability for HPM. Conducted susceptibility testing of electronic targets. Identified and mitigated HPM susceptibility for military systems against both domestic and foreign sources. Validated integration of electromagnetic codes with thermal and electron transport codes for HPM sources and components. Applied plasma model for high field regions. Investigated improved material physics models. Initiated development of automatic refinement for HPM system design.			
(U) In FY 2008: Incorporate elemental modeling into predictive code for use in targeting and war gaming. Continue susceptibility testing of electronic targets. Apply hardening techniques and technology to identified platforms. Identify and mitigate HPM susceptibility for military systems of interest to HPM sources. Continue to refine preliminary battle damage assessment technologies for use with HPM. Apply virtual modeling for HPM system enhancement. Continue to investigate and integrate improved material models into HPM tube simulations. Continue development of automatic design enhancement.			
(U) In FY 2009: Apply physics-based understanding and models to predict target effects and incorporate results into an engagement model. Continue verification and validation of engagement model software. Expand microwave effects mitigation effort to harden multiple USAF systems. Explore propagation of microwave signals through electro-static discharge protection devices on circuit boards and provide hardening recommendations to chip manufacturers. Verify linkages between components in an HPM system. Integrate, verify, and improve material models for field, secondary, and thermal emission models.			
(U) MAJOR THRUST: Investigate HPM technologies that support offensive and force protection airborne tactical applications, including non-lethal counterpersonnel applications, made possible by the increased power available on future aircraft. Funding was increased in FY 2009 for additional demonstrations leading to an earlier transition of tactical HPM weapon technologies.	6.641	6.154	9.912
(U) In FY 2007: Developed HPM source materials and assessed applicability of solid state subsystem designs supporting ruggedized high power airborne and counter-improvised explosive device systems. Extended HPM system source code to allow multiple options for high power subsystem components. Matured relativistic magnetron technologies. Refined existing beam control/antenna concepts to meet airborne requirements including addressing issues related to propagation, breakdown, and radomes. Researched, studied, and identified technology or data			

Exhibit R-2a, RDT&E Project Justification

DATE
February 2008

BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602605F DIRECTED ENERGY TECHNOLOGY	PROJECT NUMBER AND TITLE 4867 Advanced Weapons & Survivability Technology
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(U) B. Accomplishments/Planned Program (\$ in Millions)	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) (effects, safety, stabilization, engagement, etc.) requirements impacting overall airborne conceptual approach. Refined millimeter wave diagnostic techniques.			
(U) In FY 2008: Continue development of HPM source materials and assess applicability of solid state subsystem designs supporting ruggedized high power airborne and counter-improvised explosive device systems. Analyze the results from the HPM system source code that reflects multiple options for high power subsystem components. Continue to refine antenna concepts to meet airborne requirements for counter electronics and counter-improvised explosive device systems including addressing issues related to propagation, breakdown, and radomes. Continue development of full power non-lethal test source. Complete millimeter wave diagnostic techniques.			
(U) In FY 2009: Demonstrate maturing HPM source materials and the applicability of solid state subsystem designs supporting ruggedized high power airborne and counter-improvised explosive device systems. Demonstrate the enhanced options for high power subsystem components based on the results of the HPM system source code. Demonstrate the antenna design that best meets airborne requirements for counter electronics and counter-improvised explosive device systems including addressing issues related to propagation, breakdown, and radomes. Complete development of full power non-lethal test source. Continue non-lethal beam control/antenna work and technology studies for airborne implementation.			
(U) Total Cost	14.934	16.290	19.964

(U) C. Other Program Funding Summary (\$ in Millions)	<u>FY 2007</u> <u>Actual</u>	<u>FY 2008</u> <u>Estimate</u>	<u>FY 2009</u> <u>Estimate</u>	<u>FY 2010</u> <u>Estimate</u>	<u>FY 2011</u> <u>Estimate</u>	<u>FY 2012</u> <u>Estimate</u>	<u>FY 2013</u> <u>Estimate</u>	<u>Cost to</u> <u>Complete</u>	<u>Total Cost</u>
(U) Related Activities:									
(U) PE 0602202F, Human Systems Technology.									
(U) PE 0603605F, Advanced Weapons Technology.									
(U) PE 0602120A, Sensors and Electronic Survivability									
(U) PE 0602624A, Weapons and Munitions Technology									
(U) PE 0602114N, Power Projection									
(U) PE 0602651M, Joint Non-Lethal Weapons Applied Research.									

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

02 Applied Research

PE NUMBER AND TITLE

**0602605F DIRECTED ENERGY
TECHNOLOGY**

PROJECT NUMBER AND TITLE

**4867 Advanced Weapons &
Survivability Technology****(U) C. Other Program Funding Summary (\$ in Millions)****(U)** PE 0603851M, Nonlethal
Weapons**(U)** This project has been
coordinated through the
Reliance 21 process to
harmonize efforts and eliminate
duplication.**(U) D. Acquisition Strategy**

Not Applicable.

Exhibit R-2a, RDT&E Project Justification

DATE
February 2008

BUDGET ACTIVITY 02 Applied Research				PE NUMBER AND TITLE 0602605F DIRECTED ENERGY TECHNOLOGY			PROJECT NUMBER AND TITLE 55SP Laser and Imaging Space Tech			
Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total	
55SP Laser and Imaging Space Tech	9.170	4.872	6.274	12.408	13.150	15.167	15.253	Continuing	TBD	
Quantity of RDT&E Articles	0	0	0	0	0	0	0			

Note: In FY 2008, relay mirror technology efforts transferred to Project 4866, Lasers and Imaging Technology, within this PE in order to more effectively manage the efforts.

(U) A. Mission Description and Budget Item Justification

Develop advanced, long-range, optical technologies such as advanced beam control; beam acquisition, tracking, and pointing; adaptive optics; dual line-of-sight pointing; large, lightweight optics; and optical coatings that support future space-object imaging systems. Assess the vulnerability of satellites to the effects of high-energy laser weapons and update catalogued satellites.

(U) B. Accomplishments/Planned Program (\$ in Millions)

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) MAJOR THRUST: Develop advanced, long-range, optical technologies such as advanced beam control; beam acquisition, tracking, and pointing; adaptive optics; dual line-of-sight pointing; large, lightweight optics; and optical coatings that support future space-object imaging systems.	7.312	2.661	3.551
(U) In FY 2007: Completed design for next generation high power relay mirror. Performed optical analysis of beam propagation to determine parameters for relay mirror systems. Continued the development of lightweight silicon carbide mirrors technology. Investigated designs for relay mirrors to enhance propagation of laser beam through turbulence. Began procurement of long lead optical components to include transmitting and receiving beam director telescopes for integration into a relay mirror payload. Developed compact lightweight electrostatic deformable mirror system. Continued development of phased array transceivers for high-resolution imaging. Continued development of advanced wavefront control techniques.			
(U) In FY 2008: Investigate the bandwidth, movement, and resolution limits of various adaptive optics concepts, correlate the attributes to user needs to include aero-optic compensation, and demonstrate a selected concept in a system level experiment. Continue development of a low power phased array transceiver experiment that includes simultaneous imaging and beam projection with wide field of regard beam steering elements. Continue research into spatial light modulators for several imaging applications.			
(U) In FY 2009: Complete testing of electrostatic deformable mirror and spatial light modulator technologies to determine maturity and utility for Air Force applications. Develop and demonstrate a high energy fiber laser phased array transceiver system level brassboard concept that includes high resolution pupil plane imaging, phase retrieval, phase compensated transmitted beams, and shared transmit/receive sub-apertures.			
(U) MAJOR THRUST: Assess the vulnerability of U.S. satellites to the effects of high-energy laser weapons and update catalogued satellites.	1.858	2.211	2.723

Exhibit R-2a, RDT&E Project Justification		DATE February 2008
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602605F DIRECTED ENERGY TECHNOLOGY	PROJECT NUMBER AND TITLE 55SP Laser and Imaging Space Tech

(U) B. Accomplishments/Planned Program (\$ in Millions)	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) In FY 2007: Developed and applied improved algorithms and hardware for satellite characterization and vulnerability assessment. Continued to update assessment methodology by incorporating new data including results of laser illumination, tracking, and compensated imaging techniques. Assessed the survivability and vulnerability of aerospace systems to the effects of directed energy. Updated response databases for continued improvement of predictive avoidance analyses and provided data to U.S. Strategic Command for mission planning tool support and improved performance of Laser Clearinghouse functions.			
(U) In FY 2008: Explore new methods to develop and apply improved algorithms and hardware for satellite characterization and assessment. Continue to refine assessment methodology by incorporating new data into modeling tools, including results of laser illumination, tracking, and compensated imaging; and applying new techniques. Assess the survivability and vulnerability of evolving aerospace systems to the effects of directed energy weapons. Integrate developed space material properties and aging effects data and algorithms into assessments. Continue to improve and mature capabilities to rapidly fuse existing sensor data to assess the operational health and status of aerospace systems while working to begin transition of these capabilities to U.S. Strategic Command and other users.			
(U) In FY 2009: Expand analysis capabilities to provide assessments of effects on aerospace systems from new and emerging directed energy concepts. Continue to refine and broaden assessment methodologies by incorporating new experimental data from laser illumination, tracking, and compensated imaging; results of space materials properties and aging analysis; and enhanced numerical techniques. Continue support of operational mission planning tools, algorithms, predictive avoidance, and space situational awareness by updating and transitioning databases and assessment capabilities. Integrate and test advanced optical and infrared sensor systems with 3.5 meter telescope and second generation sodium beacon adaptive optics for dim space object tracking, detection, and imaging.			
(U) Total Cost	9.170	4.872	6.274

(U) C. Other Program Funding Summary (\$ in Millions)	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to</u>	<u>Total Cost</u>
	<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Complete</u>	
(U) Related Activities:									
(U) PE 0603444F, Maui Space Surveillance Systems.									
(U) PE 0603605F, Advanced Weapons Technology.									
(U) PE 0601108F, High Energy									

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

02 Applied Research

PE NUMBER AND TITLE

0602605F DIRECTED ENERGY
TECHNOLOGY

PROJECT NUMBER AND TITLE

55SP Laser and Imaging Space Tech

(U) C. Other Program Funding Summary (\$ in Millions)

Laser Research Initiatives.

(U) PE 0602890F, High Energy
Laser Research.(U) PE 0603924F, High Energy
Laser Advanced Technology
Program.(U) PE 0603883C, Ballistic Missile
Defense Boost Phase Segment.(U) PE 0602120A, Sensors and
Electronic Survivability.(U) PE 0602307A, Advanced
Weapons Technology.(U) PE 0602624A, Weapons and
Munitions Technology.(U) PE 0603004A, Weapons and
Munitions Advanced
Technology.(U) PE 0602114N, Power Projection
Applied Research.(U) PE 0602702E, Tactical
Technology.(U) PE 0603175C, Ballistic Missile
Defense Technology.(U) PE 0603883C, Ballistic Missile
Defense Boost Phase Segment.(U) PE 0602651M, Joint Non-Lethal
Weapons Applied Research.(U) PE 0602651M, Joint Non-Lethal
Weapons Applied Research.(U) This project has been
coordinated through the

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

02 Applied Research

PE NUMBER AND TITLE

0602605F DIRECTED ENERGY
TECHNOLOGY

PROJECT NUMBER AND TITLE

55SP Laser and Imaging Space Tech

(U) C. Other Program Funding Summary (\$ in Millions)

Reliance 21 process to
harmonize the efforts and
eliminate duplication.

(U) D. Acquisition Strategy

Not Applicable.

UNCLASSIFIED

PE NUMBER: 0602702F

PE TITLE: Command Control and Communications

Exhibit R-2, RDT&E Budget Item Justification	DATE February 2008
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BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602702F Command Control and Communications
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Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
Total Program Element (PE) Cost	125.791	121.417	109.492	123.122	109.536	124.772	127.275	Continuing	TBD
4519 Communications Technology	28.734	32.746	30.681	38.837	25.531	34.344	35.952	Continuing	TBD
4594 Information Technology	32.946	31.946	32.564	29.136	30.994	37.404	39.557	Continuing	TBD
5581 Command and Control (C2) Technology	48.236	39.620	36.256	46.508	44.126	43.062	41.917	Continuing	TBD
66SP Space Optical Network Tech	15.875	17.105	9.991	8.641	8.885	9.962	9.849	Continuing	TBD

Note: In FY 2007, Project 6266SP, Space Optical Network Technology, efforts were transferred from PE 0602500F, Multidisciplinary Space Technology, Project 5082, Optical Networking Technology, in order to more effectively manage and provide oversight of the efforts. FY 2008 funding totals do not include \$1.800 million FY 2008 GWOT requirements still pending Congressional consideration.

(U) A. Mission Description and Budget Item Justification

This program develops technology for Air Force Command, Control, and Communications (C3). Advances in C3 are required to increase warfighter readiness and effectiveness by providing the right information, at the right time, in the right format, anytime, anywhere in the world. The program has four projects. The Communication Technology project develops assured and secure communications technology, and the capability to attack and exploit adversarial information and information systems. The Information Technology project develops improved and automated capabilities to generate, process, fuse, exploit, interpret, and disseminate timely and accurate information. The Command and Control Technology project investigates and develops planning, assessment, and knowledge base technologies to allow the warfighter to plan, assess, execute, monitor, and re-plan on the complex, compressed time scales required for tomorrow's conflicts. The Space Optical Networking Technology project develops the technology base for the next generation of ultra-wide- bandwidth, multi-channelled, air and space-based communications networks on and between platforms. Note: In FY 2008, Congress added \$1.6 million for Adaptive Optics for Lasercom System, \$2.0 million for Compact Laser Terminal for Airborne Network Centric Warfare, and \$1.9 million for Cyber Attack Mitigation Lab. This program is Budget Activity 2, Applied Research, since it develops and determines the technical feasibility and military utility of evolutionary and revolutionary technologies.

Exhibit R-2, RDT&E Budget Item Justification

DATE

February 2008

BUDGET ACTIVITY

02 Applied Research

PE NUMBER AND TITLE

0602702F Command Control and Communications

(U) **B. Program Change Summary (\$ in Millions)**

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) Previous President's Budget	128.680	116.705	105.496
(U) Current PBR/President's Budget	125.791	121.417	109.492
(U) Total Adjustments	-2.889	4.712	
(U) Congressional Program Reductions		-0.011	
Congressional Rescissions		-0.777	
Congressional Increases		5.500	
Reprogrammings	-1.913		
SBIR/STTR Transfer	-0.976		
(U) <u>Significant Program Changes:</u>			
Not Applicable.			

C. Performance Metrics

(U) Under Development.

Exhibit R-2a, RDT&E Project Justification

DATE
February 2008

BUDGET ACTIVITY 02 Applied Research				PE NUMBER AND TITLE 0602702F Command Control and Communications			PROJECT NUMBER AND TITLE 4519 Communications Technology			
Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total	
4519 Communications Technology	28.734	32.746	30.681	38.837	25.531	34.344	35.952	Continuing	TBD	
Quantity of RDT&E Articles	0	0	0	0	0	0	0			

(U) A. Mission Description and Budget Item Justification

The Air Force requires technologies that enable assured, worldwide/theater, high capacity, communications and networking for Air Force Task Forces. These communication and networking technologies will provide capabilities for en-route and deployed distributed collaborative command, control, surveillance, reconnaissance and exploitation. A rapidly deployed force requires assured connectivity with reliable, responsive, affordable information exchange via all available communications media. This project provides the technologies for: multi-level, secure, seamless networks; advanced communications processors; anti-jam and low probability of intercept techniques; lightweight, phased array antennas; and modular, programmable, low-cost software radios. It includes technologies for advanced processors and devices, advanced network protocols and services, intelligent communications management and control, advanced communications algorithms, and enabling communication signal processing techniques.

(U) B. Accomplishments/Planned Program (\$ in Millions)

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) MAJOR THRUST: Develop assured and survivable information and networking technologies enabling worldwide command, control, surveillance, reconnaissance, and exploitation operations for the Air Force.	11.830	9.669	9.996
(U) In FY 2007: Completed development of capabilities for self-organizing, self-healing, autonomous networking. Developed policy-based network management technologies for real-time network response to changes in INFOCON levels. Developed and tested communications/resource network management schemas and sensor exploitation technologies enabling the dynamic integration of communications and sensor management functions for more effective moving target exploitation and fusion. Developed airborne content-based delivery networking (CBDN), synergistic with the Joint Tactical Radio System Wideband Networking Waveform's Network Service Layer, and applied to extremely dynamic infrastructure and network/platform mobility dictated by tactical aircraft.			
(U) In FY 2008: Continue development of policy-based network management technologies for real-time network response to changes in INFOCON levels. Continue development of airborne CBDN, synergistic with the Joint Tactical Radio System Wideband Networking Waveform's Network Service Layer, and apply to extremely dynamic airborne nets. Continue design and development of airborne network modeling and simulation technology. Initiate design and development of cognitive networking technology that senses operating environment, learns application requirements, and intelligently adapts network protocols. Initiate design and development of network operations and security capability to provide policy-based, mission-based, cross-domain, heterogeneous network quality of performance, security, configuration, and fault management in a net-centric environment. Develop and complete intelligent network management agents designed to monitor the airborne domain's handling of the flow of information from platform to platform through various interconnected communication nodes and links. Initiate			

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

02 Applied Research

PE NUMBER AND TITLE

0602702F Command Control and
Communications

PROJECT NUMBER AND TITLE

4519 Communications Technology

(U) **B. Accomplishments/Planned Program (\$ in Millions)**FY 2007FY 2008FY 2009

development of a resilient and self-regenerating information Network Centric Warfare enterprise that dynamically recognizes, characterizes, and understands novel cyber attacks and service anomalies, aids in the creation of synthetically diverse, functionally equivalent software, and continuously monitors, reconfigures, and self optimizes the mission critical enterprise to resist new attacks.

- (U) In FY 2009: Complete development of airborne CBDN, synergistic with the Joint Tactical Radio System Wideband Networking Waveform's Network Service Layer, and applies to extremely dynamic airborne nets. Continue design and development of airborne network modeling and simulation technology. Continue design and development of cognitive networking technology that senses operating environment, learns application requirements, and adapts network protocols. Complete development of policy-based network management technologies for real-time network response to changes in INFOCON levels. Continue design and development of network operations and security capability to provide policy based, mission based, cross domain, heterogeneous network quality of performance, security, configuration, and fault management. Initiate development of small hand-held multi-data rate, internet protocol compatible, covert network radios. Continue development of a resilient and self-regenerating information Network Centric Warfare enterprise that dynamically recognizes, characterizes, and understands novel cyber attacks and service anomalies, aids in the creation of synthetically diverse, functionally equivalent software, and continuously monitors, reconfigures, and self optimizes the mission critical enterprise to resist new attacks. Initiate development of secure data sharing to prevent the disclosure of sensitive information to untrustworthy users.

(U)

- (U) MAJOR THRUST: Develop improved, higher bandwidth communications and signal processing technologies to provide secure, adaptive, covert, anti-jam, and assured global battlespace connectivity to highly mobile aerospace forces, while reducing the equipment footprint.

4.618

4.329

3.704

- (U) In FY 2007: Completed first phase development of information assurance technologies that improve the robustness of the Global Information Grid in both wireline and wireless networks for air, space, ground, and joint/coalition environments to preclude information systems attacks. Demonstrated promising higher performance, adaptively combined multi-dimensional (space, time, frequency, coding, polarization) transmission techniques that enable high bandwidth information transmission and exploitation capabilities amongst airborne command and control, and intelligence, surveillance, and reconnaissance platforms, and various weapon delivery systems with their smart munitions. Tested and demonstrated a multi-mode, multi-function, sense-and-adapt air-mobile communications capability to dynamically alter communications methods under fast-changing environment within the framework of the Joint Tactical Radio System or compatible software defined radios. Developed and tested promising quantum key distribution and cryptography technologies to effect ultra-secure communications for wired and wireless

Exhibit R-2a, RDT&E Project Justification		DATE February 2008
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602702F Command Control and Communications	PROJECT NUMBER AND TITLE 4519 Communications Technology

(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
networks. Performed transition planning.			
(U) In FY 2008: Complete demonstration of adaptively combined multi-dimensional (space, time, frequency, coding, polarization) transmission techniques that enable high bandwidth information transmission and exploitation capabilities. Complete demonstration of multi-mode, multi-function, sense-and-adapt air-mobile communications capability to dynamically alter communications methods under fast-changing environment. Continue development of quantum key distribution and cryptography technologies to effect ultra-secure communications for wired and wireless networks. Initiate design and demonstration of assured access anti-jam communications capability that combines multi-dimensional (space, time, frequency, coding, polarization) transmission techniques, multi-frequency, multi wavelength, multi path techniques, and spectrum sense and adapt techniques. Initiate investigation to provide assured access (anti-jam) covert high capacity spectrum dominance for global networking while denying the adversary the same. Initiate development of scaleable video compression schemes which dynamically trade off bandwidth and quality based upon the priority of the required information. Initiate the development of advanced, automated, network and bandwidth management technologies to move, manage, and process information in real-time for the warfighter.			
(U) In FY 2009: Complete development of quantum key distribution and cryptography technologies to effect ultra-secure communications for wired and wireless networks. Continue design and demonstration of assured access anti jam communications capability that combines multi-dimensional (space, time, frequency, coding, polarization) transmission techniques, multi-frequency, multi-wavelength, multi-path techniques, and spectrum sense and adapt techniques. Continue the development of advanced, automated, network and bandwidth management technologies to move, manage, and process information in real-time for the warfighter.			
(U) MAJOR THRUST/CONGRESSIONAL ADD: Develop critical information transmission technologies to permit the seamless integration of aerospace weapon systems' C2, intelligence, surveillance, and reconnaissance data/information. Note: This effort includes Congressional Add funding of \$2.0 million in FY 2008.	2.091	3.494	1.489
(U) In FY 2007: Explored multiple technologies/techniques for tunable, high power radio frequency filtering to reduce overall radio frequency component equipment size, weight, and signal losses. Developed, tested, and assessed exploratory radio frequency and optical information transfer technologies.			
(U) In FY 2008: Complete development, test, and assessment of exploratory radio frequency and optical information transfer technologies. Continue to explore multiple technologies/techniques for tunable, high power radio frequency filtering to reduce overall radio frequency component equipment size, weight, and signal losses applicable to battlefield network operations. Conduct the Congressionally-directed Compact Laser Terminal for Airborne			

Exhibit R-2a, RDT&E Project Justification	DATE February 2008
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BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602702F Command Control and Communications	PROJECT NUMBER AND TITLE 4519 Communications Technology
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	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u>			
Network Centric Warfare to develop a compact, low power consumption wavelength tunable laser transmitter for free-space optical communications in an airborne network.			
(U) In FY 2009: Complete exploring multiple technologies/techniques for tunable, high power radio frequency filtering to reduce overall radio frequency component equipment size, weight, and signal losses applicable to battlefield network operations.			
(U) MAJOR THRUST/CONGRESSIONAL ADD: Develop cyber operations technologies for enabling worldwide command, control, communications and intelligence. Note: Increase in funding in FY 2008 and FY 2009 is due to emphasis on offensive cyber operations. Note: This effort includes Congressional Add funding of \$1.9 million in FY 2008.	7.741	13.654	15.492
(U) In FY 2007: Completed development of intrusion detection techniques for wireless networks. Developed automated capabilities for damage assessment and recovery. Developed techniques for defining defensive courses-of-action to counter adversary information warfare attacks. Developed defensive techniques for wireless, mobile, and embedded systems. Developed detection and eradication techniques for malicious code. Developed active response and computer network attack technologies. Developed advanced correlation fusion techniques for defensive course of action analysis. Conducted efforts in self-healing systems.			
(U) In FY 2008: Complete development of techniques for defining rapid defensive courses-of-action (COA) to counter adversary information warfare attacks. Continue to develop defensive techniques for wireless, mobile and embedded systems. Demonstrate detection and eradication techniques for malicious code. Complete development of advanced correlation fusion techniques for defensive course of action analysis. Complete efforts in self-healing systems. Initiate assured end-to-end Quality of Service (QoS) and Quality of Assurance (QoA) integration to the information system enterprise during malicious and non-malicious faults. Develop a prototype that will be able to model the unique aspects of an IP-based airborne network (e.g., aircraft communications, antennas, and networking components) against a variety of cyber threats with the end-goal of improving the overall defenses of the airborne network. Initiate development of access techniques allowing "cyber paths" to protected adversary information systems through a multiplicity of attack vectors. Initiate development of stealth and persistence technologies enabling continued operation within the adversary information network. Initiate programs to provide the capability to exfiltrate any and all types of information from compromised information systems enabling cyber intelligence gathering to achieve cyber awareness and understanding. Initiate technology programs to deliver D5 (deny, degrade, destroy, disrupt, and deceive) effects to the adversary information systems enabling integrated and synchronized cyber and traditional kinetic operations. Conduct Congressionally-directed Cyber Attack Mitigation Lab effort to			

Exhibit R-2a, RDT&E Project Justification	DATE February 2008
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BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602702F Command Control and Communications	PROJECT NUMBER AND TITLE 4519 Communications Technology
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	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u>			
develop malware detection and reverse engineering in order to provide a significant increase in understanding of malware, as well as protection to the Global Information Grid and other critical infrastructures..			
(U) In FY 2009: Initiate work in Cyber Command and Control for defensive cyber operations to achieve cyber awareness and understanding. Continue to develop defensive techniques for wireless, mobile, and embedded systems. Continue assured end-to-end Quality of Service (QoS) and Quality of Assurance (QoA) integration to the information system enterprise doing malicious and non-malicious faults. Initiate work in autonomic defensive response to rapidly recover from adversary cyber attacks. Continue development of information system access methods. Initiate efforts to propagate through adversary networks. Continue development of stealth and persistence technologies enabling network discovery, propagation to new locations, and data exfiltration/infiltration. Continue cyber intelligence gathering efforts to achieve cyber situational awareness and understanding. Continue cyber and traditional kinetic weapon integration technology development and initiate efforts for cyber delivery to influence operations effects.			
(U) CONGRESSIONAL ADD: Adaptive Optics Lasercom System.	2.454	1.600	0.000
(U) In FY2007: Developed and demonstrated reliable bi-directional ground and/or airborne lasercom communications link that automatically acquires and maintains itself in a seamless operation.			
(U) In FY2008: Continue the integration of the laser communications terminal into a Wescam turret and support an air to ground flight test scheduled for mid-2008. The flight test will validate the laser beam pointing, acquisition, and tracking; the laser communication terminal operation at altitude; and the performance of the adaptive optics in an airborne environment.			
(U) In FY2009: Not Applicable.			
(U) Total Cost	28.734	32.746	30.681

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to</u>	<u>Total Cost</u>
	<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Complete</u>	
(U) Related Activities:									
(U) PE 0603789F, C3I Advanced Development.									
(U) This project has been coordinated through the									

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

02 Applied Research

PE NUMBER AND TITLE

**0602702F Command Control and
Communications**

PROJECT NUMBER AND TITLE

4519 Communications Technology**(U) C. Other Program Funding Summary (\$ in Millions)**

Reliance 21 process to
harmonize efforts and eliminate
duplication.

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification

DATE
February 2008

BUDGET ACTIVITY 02 Applied Research				PE NUMBER AND TITLE 0602702F Command Control and Communications			PROJECT NUMBER AND TITLE 4594 Information Technology		
Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
4594 Information Technology	32.946	31.946	32.564	29.136	30.994	37.404	39.557	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

The Air Force requires technologies that improve and automate their capability to generate, process, manage, fuse, exploit, interpret, and disseminate timely and accurate information. This project improves global awareness at all levels, enabling warfighters to understand relevant military situations on a consistent basis with the timeliness and precision needed to accomplish their missions. Global awareness is achieved by exploiting information provided by the Air Force, other government agencies, and open source information. The information is fused to support the dynamic planning, assessment, and execution cycles via the global information enterprise. Knowledge, information, and data are all archived in the global information base for continued use and historical analysis. The information technologies required to achieve this capability are developed under this project in an affordable manner and include appropriate access mechanisms for our coalition partners. This project develops high-payoff embedded information systems technologies for the next generation of distributed information integration architectures to enable global information dominance and air and space superiority. The embedded information systems technologies provide affordable, innovative, secure, net-enabled embedded information systems to the warfighter.

(U) B. Accomplishments/Planned Program (\$ in Millions)

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) MAJOR THRUST: Develop innovative multi-sensor collaborative fusion technologies in a fully distributed air and space environment.	7.501	7.016	6.856
(U) In FY 2007: Evaluated fusion management and advanced the state-of-the-art in track-to-track fusion techniques. Developed the process of probabilistic identification through the use of multi-source fusion. Increased probabilistic confidence through the inclusion of higher-level fusion techniques in the situational assessment and process refinement area. Developed techniques to dynamically update advanced reasoning fusion engines to adapt to changing threat conditions. Developed intelligence, surveillance, and reconnaissance management techniques that optimize the fusion process for identification and continuous tracking of military significant threats. Evaluated network centric approaches to provide distributed fusion techniques to the warfighter.			
(U) In FY 2008: Evaluate fusion management and advance the state-of-the-art in track-to-track fusion techniques. Continue the process of probabilistic identification through the use of multi-source fusion. Continue to increase probabilistic confidence through the inclusion of higher-level fusion techniques in the situational assessment and process refinement area. Continue to develop techniques to dynamically update advanced reasoning fusion engines to adapt to changing threat conditions. Continue to develop intelligence, surveillance, and reconnaissance management techniques that optimize the fusion process for identification and continuous tracking of military significant threats. Evaluate network centric approaches to provide distributed fusion techniques to the warfighter. Develop new track algorithms that combine traditional kinematic associations with multi-INT (multiple types of			

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

02 Applied Research

PE NUMBER AND TITLE

0602702F Command Control and
Communications

PROJECT NUMBER AND TITLE

4594 Information Technology

(U) **B. Accomplishments/Planned Program (\$ in Millions)**FY 2007FY 2008FY 2009

intelligence) reasoning to improve the identification and track life times of ground moving targets; taking into account the limitations of gap times, dense target environments and large sensor data inaccuracies. Develop a set of algorithms that can automatically develop, reason, and dynamically update various sub-sets of the existing intelligence preparation of the battlespace products (e.g., named areas, target areas, COA, units, infrastructure areas, lines of communication). Initiate development of fused air, ground, and space information through machine-to-machine automatic fusion and dynamic re-tasking processes resulting in a single network centric operational picture. Processes to be examined include machine-to-machine automated multi-INT fusion, long-term automated tracking and ID of nominated targets, and automated/adaptive pattern recognition. Initiate investigation of Fusion of CybINT (Cyber Intelligence) with traditional INTs.

- (U) In FY 2009: Evaluate fusion management and advance the state-of-the-art in track-to-track fusion techniques. Complete the process of probabilistic identification through the use of multi-source fusion. Continue to increase probabilistic confidence through the inclusion of higher-level fusion techniques in the situational assessment and process refinement area. Complete the development of techniques to dynamically update advanced reasoning fusion engines to adapt to changing threat conditions. Complete the development and assessment of intelligence, surveillance, and reconnaissance management techniques that optimize the fusion process for identification and continuous tracking of military significant threats. Complete the development and assessment of network centric approaches to provide distributed fusion techniques to the warfighter. Continue the development of new track algorithms that combine traditional kinematic associations with multi-INT reasoning to improve the identification and track life times of ground moving targets; taking into account the limitations of gap times, dense target environments and large sensor data inaccuracies. Complete the development of a set of algorithms that can automatically develop, reason, and dynamically update various sub-sets of the existing intelligence preparation of the battlespace products (e.g., named areas, target areas, COA, units, infrastructure areas, lines of communication). Continue development of fused air, ground, and space information through machine-to-machine automatic fusion and dynamic re-tasking processes resulting in a single network centric operational picture. Processes to be examined include machine-to-machine automated multi-INT fusion, long-term automated tracking and ID of nominated targets, and automated/adaptive pattern recognition. Continue investigation of Fusion of CybINT with traditional INTs.

(U)

- (U) MAJOR THRUST: Develop higher-level fusion and the enabling information/knowledge base technologies to achieve situational awareness and understanding at all command levels for the dynamic planning, assessment, and execution processes.

6.618

7.272

9.145

- (U) In FY 2007: Enhanced techniques for interactive contextual reasoning with inference techniques for self-organizing

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

02 Applied Research

PE NUMBER AND TITLE

0602702F Command Control and
Communications

PROJECT NUMBER AND TITLE

4594 Information Technology

(U) **B. Accomplishments/Planned Program (\$ in Millions)**FY 2007FY 2008FY 2009

data repositories and content-based extraction to support identification of potential events in the world. Enhanced web-based search techniques, data filtering techniques, and information aggregation methods to take advantage of the explosion of available open source data on the Web required for rapid situational understanding. Developed inferencing techniques for reasoning about the situation and for predicting enemy intent and threat possibility.

- (U) In FY 2008: Complete enhancement of techniques for interactive contextual reasoning with inference techniques for self-organizing data repositories and content-based extraction to support identification of potential events in the world. Continue enhancement of web-based search techniques, data filtering techniques, and information aggregation methods to take advantage of the explosion of available open source data on the Web required for rapid situational awareness and understanding. Continue developing inferencing techniques for reasoning about the situation and for predicting adversarial intent and threat possibility. Develop a dynamic real-time information management capability with the objective of increasing the execution speeds of embedded high performance computers and enterprise infospheres by 100X. Initiate development of multi-source and automated recognition techniques to support analysis of current situations. Initiate development of technology demonstration plans for cyber situational awareness and understanding using an autonomous set of cooperative agents under positive control to defend mission critical Air Force assets. Initiate development of technology demonstration plans for active intelligence, surveillance, and reconnaissance (ISR) defense on wired networks to perform an adaptive response to multiple, coordinated, sustained attacks. Initiate research to forecast actionable futures to support a decision maker's ability to appraise and plan the "best" blue course of action for Rapid, Decide, Act, and Adapt. Initiate research to achieve the capability to analyze multiple COA having cascading effects in near real-time. The capability will be able to mix kinetic and non-kinetic options, continuously forecast the direct and indirect effects of each COA, and play COAs forward in time to identify key plan dependencies, decision points, and the foreclosure of options.

- (U) In FY 2009: Complete enhancement of web-based search techniques, data filtering techniques, and information aggregation methods to take advantage of the explosion of available open source data on the Web required for rapid situational awareness and understanding. Continue developing inferencing techniques for reasoning about the situation and for predicting enemy intent and threat possibility. Continue development of multi-source and automated recognition techniques to support analysis of current situations. Continue development of technology demonstration plans for cyber situational awareness and understanding using an autonomous set of cooperative agents under positive control to defend mission critical Air Force assets. Initiate development of technology demonstration plans for active ISR defense on wired networks to perform an adaptive response to multiple, coordinated, and sustained attacks. Continue research to achieve the capability to analyze multiple courses of action (COA) having cascading effects in near real-time. The capability will be able to mix kinetic and non-kinetic options,

Exhibit R-2a, RDT&E Project Justification	DATE February 2008
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BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602702F Command Control and Communications	PROJECT NUMBER AND TITLE 4594 Information Technology
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	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u>			
continuously forecast the direct and indirect effects of each COA, and play COAs forward in time to identify key plan dependencies, decision points, and the foreclosure of options. Continue research to forecast actionable futures to support a decision maker's ability to appraise and plan the "best" blue course of action for Rapid, Decide, Act, and Adapt. Complete the development of a set of algorithms that can automatically develop, reason, dynamically update various sub-sets of the existing intelligence preparation of the battlespace products (e.g., named areas, target areas, COA, units, infrastructure areas, lines of communication).			
(U) MAJOR THRUST: Develop automatic and dynamically reconfigurable, affordable, scalable, distributed petaflop processing technologies for real-time C2 global information systems.	4.680	6.232	7.035
(U) In FY 2007: Completed evaluation of architectural features for cognitive information processing. Developed algorithms for next generation information technologies for C2 systems. Developed architecture for cognitive information processing. Developed and characterized high performance computers for quantum computing applications. Initiated development and characterization of the next generation of high performance computers.			
(U) In FY 2008: Initiate implementation of architectural features for cognitive information processing. Continue algorithm development for next generation information technologies for C2 systems. Continue development and characterization of high performance computers for quantum computing applications. Continue development and characterization of the next generation of high performance computers. Develop a prototype chip that contains a hybrid architecture design, which will provide an emulation capability for large-scale cognitive architecture evaluations. Initiate the development of the tools, techniques, standards, and technologies required to build highly complex software-intensive systems.			
(U) In FY 2009: Continue implementation of architectural features for cognitive information processing. Complete algorithm development for next generation information technologies for C2 systems. Complete architectural development for cognitive information processing. Complete development and characterization of high performance computers for quantum computing applications. Continue development and characterization of the next generation of high performance computers. Complete the development of a prototype chip that contains a hybrid architecture design, which will provide an emulation capability for large-scale cognitive architecture evaluations. Continue the development of the tools, techniques, standards, and technologies required to build highly complex software-intensive systems. Initiate development of high capacity processing on demand, which will reduce the ever increasing amounts of raw data to actionable information. Provide hardware and system/support software that enables complex software to be readily composed.			

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

02 Applied Research

PE NUMBER AND TITLE

0602702F Command Control and
Communications

PROJECT NUMBER AND TITLE

4594 Information Technology

(U) **B. Accomplishments/Planned Program (\$ in Millions)**

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) MAJOR THRUST: Develop modeling and simulation technologies for the next generation of planning, assessment, and execution environments.	2.724	2.775	2.269
(U) In FY 2007: Demonstrated advanced modeling and simulation technologies to support next generation planning execution and assessment environments. Demonstrated adversarial behavior models and modeling techniques for course of action assessment and prediction. Conducted concept demonstrations of integrated interaction and assessment of friendly versus enemy courses of action. Demonstrated a prototypical dynamic situation assessment and prediction system. Investigated advanced concepts to provide approaches for a modeling toolset that enables the warfighter to build composable simulations.			
(U) In FY 2008: Complete demonstrations of advanced modeling and simulation technologies to support next generation planning, assessment, and execution environments. Continue to demonstrate adversarial behavior models and modeling techniques for COA assessment and prediction. Continue to conduct concept demonstrations of integrated interaction and assessment of friendly versus adversary courses of action. Continue to demonstrate a prototypical dynamic situation assessment and prediction system. Continue to investigate advanced concepts to provide approaches for a modeling toolset that enables the warfighter to build composable simulations. Initiate investigation of ability to forecast potential adversaries and events based on indications of known evidence and projected known and/or anticipated threat(s).			
(U) In FY 2009: Complete demonstrations of adversarial behavior models and modeling techniques for courses of action assessment and prediction. Continue to conduct concept demonstrations of integrated interaction and assessment of friendly versus adversary courses of action. Complete demonstration of a prototypical dynamic situation assessment and prediction system. Continue to investigate advanced concepts to provide approaches for a modeling toolset that enables the warfighter to build composable simulations. Continue investigation of ability to forecast potential adversaries and events based on indications of known evidence and projected known and/or anticipated threat(s).			
(U) MAJOR THRUST: Develop real-time embedded information system technologies for complex, time-critical, embedded systems to enable affordable design and development of state-of-the-art hardware and software, innovatively incorporate new capabilities, reactively adapt to multiple missions and changing environments, verify, validate, and assure functionality and integrity, and facilitate rapid insertion to support real-time, collaborative operations within a net-centric enterprise.	2.168	2.683	1.954
(U) In FY 2007: Developed dynamically reconfigurable aerospace systems using adaptive computing techniques to support image/video processing and data compression. Completed program to develop adaptive embedded computing technologies to support enhanced interoperability and information exchange between tactical C2			

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

02 Applied Research

PE NUMBER AND TITLE

0602702F Command Control and
Communications

PROJECT NUMBER AND TITLE

4594 Information Technology

(U) **B. Accomplishments/Planned Program (\$ in Millions)**FY 2007FY 2008FY 2009

platforms to support network centric operations, based on Real-Time Java and reconfigurable computing. Developed processes, methods, and techniques to provide assured performance, integrity, and security of real-time embedded information systems. Developed algorithms, methods, and processes to support real-time, adaptive resource management of system resources across multiple tactical platforms. Developed multi-level secure middleware for real-time embedded system architectures. Developed methods of computation and computing processes using biologically-inspired and biologically-based computation for embedded systems application. Developed power-aware, polymorphic aerospace systems for mission-aware computing.

(U) In FY 2008: Continue development of dynamically reconfigurable aerospace systems using adaptive computing techniques to support image/video processing and data compression. Continue development of affordable, high assurance architecture components for real-time embedded systems supporting Multi-Level Security/Multiple Single Levels of Security (MLS/MSLS) and mixed criticality. Continue development of methods of computation and computing processes using biologically-inspired and biologically-based computation for embedded systems application. Initiate development of power-aware, polymorphic aerospace systems for mission-aware computing.

(U) In FY 2009: Complete development of dynamically reconfigurable aerospace systems using adaptive computing techniques to support image/video processing and data compression. Complete development of affordable, high assurance components for real-time embedded systems supporting MLS/MSLS and mixed criticality. Complete development of methods of computation and computing processes using biologically-inspired and biologically-based computation for embedded systems application. Complete development of power-aware, polymorphic aerospace systems for mission-aware computing.

(U) MAJOR THRUST/CONGRESSIONAL ADD: Develop digital information exploitation technologies for electronic communications and special signals intelligence, imagery, and measurement signatures to increase accuracy, correlation, and timeliness of the information value to the decision maker. Note: This effort includes Congressional Add funding of \$1.5 million in FY 2007.

9.255

5.968

5.305

(U) In FY 2007: Completed first phase development of techniques in steganography, steganalysis, watermarking, and digital data forensics for imagery, video, and speech information protection and authentication, and intelligence exploitation. Developed the multi-intelligence toolsets for the processing, exploitation, and dissemination of actionable intelligence, including the development of measurement and signatures intelligence (MASINT) capability which integrates inputs from various sensors and visually display the critical MASINT information. Conducted Congressionally-directed effort for MASINT visualization tools.

(U) In FY 2008: Continue the development of the multi-intelligence toolsets for the processing, exploitation, and

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY
02 Applied Research

PE NUMBER AND TITLE
0602702F Command Control and Communications

PROJECT NUMBER AND TITLE
4594 Information Technology

(U) **B. Accomplishments/Planned Program (\$ in Millions)**

FY 2007

FY 2008

FY 2009

dissemination of actionable intelligence. Develop more effective multi-sensor signature exploitation algorithms to enhance detection (by 50%), identification (by 25%), and assessment (10X reduction in analyst time) of difficult targets; taking into account the complementary signature features (e.g., geo-physical, materials) that can be derived from multiple MASINT sensors. Develop algorithms to automatically detect and identify audio protection and channelization effects in modern modulated personal communications systems (PCS) with the goal of providing analysts the capability to automatically detect speech privacy and identify methods and means used.

(U) In FY 2009: Continue the development of the multi-intelligence the processing, exploitation, and dissemination of actionable intelligence. Complete the development of more effective multi-sensor signature exploitation algorithms to enhance detection (by 50%), identification (by 25%), and assessment (10X reduction in analyst time) of difficult targets; taking into account the complementary signature features (e.g., geo-physical, materials) that can be derived from multiple MASINT sensors. Complete the development to automatically detect and identify audio protection and channelization effects in modern modulated personal communications systems with the goal of providing analysts the capability to automatically detect speech privacy and identify methods and means used. Initiate development of methods and mechanisms to achieve robust/tamper-proof self-authenticating, self-regenerating code/data and detection and eradication systems for polymorphic malware. Research will include the detection and prevention of embedded malicious software (malware), system self-optimization/diagnosis/recovery, and the development of self-correcting watermarked code and data for trusted and optimized computing.

(U) Total Cost

32.946

31.946

32.564

(U) **C. Other Program Funding Summary (\$ in Millions)**

FY 2007
Actual

FY 2008
Estimate

FY 2009
Estimate

FY 2010
Estimate

FY 2011
Estimate

FY 2012
Estimate

FY 2013
Estimate

Cost to
Complete

Total Cost

(U) Related Activities:

(U) PE 0603789F, C3I Advanced Development.

(U) This project has been coordinated through the Reliance 21 process to harmonize efforts and eliminate duplication.

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

02 Applied Research

PE NUMBER AND TITLE

0602702F Command Control and
Communications

PROJECT NUMBER AND TITLE

4594 Information Technology

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification

DATE
February 2008

BUDGET ACTIVITY 02 Applied Research				PE NUMBER AND TITLE 0602702F Command Control and Communications			PROJECT NUMBER AND TITLE 5581 Command and Control (C2) Technology		
Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
5581 Command and Control (C2) Technology	48.236	39.620	36.256	46.508	44.126	43.062	41.917	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

The Air Force requires C2 technologies that will provide the next generation of weapon systems with improved processing and presentation of information for real-time, distributed battle management and control. Technologies in this project must be capable of taking advantage of future net-centric environments including new structured and ad hoc processes in response to rapidly changing warfare challenges. Technologies being developed will increase capability, quality, and information interoperability, while reducing the cost of C2 systems and infrastructure. Technology development in this project focuses on planning and assessing techniques knowledge bases, distributed information systems, and information management and distribution services. Advances in planning and assessment technologies will vastly improve the military decision making process within C2 systems. Advances in the ability to rapidly detect, classify, identify, and continuously track objects and events will improve the awareness and understanding and prediction of adversarial intentions, allowing the development of various courses of action to counter their intentions. Advances in the development of very large comprehensive knowledge bases to rapidly formulate and create new knowledge are needed by the Expeditionary Aerospace Force. Advances in distributed intelligent information systems will allow automatic rapid reconfiguration of C2 centers to respond to varying crisis levels, as required, by a Net-Centric Aerospace Force. Advances in robust information management and dissemination technologies will ensure the delivery of high-quality, timely, secure information to the warfighter.

(U) B. Accomplishments/Planned Program (\$ in Millions)

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) MAJOR THRUST: Investigate and develop technologies for the rapid development and application of next generation knowledge bases for aerospace C2 systems.	7.503	6.456	4.892
(U) In FY 2007: Completed development of technologies for the rapid development and application of next generation knowledge bases for aerospace C2 systems. Developed foundations, technology, and tools to enable effective, practical automated reasoning of the scale and complexity required for computers to perform complex tasks in the real-world requiring intelligence. Investigated and developed specialized cognitive architectures using self-aware, learning agents that can generate well-focused knowledge bases for automated intelligent extraction, correlation, and classification of link patterns for discovering relevant linkages between entities.			
(U) In FY 2008: Continue to develop foundations, technology, and tools to enable effective, practical automated reasoning of the scale and complexity required for computers to perform complex tasks in the real-world requiring intelligence. Continue to investigate and develop specialized cognitive architectures using self-aware, learning agents that can generate well-focused knowledge bases for automated intelligent extraction, correlation, and classification of link patterns for discovering relevant linkages between entities. Develop a prototype that will have the capability, given commander's policies and Rules of Engagement, to apply context-aware access control to			

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

02 Applied Research

PE NUMBER AND TITLE

0602702F Command Control and
Communications

PROJECT NUMBER AND TITLE

5581 Command and Control (C2)
Technology(U) **B. Accomplishments/Planned Program (\$ in Millions)**FY 2007FY 2008FY 2009

rapidly detect significant events and initiate reprioritization as required using operational databases and an available information management infrastructure. Initiate development of automated capture and self-organization of knowledge in globally distributed repositories.

- (U) In FY 2009: Continue to develop foundations, technology, and tools to enable effective, practical automated reasoning of the scale and complexity required for computers to perform complex tasks in the real-world requiring intelligence. Continue to investigate and develop specialized cognitive architectures using self-aware, learning agents that can generate well-focused knowledge bases for automated intelligent extraction, correlation, and classification of link patterns for discovering relevant linkages between entities.

(U)

- (U) MAJOR THRUST: Investigate, analyze, and develop technologies for automatic rapid reconfiguration of distributed intelligent information systems to varying crisis levels faced by the Expeditionary Aerospace Force.

13.222

10.174

9.939

- (U) In FY 2007: Developed dynamic and adaptable interface technology that allows commanders to create a mission-tailored view of the configuration and status of the currently executing Air Operations Center (AOC) C2 process. Developed advanced interactive displays suitable for rapid deployment in harsh environments with C2 applications and command centers. Developed advanced techniques and AOC-based applications for information visualization for use in conjunction with multiple, heterogeneous data sets. Developed technologies to improve the fidelity, accuracy, and interconnection of computer-based wargames used to prepare contingency plans and response strategies. Developed technologies for a holistic tool set that commanders can use to probe, study, analyze, visualize, reason, and predict activities in the battlespace.

- (U) In FY 2008: Complete the development of dynamic and adaptable interface technology that allows commanders to create a mission-tailored view of the configuration and status of the currently executing AOC C2 process. Continue to develop advanced interactive displays suitable for rapid deployment in harsh environments with C2 applications and command centers. Continue development of advanced techniques and AOC-based applications for information visualization for use in conjunction with multiple, heterogeneous data sets. Continue to develop technologies to improve the fidelity, accuracy, and interconnection of computer-based wargames used to prepare contingency plans and response strategies. Continue development of technologies for a holistic tool set that commanders can use to probe, study, analyze, visualize, reason, and predict activities in and around the battlespace. Develop an advanced mission planning process that will provide a self-healing, secure, rule-based automatic scheduling process that resembles an auction style planning capability. Initiate development of capabilities to be more agile within a net centric enabled environment. Develop timely option generation selection and coordination capabilities that account for uncertainty and missing and erroneous information, and supports intuitive decision making process between man

Exhibit R-2a, RDT&E Project Justification	DATE February 2008
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BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602702F Command Control and Communications	PROJECT NUMBER AND TITLE 5581 Command and Control (C2) Technology
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	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
<p>(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u></p> <p>and machine collaborating on complex, dynamic problems exploiting the respective strengths of machines (process lots of data) and human (analytical reasoning). Develop dynamic workflow and workload management capabilities to manage the command and control constellation of resources.</p>			
<p>(U) In FY 2009: Continue to develop advanced interactive displays suitable for rapid deployment in harsh environments with C2 applications and command centers. Continue development of advanced techniques and AOC-based applications for information visualization for use in conjunction with multiple, heterogeneous data sets. Continue to develop technologies to improve the fidelity, accuracy, and interconnection of computer-based wargames used to prepare contingency plans and response strategies. Continue development of technologies for a holistic tool set that commanders can use to probe, study, analyze, visualize, reason, and predict activities in the battlespace. Continue development of capabilities to be more agile within a net centric enabled environment. Continue the development of timely option generation selection and coordination capabilities that account for uncertainty and missing and erroneous information, and supports intuitive decision making process between man and machine collaborating on complex, dynamic problems exploiting the respective strengths of machines (process lots of data) and human (analytical reasoning). Continue the development of dynamic workflow and workload management capabilities to manage the command and control constellation of resources.</p>			
<p>(U) MAJOR THRUST: Investigate and develop technologies to securely share information via publish, subscribe, and query with coalition partners as part of the overall Global Information Grid approach. Sharing of information is in part a function of secure sharing, but is also a function of the managing of the information in assessing the trustworthiness of the information and its markup.</p>	9.074	7.707	6.649
<p>(U) In FY 2007: Completed development of techniques and tools that will ensure availability, integrity, and survivability of information within a coalition net-centric environment. Completed development of technology approaches to rapidly assimilate appropriate coalition partners into appropriate community of interest (COI) Infospheres. Completed investigation on performing and enforcing role-based access control to these COI Infospheres. Conducted cross-domain information sharing research and development to include collaborative monitoring and management of multi-national enterprise resources. Developed techniques and tools that will ensure availability, integrity, and survivability of information within a coalition net-centric environment. Investigated technologies, which can determine the pedigree of information in a coalition environment and assess the trustworthiness of the marked up information to be shared throughout the coalition. Investigated and prototyped the application of information fusion and information management technologies such as fuselets to extend composite views of events across a multi-domain enterprise into fused events. Developed publish/subscribe technologies for application to a</p>			

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

02 Applied Research

PE NUMBER AND TITLE

0602702F Command Control and
Communications

PROJECT NUMBER AND TITLE

5581 Command and Control (C2)
Technology(U) **B. Accomplishments/Planned Program (\$ in Millions)**FY 2007FY 2008FY 2009

content-based delivery networking (CBDN) system for intelligent network management of user information.

- (U) In FY 2008: Continue cross-domain information sharing research and development to include collaborative monitoring and management of multi-national enterprise resources. Continue development of techniques and tools that will ensure availability, integrity, and survivability of information within a coalition net-centric environment. Continue to investigate and prototype the application of information fusion and information management technologies such as fuselets to extend composite views of events across a multi-domain enterprise into fused events. Continue development of publish/subscribe/query technologies for application to a CBDN system for intelligent network management of user information. Initiate development of technologies to systematically integrate information sources across COIs.

- (U) In FY 2009: Complete cross-domain information sharing research and development to include collaborative monitoring and management of multi-national enterprise resources. Continue development of techniques and tools that will ensure availability, integrity, and survivability of information within a coalition net-centric environment. Continue to investigate technologies, which can determine the pedigree of information in a coalition environment and assess the trustworthiness of the marked up information to be shared throughout the coalition. Continue to investigate and prototype the application of information fusion and information management technologies such as fuselets to extend composite views of events across a multi-domain enterprise into fused events. Continue development of publish/subscribe/query technologies for application to a CBDN system for intelligent network management of user information.

- (U) MAJOR THRUST: Develop next generation monitoring, planning, execution, and assessment technologies and tools enabling distributed aerospace commanders to efficiently and collaboratively develop effects-based campaigns.

9.618

7.872

6.739

- (U) In FY 2007: Completed development of next generation of monitoring, planning, execution, and assessment technologies and tools enabling aerospace commanders to efficiently and collaboratively develop effects-based campaigns. Completed development of technologies to dynamically and rapidly assess the battlespace and provide near-real-time command of manned and unmanned forces to execute the required missions. Completed the incorporation of decision support science into C2 tools. Completed course of action analysis capability to allow collaboration between geographically remote locations. Investigated application of decision support sciences and advanced decision-making concepts to C2 activities within a Coalition AOC. Developed intelligent information systems capable of supporting joint/coalition C2 for various missions in a dynamically changing environment. Developed tools to increase situational awareness through intelligent information processing. Applied system of systems and federation of systems engineering in the creation of joint C2 capabilities. Explored the application of

Exhibit R-2a, RDT&E Project Justification		DATE February 2008		
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602702F Command Control and Communications	PROJECT NUMBER AND TITLE 5581 Command and Control (C2) Technology		
		<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
<p>(U) B. Accomplishments/Planned Program (\$ in Millions)</p> <p>intelligent software agents as virtual battle staff members to enhance various C2 processes. Developed and demonstrated an effects-based dynamic tasking process enabled by dynamically accessible data and information services.</p>				
<p>(U) In FY 2008: Continue to investigate application of decision support sciences and advanced decision-making concepts to C2 activities within a Coalition AOC. Continue to develop intelligent information systems capable of supporting joint/coalition C2 for various missions in a dynamically changing environment. Continue to develop tools to increase situational awareness and understanding through intelligent information processing. Continue the application of system-of-systems and federation-of-systems engineering in the creation of joint C2 capabilities. Continue to explore the application of intelligent software agents as virtual battle staff members to enhance various C2 processes. Complete the development and demonstration of an effects-based dynamic tasking process enabled by dynamically accessible data and information services. Initiate development of capability for a full-spectrum analysis for effects attainment at all levels of a campaign, linking leading indicators to desired and undesirable effects. The capability will utilize causal reasoning, linking effects to actions to desired end-state, will develop non-deterministic, non-linear causal linkages, and will be capable of reasoning through uncertainty and ambiguity. Initiate research to achieve the ability to predict the current and future impact of an adversary cyber attack on Air Force information systems. Develop effects-based defense models to help predict the 1st and 2nd order impact of cyber attacks on an information system/mission. Develop Cyber defense containment scenarios that minimize current and future adversary impact to net-centric warfare (NCW) mission.</p>				
<p>(U) In FY 2009: Continue to investigate application of decision support sciences and advanced decision-making concepts to C2 activities within a Coalition AOC. Continue to develop intelligent information systems capable of supporting joint/coalition C2 for various missions in a dynamically changing environment. Continue to develop tools to increase situational awareness and understanding through intelligent information processing. Continue the application of system-of-systems and federation-of-systems engineering in the creation of joint C2 capabilities. Continue to explore the application of intelligent software agents as virtual battle staff members to enhance various C2 processes. Continue the development of capability for a full-spectrum analysis for effects attainment at all levels of a campaign, linking leading indicators to desired and undesirable effects. The capability will utilize causal reasoning, linking effects to actions to desired end-state, will develop non-deterministic, non-linear causal linkages, and will be capable of reasoning through uncertainty and ambiguity.</p>				
<p>(U) MAJOR THRUST: Investigate and develop technologies to implement flexible, high performance, secure, scalable, and survivable information management and dissemination services to enable a Global Information Grid-based COI</p>		2.113	2.016	1.898

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

02 Applied Research

PE NUMBER AND TITLE

0602702F Command Control and
Communications

PROJECT NUMBER AND TITLE

5581 Command and Control (C2)
Technology(U) **B. Accomplishments/Planned Program (\$ in Millions)**FY 2007FY 2008FY 2009

Infosphere.

- (U) In FY 2007: Completed investigation in the use of semantic markup and semantic web languages as part of the COI Infosphere. Completed investigation of technology and approaches to prioritizing information in a COI Infosphere so as to effectively utilize communication and computing resources. Developed high-payoff publish, subscribe, and query laboratory prototypes, which provide higher levels of performance, security, and scalability capable of exceeding commercial products and support Air Force net-centric environment needs. Investigated automated methods of tailoring the user perspective of the COI Infosphere to reduce information overload and increase information awareness and utilization. Developed technology and techniques to monitor, obtain feedback, and assert control over the COI Infosphere. Investigated the security policy enforcement between COI Infospheres at various levels of security classification. Investigated methods and techniques for dynamically evolving the netcentric environment so as to avoid system crashes or latency as new information sources arrive or depart the environment.
- (U) In FY 2008: Continue to develop high-payoff publish, subscribe, and query laboratory prototypes, which provide higher levels of performance, security, and scalability capable of exceeding commercial products and support Air Force net-centric environment needs. Continue to investigate automated methods of tailoring the user perspective of the COI Infosphere to reduce information overload and increase information awareness and utilization. Continue to develop technology and techniques to monitor, obtain feedback, and assert control over the COI Infosphere. Continue to investigate the security policy enforcement between COI Infospheres at various levels of security classification. Continue to investigate methods and techniques for dynamically evolving the net-centric environment so as to avoid system crashes or latency as new information sources arrive or depart the environment. Initiate decentralization and fault tolerant information management services for the tactical environment. Initiate development of information transformation services and adaptive information management services that learn, self-configure, self-manage, and are self-healing. Initiate a study on collaboration services on demand that will exploit dynamic information services matching end user devices (laptops, cell phones, etc.) with appropriate information formats.
- (U) In FY 2009: Continue to develop high-payoff publish, subscribe, and query laboratory prototypes, which provide higher levels of performance, security, and scalability capable of exceeding commercial products and support Air Force net-centric environment needs. Develop the security policy enforcement between COI Infospheres at various levels of security classification. Investigate methods and techniques for dynamically evolving the net-centric environment so as to avoid system crashes or latency by exploiting information technologies based on Quality of Service mechanism. Initiate integration of information services across operational boundaries and dissimilar infrastructure based systems. Continue development of information transformation services and adaptive

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Exhibit R-2a, RDT&E Project Justification		DATE February 2008		
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602702F Command Control and Communications	PROJECT NUMBER AND TITLE 5581 Command and Control (C2) Technology		
(U) B. Accomplishments/Planned Program (\$ in Millions)	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	
information management services that learn, self-configure, self-manage, and are self-healing.				
(U) MAJOR THRUST/CONGRESSIONAL ADD: Develop distributed collaboration technologies, advance collaboration science, virtual environments, and predictive simulation tools to facilitate the development and fielding of next generation operational collaborative decision support systems. This effort includes Congressional Add funding of \$1.0 million in FY 2007.	6.706	5.395	6.139	
(U) In FY 2007: Developed advanced information technologies for collaborative decision-making and knowledge management in support of capability-based planning and next generation planning, execution, and assessment environments, including data exchange protocols, access privileges and data access. Prototyped distributed collaborative environment technologies for advanced decision support for high-profile system concepts, such as the Global Strike Concept of Operations and operations other than war. Conducted Congressionally directed effort for Advanced Collaborative Platform for Net-Centric Command and Control (C2).				
(U) In FY 2008: Continue development of advanced information technologies for collaborative decision-making and knowledge management in support of capability-based planning and next generation planning, execution, and assessment environments. Continue to prototype distributed collaborative environment technologies for advanced decision support for high-profile system concepts, such as the Global Strike Concept of Operations and operations other than war. Initiate a study on collaboration services on demand that will exploit dynamic information services matching end user devices (laptops, cell phones, etc.) with appropriate information formats. Support context aware collaborative user interfaces and semantic interoperability.				
(U) In FY 2009: Complete development of advanced information technologies for collaborative decision-making and knowledge management in support of capability-based planning and next generation planning, execution, and assessment environments. Complete prototyping distributed collaborative environment technologies for advanced decision support for high-profile system concepts, such as the Global Strike Concept of Operations and operations other than war. Continue study on collaboration services on demand that will exploit dynamic information services matching end user devices (laptops, cell phones, etc.) with appropriate information formats. Support context aware collaborative user interfaces and semantic interoperability.				
(U) Total Cost	48.236	39.620	36.256	

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY
02 Applied Research

PE NUMBER AND TITLE
0602702F Command Control and Communications

PROJECT NUMBER AND TITLE
5581 Command and Control (C2) Technology

(U) **C. Other Program Funding Summary (\$ in Millions)**

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to</u>	<u>Total Cost</u>
	<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Complete</u>	

(U) Related Activities:

(U) PE 0603617F, C3 Applications.

(U) PE 0303401F,
Communications-Computer
Systems (C-CS) Security
RDT&E.

(U) PE 0603789F, C3I Advanced
Development.

(U) This project has been
coordinated through the
Reliance 21 process to
harmonize efforts and eliminate
duplication.

(U) **D. Acquisition Strategy**

Not Applicable.

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY 02 Applied Research				PE NUMBER AND TITLE 0602702F Command Control and Communications			PROJECT NUMBER AND TITLE 66SP Space Optical Network Tech			
Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total	
66SP Space Optical Network Tech	15.875	17.105	9.991	8.641	8.885	9.962	9.849	Continuing	TBD	
Quantity of RDT&E Articles	0	0	0	0	0	0	0			

Note: In FY 2007, Project 6266SP, Space Optical Network Technology, efforts were transferred from PE 0602500F, Multidisciplinary Space Technology, Project 5082, Optical Networking Technology, in order to more effectively manage and provide oversight of the efforts.

(U) **A. Mission Description and Budget Item Justification**

This project develops the technology base for the next generation of ultra-wide bandwidth, multi-channelled, air- and space-based communications networks on and between platforms. As the application of laser-based, point-to-point communications between satellites emerges, air- and space-based optical networks, whose communications capacities are thousands of times greater than current communications satellites, become a realistic possibility. This project will assess and adapt the emerging communication and information technologies, for applications in air and space. This project will explore technologies for implementing photonic chip scale optical Code Division Multiple Access (CDMA) and Wavelength Division Multiplexed (WDM) transceivers and prototype networks, built to demonstrate the benefits associated with the advanced fiber optic, wireless, platform, and satellite networks that can be built from them. This project will develop and demonstrate technology to integrate current Radio Frequency (RF) with high data rate Optical Laser communications, along with network management techniques, tools and software to support them. These technologies have potential applications in specific military systems including reliable, high bandwidth, jam-resistant communications at the theater level, and multiplexing of multiple DoD users onto a common networking infrastructure for reduced manning and logistics.

(U) **B. Accomplishments/Planned Program (\$ in Millions)**

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) MAJOR THRUST: Develop and assess optical network technologies for application in the space environment.	1.510	1.510	2.976
(U) In FY 2007: Completed demonstration of highly integrated multi-gigabit optical network with 4 x 4 optical data router and optical backbone interface chips. Initiated demonstration of highly integrated multi-gigabit optical network with 16 x 16 optical data router and optical backbone interface chips.			
(U) In FY 2008: Complete demonstration of 16 x 16 optical data router and optical backbone interface chips for integration with on board Integrated Core Processor. Initiate design and development of 40 channel multi-wavelength optical network for on-board air and space applications			
(U) In FY 2009: Continue development of 40 channel multi wavelength optical network for on-board air and space applications.			
(U) MAJOR THRUST/CONGRESSIONAL ADD: Develop and assess existing and emerging Optical CDMA and WDM modulation schemes and protocols for use in space-based optical networks. NOTE: This thrust contains \$1.1 million in Congressional Add funding in FY 2007.	4.045	3.551	1.803
(U) In FY 2007: Designed and developed optical burst switching and optical label switching protocols for applicability to air- and space-based optical networks. Conducted flight demonstration of industry standard single mode optical			

Exhibit R-2a, RDT&E Project Justification		DATE February 2008		
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602702F Command Control and Communications	PROJECT NUMBER AND TITLE 66SP Space Optical Network Tech		
(U) B. Accomplishments/Planned Program (\$ in Millions)		<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) communications bus interface chip for airborne platforms. Developed and demonstrated a compact, highly integrated optical interconnect for space-based optical networking through research placing greater emphasis on WDM rather than spatial parallelism. Conducted Congressionally-directed effort for Massively Parallel Optical Interconnects.				
(U) In FY 2008: Continue design and development of optical burst switching and optical label switching protocols for applicability to air- and space-based optical networks. Complete flight demonstration of industry standard single mode optical communications bus interface chip for airborne platforms				
(U) In FY 2009: Initiate flight demonstration of multi-gigabit, multi-wavelength optical communications bus interface chip for space and air platforms.				
(U)				
(U) MAJOR THRUST/CONGRESSIONAL ADD: Develop and demonstrate heterogeneous, seamless, secure, self-configuring high capacity air/space/surface wireless networks that integrate current RF with high data rate Optical Laser communications. NOTE: This thrust contains \$1.6 million in Congressional Add funding in FY 2007.		8.163	12.044	5.212
(U) In FY 2007: Designed and developed waveform, coding, management, and atmospheric mitigation technologies for a combined RF/laser communications terminal. Demonstrated development of industry standard single mode optical communications bus for airborne platforms and air-to-air or air-to-ground RF and laser networked communication. Developed and demonstrated a tunable chirp managed, directly modulated laser transmitter for extremely high data rates in free space optical communications. Conducted Congressionally-directed effort for Digital Free-Space Optical Laser Transmitter Modems.				
(U) In FY 2008: Complete the characterization of the combiner RF/laser communications brassboard. Design and develop higher throughput RF waveform data link technology for operation under adverse weather conditions. Conduct flight demonstration of combined RF/laser communications brassboard in cooperation with the demonstration of advanced airborne sensor technologies.				
(U) In FY 2009: Complete the development and start the characterization of higher throughput RF waveform data link technology for operation under adverse weather conditions. Initiate the design of an integrated RF/laser communications airborne qualifiable brassboard.				
(U)				
(U) CONGRESSIONAL ADD: Space Qualified Common Data Link.		2.157	0.000	0.000
(U) In FY2007: Developed space qualified Common Data Link hardware, and extend the performance of the hardware to ensure the hardware will have an environmental robustness to operate in the space environment.				
(U) In FY2008: Not Applicable.				

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY
02 Applied Research

PE NUMBER AND TITLE
0602702F Command Control and Communications

PROJECT NUMBER AND TITLE
66SP Space Optical Network Tech

(U) **B. Accomplishments/Planned Program (\$ in Millions)**

(U) In FY2009: Not Applicable.

(U)

(U) Total Cost

FY 2007

FY 2008

FY 2009

15.875

17.105

9.991

(U) **C. Other Program Funding Summary (\$ in Millions)**

FY 2007
Actual

FY 2008
Estimate

FY 2009
Estimate

FY 2010
Estimate

FY 2011
Estimate

FY 2012
Estimate

FY 2013
Estimate

Cost to
Complete

Total Cost

(U) Related Activities:

(U) PE 0603789F, C3I Advanced Development.

(U) This project has been coordinated through the Reliance 21 process to harmonize efforts and eliminate duplication.

(U) **D. Acquisition Strategy**

Not Applicable.

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PE NUMBER: 0602890F
 PE TITLE: High Energy Laser Research

Exhibit R-2, RDT&E Budget Item Justification	DATE February 2008
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BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602890F High Energy Laser Research
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Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
Total Program Element (PE) Cost	55.580	49.949	49.449	53.561	54.558	55.434	54.855	Continuing	TBD
5096 High Energy Laser Research	55.580	49.949	49.449	53.561	54.558	55.434	54.855	Continuing	TBD

(U) A. Mission Description and Budget Item Justification

This program funds Department of Defense (DoD) high energy laser (HEL) applied research through the HEL Joint Technology Office (JTO). HEL weapon systems have many potential advantages, including speed-of-light delivery, precision target engagement, significant magazine depth, low-cost per kill, and reduced logistics requirements. HELs have the potential to perform a wide variety of military missions including interception of ballistic missiles in boost phase; defeat of high-speed, maneuvering anti-ship and anti-aircraft missiles; and the ultra-precision negation of targets in urban environments with no/little collateral damage. In general, efforts funded under this program are chosen for their potential to have an impact on multiple HEL systems and multiple Service missions while complimenting Service/Agency programs that are directed at specific Service needs. A broad range of technologies are addressed in key areas such as chemical lasers, solid state lasers, free electron lasers, laser beam control, and laser lethality mechanisms. This program is part of an overall DoD HEL Science and Technology program. This program is in Budget Activity 2, Applied Research, since it develops and determines the technical feasibility and military utility of evolutionary and revolutionary technologies.

(U) B. Program Change Summary (\$ in Millions)

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) Previous President's Budget	52.136	50.303	51.159
(U) Current PBR/President's Budget	55.580	49.949	49.449
(U) Total Adjustments	3.444	-0.354	
(U) Congressional Program Reductions		-0.035	
Congressional Rescissions		-0.319	
Congressional Increases			
Reprogrammings	4.850		
SBIR/STTR Transfer	-1.406		

(U) Significant Program Changes:

Not Applicable.

C. Performance Metrics

Under Development.

Exhibit R-2a, RDT&E Project Justification

DATE
February 2008

BUDGET ACTIVITY 02 Applied Research				PE NUMBER AND TITLE 0602890F High Energy Laser Research			PROJECT NUMBER AND TITLE 5096 High Energy Laser Research			
Cost (\$ in Millions)		FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
5096	High Energy Laser Research	55.580	49.949	49.449	53.561	54.558	55.434	54.855	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This program funds Department of Defense (DoD) high energy laser (HEL) applied research through the HEL Joint Technology Office (JTO). HEL weapon systems have many potential advantages, including speed-of-light delivery, precision target engagement, significant magazine depth, low-cost per kill, and reduced logistics requirements. HELs have the potential to perform a wide variety of military missions including interception of ballistic missiles in boost phase; defeat of high-speed, maneuvering anti-ship and anti-aircraft missiles; and the ultra-precision negation of targets in urban environments with no/little collateral damage. In general, efforts funded under this program are chosen for their potential to have an impact on multiple HEL systems and multiple Service missions while complimenting Service/Agency programs that are directed at specific Service needs. A broad range of technologies are addressed in key areas such as chemical lasers, solid state lasers, free electron lasers, laser beam control, and laser lethality mechanisms. This program is part of an overall DoD HEL Science and Technology program. This program is in Budget Activity 2, Applied Research, since it develops and determines the technical feasibility and military utility of evolutionary and revolutionary technologies.

(U) B. Accomplishments/Planned Program (\$ in Millions)

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) MAJOR THRUST: Advance solid-state laser development.	14.027	10.271	9.224
(U) In FY 2007: Participated in the 100 kilowatt Joint High Power Solid State Laser (JHPSSL) demonstrations. Analyzed successful efforts from applied research projects (e. g. long-life diode laser drivers, thin-disc amplifiers, and fiber laser amplifiers) for future advanced demonstration of solid state laser systems.			
(U) In FY 2008: Continue to participate in the 100 kilowatt JHPSSL project. Provide independent government-sponsored measurements of the 100 kilowatt lasers. Participate in planning for a joint high-power beam director suitable for mating with a JHPSSL device.			
(U) In FY 2009: Participate in the 100 kilowatt laboratory demonstrations. Continue participation in the joint development of a high-power beam director suitable for mating with a 100 kilowatt JHPSSL device.			
(U) MAJOR THRUST: Mature technologies that will provide system level performance commensurate with fieldable solid-state laser devices.	7.733	8.232	8.456
(U) in FY 2007: Developed technology that will lead to improved laser gain material and single mode fibers suitable for beam combination. Improved the efficiency and reliability of diode pump sources. Conducted Service and Agency proposal call for FY 2007, funded eight projects.			
(U) In FY 2008: Develop technology that will lead to improved fieldability, serviceability, and ruggedness. Develop power scaling architectures with good beam quality and suitable mass and weight. Conduct an industry proposal call			

UNCLASSIFIED

Exhibit R-2a, RDT&E Project Justification		DATE February 2008		
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602890F High Energy Laser Research	PROJECT NUMBER AND TITLE 5096 High Energy Laser Research		
<u>B. Accomplishments/Planned Program (\$ in Millions)</u>		<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) for FY 2008.				
(U) In FY 2009: Develop technology that will lead to improved fieldability, serviceability, and ruggedness. Develop power scaling architectures with good beam quality and suitable mass and weight. Improve the efficiency and reliability of diode pump sources. Investigate eye-safer laser technologies. Conduct Service and Agency proposal call for FY 2009.				
(U)				
(U)	MAJOR THRUST: Investigate new technologies that have revolutionary potential for HEL applications.	2.189	2.411	2.423
(U)	In FY 2007: Explored novel laser technologies to increase efficiency and decrease mass/volume. Integrated short-pulse laser technology into this initiative. Conducted a Service and Agency proposal call for FY 2007, funded three projects.			
(U)	In FY 2008: Explore novel laser technologies to increase efficiency and decrease mass/volume. Conduct an industry proposal call for FY 2008.			
(U)	In FY 2009: Explore novel laser technologies to increase efficiency and decrease mass/volume. Conduct a Service and Agency proposal call for FY 2009.			
(U)				
(U)	MAJOR THRUST: Explore free electron lasers (FEL) that have potential in future HEL weapons. Conduct system level technology development and trade studies to facilitate scaling FELs to weapons-class power levels and shipboard integration.	9.463	9.674	9.923
(U)	In FY 2007: Demonstrated high average current photocathode and injector capability, suitable beam-breakup thresholds, and power scaling of the optical resonator. Continued component testing with the 14 kilowatt device to define a development path for scaling to 100 kilowatts. Conducted a Service and Agency proposal call for FY 2007, funded six projects.			
(U)	In FY 2008: Continue to investigate the development path for scaling to a 100 kilowatt lab demonstration. Conduct an industry proposal call for FY 2008.			
(U)	In FY 2009: Continue to investigate the development path for scaling to a 100 kilowatt lab demonstration. Conduct a Service and Agency proposal call for FY 2009.			
(U)				
(U)	MAJOR THRUST: Conduct technology experiments to select promising chemical generator and chemical regeneration technologies that can be scaled for weapons application.	7.303	5.690	5.957
(U)	In FY 2007: Demonstrated closed-cycle chemical oxygen-iodine laser device. Demonstrated electric-oxygen pumping schemes to minimize the chemistry. Developed electric-gas phase laser generation technologies.			

UNCLASSIFIED

Exhibit R-2a, RDT&E Project Justification		DATE February 2008		
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602890F High Energy Laser Research	PROJECT NUMBER AND TITLE 5096 High Energy Laser Research		
		<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) B. Accomplishments/Planned Program (\$ in Millions)				
Conducted a Service and Agency proposal call for FY 2007, funded four projects.				
(U) In FY 2008: Investigate closed-cycle chemical lasers. Explore novel concepts on electric-gas phase laser generation.				
Conduct an industry proposal call for FY 2008.				
(U) In FY 2009: Investigate closed-cycle chemical lasers. Explore novel concepts on electric-gas phase laser generation.				
Conduct a Service and Agency proposal call for FY 2009.				
(U)				
(U) MAJOR THRUST: Develop technology to support high performance beam control systems and integrated demonstrations.		8.918	9.615	9.460
(U) In FY 2007: Developed beam control technologies, such as an all-fiber laser with conformal apertures and active controls for boundary layer mitigation. Demonstrated atmospheric compensation technologies. Conducted a Service and Agency proposal call for FY 2007, funded eight projects.				
(U) In FY 2008: Develop/provide beam control technology options for laser weapon use on multiple platforms (aircraft, ground vehicles and shipboard systems). Conduct an industry proposal call for FY 2008.				
(U) In FY 2009: Participate in a joint high-power beam director development effort, suitable for mating with a 100 kilowatt JHPSSL laser device. Develop/provide beam control technology options for laser weapon use on multiple platforms (aircraft, ground vehicles and shipboard systems). Explore advanced component and control techniques for difficult environments such as high speed flight, high turbulence, and extended ranges. Conduct a Service and Agency proposal call for FY 2009.				
(U)				
(U) MAJOR THRUST: Develop a lethality database, and integrate it into a systems-level architecture plan.		3.814	4.056	4.006
(U) In FY 2007: Cataloged existing lethality databases for common use. Developed an architecture plan to consolidate and compare historical data. Initiated laser systems inputs for the Joint Munitions Effect Manual.				
(U) In FY 2008: Integrate lethality data into campaign-level HEL system models. Develop laser systems inputs for the Joint Munitions Effect Manual.				
(U) In FY 2009: Integrate lethality data into campaign-level HEL system models. Develop databases that will be accepted by the HEL community and integrate in validated models for laser systems designers. Develop laser systems inputs for the Joint Munitions Effect Manual.				
(U)				
(U) CONGRESSIONAL ADD: Air Laser Technology Development.		2.133	0.000	0.000
(U) In FY 2007: Investigated production of oxygen deltslets through electric pumping.				
(U) In FY 2008: Not Applicable.				

Exhibit R-2a, RDT&E Project Justification	DATE February 2008
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BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602890F High Energy Laser Research	PROJECT NUMBER AND TITLE 5096 High Energy Laser Research
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(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) In FY 2009: Not Applicable.			
(U) Total Cost	55.580	49.949	49.449

(U) <u>C. Other Program Funding Summary (\$ in Millions)</u>		<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to</u>	<u>Total Cost</u>
		<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Complete</u>	
(U) PE 0601108F, High Energy Laser Research Initiatives.										
(U) PE 0603444F, Maui Space Surveillance System.										
(U) PE 0603605F, Advanced Weapons Technology.										
(U) PE 0603924F, High Energy Laser Advanced Technology Program.										
(U) PE 0603883C, Ballistic Missile Defense Boost Phase Segment.										
(U) PE 0602605F, Directed Energy Technology.										
(U) PE 0602307A, Advanced Weapons Technology.										
(U) PE 0602114N, Power Projection Applied Research.										
(U) PE 0602120A, Sensors and Electronic Survivability.										
(U) PE 0603004A, Weapons and Munitions Advanced Technology.										
(U) PE 0602702E, Tactical Technology.										
(U) PE 0603175C, Ballistic Missile Defense Technology.										

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

02 Applied Research

PE NUMBER AND TITLE

**0602890F High Energy Laser
Research**

PROJECT NUMBER AND TITLE

5096 High Energy Laser Research**(U) C. Other Program Funding Summary (\$ in Millions)****(U)** PE 0602651M, Joint Non-Lethal
Weapons Applied Research.**(U)** PE 0603651M, Joint Non-Lethal
Weapons Technology
Development.**(U)** This project has been
coordinated through the
Reliance process to harmonize
efforts and eliminate duplication.**(U) D. Acquisition Strategy**

Not Applicable.

UNCLASSIFIED

PE NUMBER: 0603112F
 PE TITLE: Advanced Materials for Weapon Systems

Exhibit R-2, RDT&E Budget Item Justification	DATE February 2008
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BUDGET ACTIVITY 03 Advanced Technology Development (ATD)	PE NUMBER AND TITLE 0603112F Advanced Materials for Weapon Systems
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Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
Total Program Element (PE) Cost	83.546	54.871	41.926	45.030	43.904	46.278	46.165	Continuing	TBD
2100 Laser Hardened Materials	32.202	25.443	24.152	28.162	29.300	30.491	30.452	Continuing	TBD
3153 Non-Destructive Inspection Development	16.657	7.424	4.185	4.335	4.393	4.749	4.705	Continuing	TBD
3946 Materials Transition	15.652	11.268	4.459	6.654	4.242	4.584	4.512	Continuing	TBD
4918 Deployed Air Base Demonstrations	13.919	6.374	5.918	2.550	2.592	2.802	2.876	Continuing	TBD
77SP Advanced Space Materials	5.116	4.362	3.212	3.329	3.377	3.652	3.620	Continuing	TBD

Note: FY 2008 funding totals do not include \$5.9 million FY 2008 GWOT requirements still pending Congressional consideration.

(U) A. Mission Description and Budget Item Justification

This program develops and demonstrates materials technology for transition into Air Force systems. The program has five projects which develop: (1) hardened materials technologies for the protection of aircrews and sensors; (2) non-destructive inspection and evaluation technologies; (3) transition data on structural and non-structural materials for aerospace applications; (4) airbase operations technologies including deployable base infrastructure, force protection, and fire fighting capabilities; and (5) advanced materials for space applications. Note: In FY 2008, Congress added \$1.2 million for Continuous Integrated Vehicle Health Monitoring System, \$1.0 million for Encapsulated Ballistic Protection System (EBPS), \$1.0 million for Coated Field Repair (2K Gun), \$1.6 million for EMI Grid Fabrication Technology, \$2.0 million for Aircraft Evaluation Readiness Initiative (AERI), \$5.0 million for Metals Affordability Initiative, \$1.6 million for Strategic Bio-fuels Supply Program, \$0.5 million for Materials Integrity Management Research, and \$1.6 million for Body Armor Improved Ballistic Protection. 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) B. Program Change Summary (\$ in Millions)

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) Previous President's Budget	82.290	39.730	39.324
(U) Current PBR/President's Budget	83.546	54.871	41.926
(U) Total Adjustments	1.256	15.141	
(U) Congressional Program Reductions			
Congressional Rescissions		-0.359	
Congressional Increases		32.300	
Reprogrammings	3.245	-16.800	
SBIR/STTR Transfer	-1.989		

(U) Significant Program Changes:

Exhibit R-2, RDT&E Budget Item Justification

DATE

February 2008

BUDGET ACTIVITY

03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE

0603112F Advanced Materials for Weapon Systems

Not Applicable.

C. Performance Metrics
Under Development.

Exhibit R-2a, RDT&E Project Justification

DATE
February 2008

BUDGET ACTIVITY 03 Advanced Technology Development (ATD)				PE NUMBER AND TITLE 0603112F Advanced Materials for Weapon Systems			PROJECT NUMBER AND TITLE 2100 Laser Hardened Materials			
Cost (\$ in Millions)		FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
2100	Laser Hardened Materials	32.202	25.443	24.152	28.162	29.300	30.491	30.452	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0		

- (U) **A. Mission Description and Budget Item Justification**
 This project develops and demonstrates advanced materials technologies that enhance protection for Air Force aircrews to ensure safety and to enable aircrews to perform required missions in threat environments. Advanced materials technologies are also developed and demonstrated to enhance protection for Air Force sensor systems to ensure safety, survivability, and operability in threat environments.
- (U) **B. Accomplishments/Planned Program (\$ in Millions)**
- | | | | |
|---|----------------|----------------|----------------|
| | <u>FY 2007</u> | <u>FY 2008</u> | <u>FY 2009</u> |
| (U) MAJOR THRUST/CONGRESSIONAL ADD: Develop and demonstrate advanced materials technologies that enhance hardening for sensors, avionics, and components to increase survivability and mission effectiveness of aerospace systems. Note: This effort includes Congressional Add funding of \$1.2 million in FY 2007 for Large Panel Sapphire Producibility. | 24.827 | 19.683 | 17.834 |
| (U) In FY 2007: Matured hardening technology and developed a hardened candidate system. Developed candidate dual band limiter materials. Developed protection strategies for large format CCDs. | | | |
| (U) In FY 2008: Demonstrate mature hardening materials technology for an Air Force tactical system. Characterize and incorporate candidate dual band limiter materials for tactical systems. Demonstrate protection strategies for large format CCDs. | | | |
| (U) In FY 2009: Transition mature hardening materials technology for an Air Force tactical system. Demonstrate performance of dual band limiter materials in tactical systems. | | | |
| (U) MAJOR THRUST/CONGRESSIONAL ADD: Develop and demonstrate advanced materials technologies that enhance protection for Air Force aircrews to ensure safety and to enable aircrews to perform required missions in a threat environment. Note: This effort includes Congressional Add funding of \$1.0 million in FY 2007 for Optical Filters for Hardened Night Vision Goggles (NVGs). | 7.375 | 5.760 | 6.318 |
| (U) In FY 2007: Demonstrated brassboard performance using state-of-the-art agile filters and optical power limiters. Characterized and incorporated agile filter and optical limiter technologies into devices for Air Force applications. | | | |
| (U) In FY 2008: Validate performance of state-of-the-art agile filters and optical power limiters in a system configuration. Optimize agile filter and optical limiter devices for Air Force applications. | | | |
| (U) In FY 2009: Transition advanced agile filters and optical power limiters technologies in a system configuration. Demonstrate agile filter and optical limiter devices for Air Force applications. | | | |
| (U) Total Cost | 32.202 | 25.443 | 24.152 |

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE

0603112F Advanced Materials for
Weapon Systems

PROJECT NUMBER AND TITLE

2100 Laser Hardened Materials

(U) **C. Other Program Funding Summary (\$ in Millions)**

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to</u>	<u>Total Cost</u>
	<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Complete</u>	

(U) Related Activities:

(U) PE 0602102F, Materials.

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

(U) PE 0603231F, Crew Systems and Personnel Protection Technology.

(U) PE 0603500F, Multi-Disciplinary Advanced Development Space Technology.

(U) PE 0604706F, Life Support Systems.

(U) This project has been coordinated through the Tri-Service Laser Hardened Materials and Structures Group and the Joint Service Agile Laser Eye Protection Program.

(U) This project has been coordinated through the Reliance 21 process to harmonize efforts and eliminate duplication.

(U) **D. Acquisition Strategy**

Not Applicable.

Exhibit R-2a, RDT&E Project Justification

DATE
February 2008

BUDGET ACTIVITY 03 Advanced Technology Development (ATD)				PE NUMBER AND TITLE 0603112F Advanced Materials for Weapon Systems			PROJECT NUMBER AND TITLE 3153 Non-Destructive Inspection Development		
Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
3153 Non-Destructive Inspection Development	16.657	7.424	4.185	4.335	4.393	4.749	4.705	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

- (U) **A. Mission Description and Budget Item Justification**
 This project develops and demonstrates advanced nondestructive inspection/evaluation (NDI/E) technologies to monitor performance integrity and to detect failure causing conditions in weapon systems components and materials. NDI/E capabilities greatly influence and/or limit many design, manufacturing, and maintenance practices. This project provides technology to satisfy Air Force requirements to extend the lifetime of current systems through increased reliability and cost-effectiveness at field and depot maintenance levels. Equally important is assuring manufacturing quality, integrity, and safety requirements.
- (U) **B. Accomplishments/Planned Program (\$ in Millions)**
- | | <u>FY 2007</u> | <u>FY 2008</u> | <u>FY 2009</u> |
|---|----------------|----------------|----------------|
| (U) MAJOR THRUST: Develop and demonstrate advanced technologies to improve capabilities to inspect for cracks and other damage to extend the total safe life of turbine engines. | 0.890 | 0.483 | 0.527 |
| (U) In FY 2007: Transitioned methods to detect and characterize damage in repaired (linear friction welded) turbine engine components. Transitioned enhanced NDI/E approaches to extend the life of superalloy engine components. | | | |
| (U) In FY 2008: Develop NDI/E approaches to extend the life of fracture-critical gas turbine engine components. | | | |
| (U) In FY 2009: Validate NDI/E approaches to extend the life of fracture-critical gas turbine engine components. | | | |
| (U) MAJOR THRUST: Develop and demonstrate advanced inspection technologies supporting low-observable (LO) systems to enhance affordability and ensure full performance and survivability. | 0.315 | 0.264 | 0.339 |
| (U) In FY 2007: Transitioned a portable, multifunctional, multiplatform diagnostics tool for use in battle damage assessment and repair of LO materials and structures. | | | |
| (U) In FY 2008: Develop and demonstrate multiuse, multiplatform LO NDI/E hand tool that meets user requirements. | | | |
| (U) In FY 2009: Transition multiuse, multiplatform LO NDI/E hand tool that meets user requirements. | | | |
| (U) MAJOR THRUST/CONGRESSIONAL ADD: Develop and demonstrate advanced technologies for improved capabilities in materials corrosion, fatigue monitoring, and testing of aging aircraft to reduce operations and maintenance costs. These technologies will contribute to full operability and safety of the aircraft fleet. Note: This effort includes Congressional Add funding of \$7.0 million in FY 2007 (\$2.0 million for Aging Aircraft Fleet Support - National Institute for Aviation Research, \$2.0 million for Assessing Aging of Military Aircraft, \$2.0 million for Inspection and Analysis Methods for Aging Military Aircraft, and \$1.0 million for Quantitative Inspection Techniques for Assessing Aging Military Aircraft). | 8.114 | 1.621 | 1.739 |

UNCLASSIFIED

Exhibit R-2a, RDT&E Project Justification		DATE February 2008		
BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE		
03 Advanced Technology Development (ATD)	0603112F Advanced Materials for Weapon Systems	3153 Non-Destructive Inspection Development		
(U) B. Accomplishments/Planned Program (\$ in Millions)		<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) In FY 2007: Demonstrated application-focused NDI/E technologies to meet emerging inspection requirements for aging aircraft.				
(U) In FY 2008: Validate NDI/E technologies to meet emerging inspection requirements for aging aircraft and develop processes.				
(U) In FY 2009: Transition application-focused NDI/E technologies to meet emerging inspection requirements for aging aircraft.				
(U)				
(U) MAJOR THRUST/CONGRESSIONAL ADD: Develop and demonstrate advanced systems status monitoring technologies to provide on-board and embedded sensing to gain continuous awareness of the state of key subsystems. Note: This effort includes Congressional Add funding of \$2.0 million in FY 2007 (\$1.0 million for Materials Integrity Management Research for AF Systems and \$1.0 million for Continuous Integrated Vehicle Health Monitoring System).		3.322	1.380	1.580
(U) In FY 2007: Validated optimal sensing approaches for real-time health monitoring of high-temperature protection systems and characterized power scavenging and signal transmission issues. Validated smart sensor technologies for wiring health analysis. Validated field-level inspection tools for assessing the structural health of airframes.				
(U) In FY 2008: Develop optimal sensing approaches for real-time health monitoring of high-temperature protection systems and characterize power scavenging and signal transmission issues. Develop improved, smaller smart sensor technologies for wiring health analysis. Develop data fusion to be used with field-level inspection tools for assessing the structural health of airframes.				
(U) In FY 2009: Develop optimal sensing approaches for real-time health monitoring of high-temperature protection systems and characterize power scavenging and signal transmission issues. Transition smart sensor technologies for wiring health analysis. Transition total field-level inspection tool for assessing the structural health of airframes.				
(U)				
(U) CONGRESSIONAL ADD: Low Observable Multi-Purpose Inspection Tool.		0.972	0.000	0.000
(U) In FY 2007: Conducted Congressionally-directed effort for Low Observable Multi-Purpose Inspection Tool.				
(U) In FY 2008: Not Applicable.				
(U) In FY 2009: Not Applicable.				
(U)				
(U) CONGRESSIONAL ADD: Improved Stealth Aircraft Availability/Functionality.		1.944	0.000	0.000
(U) In FY 2007: Conducted Congressionally-directed effort for Improved Stealth Aircraft Availability/Functionality.				
(U) In FY 2008: Not Applicable.				

Exhibit R-2a, RDT&E Project Justification	DATE February 2008
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BUDGET ACTIVITY 03 Advanced Technology Development (ATD)	PE NUMBER AND TITLE 0603112F Advanced Materials for Weapon Systems	PROJECT NUMBER AND TITLE 3153 Non-Destructive Inspection Development
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(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) In FY 2009: Not Applicable.			
(U) CONGRESSIONAL ADD: Advanced Inspection Techniques and Analysis Methods for Multi-layer Structures and Widespread Fatigue Damage in Aging Military Aircraft.	1.100	0.000	0.000
(U) In FY 2007: Conducted Congressionally-directed effort for Advanced Inspection Techniques and Analysis Methods for Multi-layer Structures and Widespread Fatigue Damage in Aging Military Aircraft.			
(U) In FY 2008: Not Applicable.			
(U) In FY 2009: Not Applicable.			
(U) CONGRESSIONAL ADD: Aircraft Evaluation Readiness Initiative (AERI).	0.000	1.987	0.000
(U) In FY 2007: Not Applicable.			
(U) In FY 2008: Conduct Congressionally-directed effort for AERI.			
(U) In FY 2009: Not Applicable.			
(U) CONGRESSIONAL ADD: Continuous Integrated Vehicle Health Monitoring System.	0.000	1.192	0.000
(U) In FY 2007: Not Applicable.			
(U) In FY 2008: Conduct Congressionally-directed effort for Continuous Integrated Vehicle Health Monitoring System.			
(U) In FY 2009: Not Applicable.			
(U) CONGRESSIONAL ADD: Materials Integrity Management Research.	0.000	0.497	0.000
(U) In FY 2007: Not Applicable.			
(U) In FY 2008: Conduct Congressionally-directed effort for Materials Integrity Management Research.			
(U) In FY 2009: Not Applicable.			
(U) Total Cost	16.657	7.424	4.185

(U) <u>C. Other Program Funding Summary (\$ in Millions)</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to Complete</u>	<u>Total Cost</u>
	<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>		
(U) Related Activities:									
(U) PE 0602102F, Materials.									
(U) This project has been									

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE

**0603112F Advanced Materials for
Weapon Systems**

PROJECT NUMBER AND TITLE

**3153 Non-Destructive Inspection
Development****(U) C. Other Program Funding Summary (\$ in Millions)**

coordinated through the
Reliance 21 process to
harmonize efforts and eliminate
duplication.

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY 03 Advanced Technology Development (ATD)				PE NUMBER AND TITLE 0603112F Advanced Materials for Weapon Systems			PROJECT NUMBER AND TITLE 3946 Materials Transition		
Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
3946 Materials Transition	15.652	11.268	4.459	6.654	4.242	4.584	4.512	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) **A. Mission Description and Budget Item Justification**

This project develops and demonstrates advanced materials and processing technologies for fielded and planned Air Force weapon, airframe, and propulsion applications. Advanced materials and processes that have matured beyond applied research are characterized, critical data are collected, and critical evaluations in the proposed operating environment are performed. These design and scale-up data improve the overall affordability of promising materials and processing technologies, providing needed initial incentives for their industrial development.

(U) **B. Accomplishments/Planned Program (\$ in Millions)**

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) MAJOR THRUST/CONGRESSIONAL ADD: Develop and demonstrate advanced materials and processing technologies for air vehicles and subsystems to enhance the lift, propulsion, low-observable performance, and overall affordability of air vehicles. Note: This effort includes Congressional Add funding of \$2.3 million in FY 2007 for Metals Affordability Initiative.	6.616	3.500	3.347
(U) In FY 2007: Developed materials-damage predictive approaches for engine health determination and life extension capability. Completed transition of high-temperature organic matrix composites for turbine engine components. Characterized advanced materials and materials process capabilities for scaled-up processing techniques and assessed process repeatability for power generation materials for airborne directed energy weapons. Demonstrated functionality of integrated methods for a mid-infrared laser source enabling aircraft countermeasures. Demonstrated flexible/lightweight conductive gap filler. Evaluated processes for removal of radar absorbing material on large aircraft areas. Demonstrated primer/sealer material for improved durability of LO materials in fluid contaminated areas on emerging fighter aircraft. Evaluated improved processing of room-temperature-storable radar absorbing structure repair materials. Demonstrated nondestructive evaluation tool for limited access areas on aircraft.			
(U) In FY 2008: Validate materials-damage predictive approaches for engine health determination and life extension capability. Transition advanced materials and materials process capabilities for component-level demonstrations of power generation materials for airborne directed energy weapons. Transition materials and processing concepts for component-level demonstrations of new material for enabling mid-IR laser output with energy sufficient for enabling new aircraft self-protection schemes. Transition flexible/lightweight conductive gap filler. Validate advanced materials and processing technologies for transition to fielded and planned Air Force weapon, airframe, and propulsion applications as well as support systems including Air Force Material Command (AFMC) center infrastructure.			
(U) In FY 2009: Validate materials-damage predictive approaches for engine health determination and life extension			

Exhibit R-2a, RDT&E Project Justification		DATE February 2008		
BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE		
03 Advanced Technology Development (ATD)	0603112F Advanced Materials for Weapon Systems	3946 Materials Transition		
(U) B. Accomplishments/Planned Program (\$ in Millions)		<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
capability. Transition advanced materials and processing technologies to fielded and planned Air Force weapon, airframe, and propulsion applications as well as support systems including AFMC center infrastructure. Evaluate domestic lithium ion precursor materials, active materials, associated testing, and battery-cell manufacturing for acceleration of industrial development.				
(U) MAJOR THRUST/CONGRESSIONAL ADD: Develop and demonstrate advanced materials and processing technologies to enhance the sustainability of Air Force aerospace systems by lowering operations and maintenance costs and ensuring the full operability and safety of systems and personnel. Note: This effort includes Congressional Add funding of \$1.0 million in FY 2007 for Coated Field Repair.		1.648	0.218	1.112
(U) In FY 2007: Developed test methodologies and evaluation techniques to facilitate transition of emerging materials and processes for sustainment of Air Force systems.				
(U) In FY 2008: Identify and prioritize critical issues that are preventing transition of emerging materials and processes for sustainment of Air Force systems.				
(U) In FY 2009: Develop test methodologies and evaluation techniques to facilitate transition of emerging materials and processes for sustainment of Air Force systems.				
(U) CONGRESSIONAL ADD: Advanced Power Technology: Silicon Carbide Power, Bipolar Junction Transistors.		1.750	0.000	0.000
(U) In FY 2007: Conducted Congressionally-directed effort for Advanced Power Technology: Silicon Carbide Power, Bipolar Junction Transistors.				
(U) In FY 2008: Not Applicable.				
(U) In FY 2009: Not Applicable.				
(U) CONGRESSIONAL ADD: Silicon Carbide Electronics Material Producibility Initiative.		5.638	0.000	0.000
(U) In FY 2007: Conducted Congressionally-directed effort for Silicon Carbide Electronics Material Producibility Initiative.				
(U) In FY 2008: Not Applicable.				
(U) In FY 2009: Not Applicable.				
(U) CONGRESSIONAL ADD: Metals Affordability Initiative.		0.000	4.968	0.000
(U) In FY 2007: Not Applicable.				
(U) In FY 2008: Conduct Congressionally-directed effort for Metals Affordability Initiative.				

Exhibit R-2a, RDT&E Project Justification	DATE February 2008
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BUDGET ACTIVITY 03 Advanced Technology Development (ATD)	PE NUMBER AND TITLE 0603112F Advanced Materials for Weapon Systems	PROJECT NUMBER AND TITLE 3946 Materials Transition
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(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) In FY 2009: Not Applicable.			
(U) CONGRESSIONAL ADD: Coated Field Repair (2K Gun).	0.000	0.993	0.000
(U) In FY 2007: Not Applicable.			
(U) In FY 2008: Conduct Congressionally-directed effort for Coated Field Repair (2K Gun).			
(U) In FY 2009: Not Applicable.			
(U) CONGRESSIONAL ADD: EMI Grid Fabrication Technology.	0.000	1.589	0.000
(U) In FY 2007: Not Applicable.			
(U) In FY 2008: Conduct Congressionally-directed effort for EMI Grid Fabrication Technology.			
(U) In FY 2009: Not Applicable.			
(U) Total Cost	15.652	11.268	4.459

(U) <u>C. Other Program Funding Summary (\$ in Millions)</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to Complete</u>	<u>Total Cost</u>
	<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>		
(U) Related Activities:									
(U) PE 0602102F, Materials.									
(U) PE 0603203F, Advanced Aerospace Sensors.									
(U) PE 0603211F, Aerospace Technology Dev/Demo.									
(U) PE 0603216F, Aerospace Propulsion and Power Technology.									
(U) PE 0603500F, Multi-Disciplinary Advanced Development Space Technology.									
(U) This project has been coordinated through the Reliance 21 process to									

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE

**0603112F Advanced Materials for
Weapon Systems**

PROJECT NUMBER AND TITLE

3946 Materials Transition**(U) C. Other Program Funding Summary (\$ in Millions)**

harmonize efforts and eliminate
duplication.

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification

DATE
February 2008

BUDGET ACTIVITY 03 Advanced Technology Development (ATD)				PE NUMBER AND TITLE 0603112F Advanced Materials for Weapon Systems			PROJECT NUMBER AND TITLE 4918 Deployed Air Base Demonstrations			
Cost (\$ in Millions)		FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
4918	Deployed Air Base Demonstrations	13.919	6.374	5.918	2.550	2.592	2.802	2.876	Continuing	TBD
Quantity of RDT&E Articles		0	0	0	0	0	0	0		

- (U) **A. Mission Description and Budget Item Justification**
 This project develops and demonstrates advanced, rapidly deployable airbase technologies that reduce airlift and manpower requirements, setup times, and sustainment costs, and improve protection and survivability of deployed Air Expeditionary Force (AEF) warfighters. Affordable, efficient technologies are developed and demonstrated to provide deployable infrastructure, advanced weapon system support, force protection, and fire fighting capability for deployed AEF operations.
- (U) **B. Accomplishments/Planned Program (\$ in Millions)**
- | | | | |
|---|----------------|----------------|----------------|
| | <u>FY 2007</u> | <u>FY 2008</u> | <u>FY 2009</u> |
| (U) MAJOR THRUST/CONGRESSIONAL ADD: Demonstrate and transition advanced rapidly deployable airbase infrastructure technologies that reduce airlift and manpower requirements, setup times, and sustainment costs in support of AEF operations. Note: In FY 2009, this effort increases emphasis on airfield damage repair technologies. This effort includes Congressional Add funding of \$3.3 million in FY 2007 for Hydrothermal Oxidation (HTO) for Alaska. | 4.680 | 0.897 | 4.395 |
- (U) In FY 2007: Demonstrated a 10 kW fuel cell power system that improves deployable power systems performance. Demonstrated packed bed fuel treatment technology. Demonstrated advanced integrated shelter power/heating, ventilation, and air conditioning concept. Developed continuous load deflection technology and improved crater/spall repair materials and methodologies for improved airfield assessment and rapid repair.
- (U) In FY 2008: Develop transition plan and specifications for system development and demonstration. Characterize catalytic and surface chemistry technologies for application to bare base utilities. Develop and demonstrate continuous load deflection technologies and improved crater/spall repair.
- (U) In FY 2009: Develop best methods for integration of advanced power generation and distribution. Characterize and ensure processes for innovative technologies.
 Begin development and demonstration of airfield damage repair and matting technologies that address field critical conditions, represented by key performance parameters, including issues like reduced weight and ease of installation and repair in the field.
- | | | | |
|---|-------|-------|-------|
| (U) MAJOR THRUST: Demonstrate and transition affordable, efficient technologies to provide force protection and fire fighting capability for deployed AEF operations. | 1.487 | 1.306 | 1.523 |
|---|-------|-------|-------|
- (U) In FY 2007: Demonstrated improved blast suppression technologies and fragmentation protection materials for new and existing structures and for explosive storage facilities. Completed demonstration of improved fire fighter safety technologies and transitioned technology to operational units. Initiated an integrated crash/rescue fire fighting

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Exhibit R-2a, RDT&E Project Justification		DATE February 2008		
BUDGET ACTIVITY 03 Advanced Technology Development (ATD)	PE NUMBER AND TITLE 0603112F Advanced Materials for Weapon Systems	PROJECT NUMBER AND TITLE 4918 Deployed Air Base Demonstrations		
(U) B. Accomplishments/Planned Program (\$ in Millions)		<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) demonstration. Integrated air filtration technologies into demonstration for expeditionary structures.				
(U) In FY 2008: Develop and analyze effectiveness of improved blast suppression technologies and fragmentation protection materials for new and existing structures. Demonstrate explosives detection technologies. Transition technical orders and construction standards supporting fire suppression technologies for fire fighter safety technologies. Evaluate ultrahigh pressure, standoff nozzles, and other innovative technologies with test bed vehicles. Develop air filtration and model/evaluate reactive filtration effectiveness for expeditionary structures.				
(U) In FY 2009: Validate and fabricate improved blast suppression technologies and fragmentation protection materials for new and existing structures. Demonstrate and validate explosives detection technologies. Evaluate and characterize improved fire fighter safety technologies and transition technology to operational units. Characterize and analyze/evaluate ultrahigh pressure, standoff nozzles, and other innovative technologies with test bed vehicles. Characterize air filtration and model/evaluate reactive filtration effectiveness for expeditionary structures.				
(U) CONGRESSIONAL ADD: Blast Resistant Barriers and Structural Design for Homeland Defense.		1.264	0.000	0.000
(U) In FY 2007: Conducted Congressionally-directed effort for Blast Resistant Barriers and Structural Design for Homeland Defense.				
(U) In FY 2008: Not Applicable.				
(U) In FY 2009: Not Applicable.				
(U) CONGRESSIONAL ADD: Body Armor Improved Ballistic Protection.		1.361	1.589	0.000
(U) In FY 2007: Conducted Congressionally-directed effort for Body Armor Underarm and Side Protection with Smart Materials.				
(U) In FY 2008: Conduct Congressionally-directed effort for Body Armor Improved Ballistic Protection.				
(U) In FY 2009: Not Applicable.				
(U) CONGRESSIONAL ADD: Combined Agent Fire Fighting System.		0.972	0.000	0.000
(U) In FY 2007: Conducted Congressionally-directed effort for Combined Agent Fire Fighting System.				
(U) In FY 2008: Not Applicable.				
(U) In FY 2009: Not Applicable.				
(U) CONGRESSIONAL ADD: Encapsulated Ballistic Protection System (EBPS).		1.555	0.993	0.000
(U) In FY 2007: Conducted Congressionally-directed effort for EBPS.				

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY 03 Advanced Technology Development (ATD)	PE NUMBER AND TITLE 0603112F Advanced Materials for Weapon Systems	PROJECT NUMBER AND TITLE 4918 Deployed Air Base Demonstrations
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(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) In FY 2008: Conduct Congressionally-directed effort for EBPS.			
(U) In FY 2009: Not Applicable.			
(U)			
(U) CONGRESSIONAL ADD: Iodinated Ionic Antimicrobial Disposal Masks.	2.600	0.000	0.000
(U) In FY 2007: Conducted Congressionally-directed effort for Iodinated Ionic Antimicrobial Disposal Masks.			
(U) In FY 2008: Not Applicable.			
(U) In FY 2009: Not Applicable.			
(U)			
(U) CONGRESSIONAL ADD: Strategic Bio-fuels Supply Program.	0.000	1.589	0.000
(U) In FY 2007: Not Applicable.			
(U) In FY 2008: Conduct Congressionally-directed effort for Strategic Bio-fuels Supply Program.			
(U) In FY 2009: Not Applicable.			
(U)			
(U) Total Cost	13.919	6.374	5.918

(U) <u>C. Other Program Funding Summary (\$ in Millions)</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to</u>	<u>Total Cost</u>
	<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Complete</u>	
(U) Related Activities:									
(U) PE 0602102F, Materials.									
(U) PE 0603287F, Physical Security									
Equipment.									
(U) PE 0604617F, Agile Combat									
Support.									
(U) This project has been									
coordinated through the									
Reliance 21 process to									
harmonize efforts and eliminate									
duplication.									
(U) <u>D. Acquisition Strategy</u>									
Not Applicable.									

Exhibit R-2a, RDT&E Project Justification

DATE
February 2008

BUDGET ACTIVITY 03 Advanced Technology Development (ATD)				PE NUMBER AND TITLE 0603112F Advanced Materials for Weapon Systems			PROJECT NUMBER AND TITLE 77SP Advanced Space Materials		
Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
77SP Advanced Space Materials	5.116	4.362	3.212	3.329	3.377	3.652	3.620	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

Note: In FY 2007, Project 77SP, Advanced Space Materials, efforts transfer from PE 0603500F, Multidisciplinary Space Technology, Project 5032, Advanced Space Materials, in order to more effectively manage and provide oversight of the efforts.

(U) A. Mission Description and Budget Item Justification

This project develops and demonstrates materials and processing technologies for transition into Air Force space systems. Materials and processes development is scaled up to the appropriate level to demonstrate materials capability in the relative environment. Sub-scale components and nonstructural material components are developed and demonstrated to validate expected materials characteristics. Critical data on both structural and nonstructural materials is developed and provided for engineering and system design decisions. Laser hardened materials technologies are developed, demonstrated, and transitioned for the broadband protection of space sensors from a variety of laser threats. Reducing risk in materials technology improves the affordability, reliability, survivability, and operational performance of current and future space systems.

(U) B. Accomplishments/Planned Program (\$ in Millions)

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) MAJOR THRUST: Develop and demonstrate advanced materials and processing technologies to enable revolutionary improvements in the performance of air-breathing and rocket-based aerospace vehicles and weapons.	5.116	2.016	1.496
(U) In FY 2007: Developed advanced materials approaches to provide durable, maintainable high-temperature protection systems for leading edge applications on high-speed, reusable launch, and future reentry vehicle concepts. Investigated combinations of candidate materials, including organic matrix composites, ceramics, metals, carbon foams, aerogels, heat pipes, and phase change materials, for management of thermal and structural loads. Developed advanced ceramic materials and processing technologies for load bearing structures designed for high-temperature, multicycle applications in an oxidizing environment. Developed rocket propulsion materials for liquid and solid rocket engine components and validate performance in scaled component demonstrations.			
(U) In FY 2008: Refine developed materials formulations and approaches for thermal protection systems and aeroshells that provide solutions for cost-effective scale-up, fabrication, and integration techniques. Validate performance of high temperature composites on integrated cryogenic tanks and hypersonic structures, demonstrating low cost component fabrication and scale-up of design and process methodologies.			
(U) In FY 2009: Utilizing newly developed materials approaches, fabricate thermal protection system sub-components for high temperature testing. Develop a sub-component cryogenic tank article and demonstrate the integration of ceramic, metallic, and carbon-carbon thermal protection system components.			
(U) MAJOR THRUST: Develop and demonstrate advanced materials technologies that enhance hardening for space	0.000	2.346	1.716

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE

0603112F Advanced Materials for
Weapon Systems

PROJECT NUMBER AND TITLE

77SP Advanced Space Materials

(U) **B. Accomplishments/Planned Program (\$ in Millions)**

systems. Note: Efforts in this major thrust were delayed until FY 2008 due to higher Air Force priorities.

FY 2007

FY 2008

FY 2009

(U) In FY 2007: Not Applicable.

(U) In FY 2008: Optimize and validate limiter and filter technology for protection against low and high power lasers. Analyze laser phenomenology for intrinsic hardening solutions to jamming and damage susceptibility in electro-optical sensors.

(U) In FY 2009: Fabricate and demonstrate limiter and filter technology for protection of space systems. Investigate impact of inserting state-of-the-art filters and optical power limiters into a realistic system configuration.

(U) Total Cost

5.116

4.362

3.212

(U) **C. Other Program Funding Summary (\$ in Millions)**

FY 2007

FY 2008

FY 2009

FY 2010

FY 2011

FY 2012

FY 2013

Cost to

Total Cost

Actual

Estimate

Estimate

Estimate

Estimate

Estimate

Estimate

Complete

(U) Not Applicable.

(U) **D. Acquisition Strategy**

Not Applicable.

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PE NUMBER: 0603203F
 PE TITLE: Advanced Aerospace Sensors

Exhibit R-2, RDT&E Budget Item Justification	DATE February 2008
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BUDGET ACTIVITY 03 Advanced Technology Development (ATD)	PE NUMBER AND TITLE 0603203F Advanced Aerospace Sensors
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Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
Total Program Element (PE) Cost	56.634	62.332	56.916	58.664	55.847	58.408	57.244	0.000	0.000
665A Advanced Aerospace Sensors Technology	17.892	17.880	16.542	26.085	23.331	21.707	20.331	0.000	0.000
69DF Target Attack and Recognition Technology	27.015	32.220	30.130	25.921	25.709	28.589	29.102	0.000	0.000
88SP Advanced Space Sensors	11.727	12.232	10.244	6.658	6.807	8.112	7.811	0.000	0.000

Note: In FY 2007, Project 88SP, Advanced Space Sensors, efforts were transferred from PE 0603500F, Multidisciplinary Advanced Development Space Technology, Project 5034, Advanced Space Sensors, in order to more effectively manage and provide oversight of the efforts. Funds for the FY 2008 Congressionally-directed Moving Target Strike in the amount of \$1.6 million are in the process of being moved from PE 0603203F, Advanced Aerospace Sensors, to PE 0603601F, Conventional Weapons Technology, for execution.

(U) A. Mission Description and Budget Item Justification

Divided into three broad project areas, this program develops technologies to enable the continued superiority of sensors from aerospace platforms. The first project develops and demonstrates advanced technologies for electro-optical sensors, radar sensors and electronic counter-countermeasures, and components and algorithms. The second project develops and demonstrates radio frequency and electro-optical sensors for detecting, locating, and targeting airborne, fixed, and time-critical mobile ground targets obscured by natural or man-made means. The third project develops and demonstrates space sensor technologies including radio-frequency sensors; intelligence, surveillance, and reconnaissance sensors; electro-optical sensors; laser warning sensors; targeting and attack radar sensors; and electronic counter-countermeasures and communications. Together, the projects in this program develop the means to find, fix, target, track, and engage air and ground targets anytime, anywhere, and in any weather. Note: In FY 2008, Congress added \$3.2 million for TACNODES and \$4.0 million for Active Unmanned Air Vehicle (UAV) Phenomenology (AUP) & ART Technology Transition. 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.

Exhibit R-2, RDT&E Budget Item Justification

DATE

February 2008

BUDGET ACTIVITY

03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE

0603203F Advanced Aerospace Sensors

(U) **B. Program Change Summary (\$ in Millions)**

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) Previous President's Budget	58.228	55.549	52.840
(U) Current PBR/President's Budget	56.634	62.332	56.916
(U) Total Adjustments	-1.594	6.783	
(U) Congressional Program Reductions		-0.007	
Congressional Rescissions		-0.410	
Congressional Increases		8.800	
Reprogrammings	-0.301	-1.600	
SBIR/STTR Transfer	-1.293		

(U) **Significant Program Changes:**

In FY 2007, Project 88SP, Advanced Space Sensors, efforts transferred from PE 0603500F, Multidisciplinary Advanced Development Space Technology, Project 5034, Advanced Space Sensors, in order to more effectively manage and provide oversight of the efforts.

C. Performance Metrics

Under Development.

Exhibit R-2a, RDT&E Project Justification

DATE
February 2008

BUDGET ACTIVITY 03 Advanced Technology Development (ATD)				PE NUMBER AND TITLE 0603203F Advanced Aerospace Sensors			PROJECT NUMBER AND TITLE 665A Advanced Aerospace Sensors Technology		
Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
665A Advanced Aerospace Sensors Technology	17.892	17.880	16.542	26.085	23.331	21.707	20.331	0.000	0.000
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project develops and demonstrates aerospace sensor and processing technologies for intelligence, surveillance, reconnaissance, target, and attack radar applications in both manned and unmanned platforms, including electro-optical sensors and electronic counter-countermeasures for radars. It provides aerospace platforms with the capability to precisely detect, track, and target both airborne (conventional and low radar cross-section) and ground-based, high-value, time-critical targets in adverse clutter and jamming environments. Project activities include developing multi-function radar and electronic combat technology. Desired warfighting capabilities include the ability to detect concealed targets in difficult background conditions.

(U) B. Accomplishments/Planned Program (\$ in Millions)

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) MAJOR THRUST: Develop integrated electro-optical sensor technologies to search, detect, locate, and identify air and ground targets at ranges significantly longer than currently achievable, including targets that are camouflaged, low-observable, or employ other means of deception. Note: Funding peaks in FY 2008 due to the final increment of funding to develop the three-dimensional laser detection and ranging system supporting automated/assisted target recognition of obscured and urban targets, and the start of the system engineering and integration phase of that effort.	3.946	6.725	4.212
(U) In FY 2007: Continued development of a multi-function active/passive electro-optical/infrared sensor demonstration system to detect, locate, and identify difficult targets in both obscured and urban environments for intelligence, surveillance, and reconnaissance applications. Finalized analysis of advanced passive and multi-function active sensing methods to optimize detection and identification of difficult targets. Completed design for multi-mode unmanned aerial vehicle based sensor, including platform integration plans. Initiated development of coarse-to-fine sensing methodologies which progress from wide area search to pinpoint identification and characterization. Incorporated long-wave infrared spectral/polarimetric imager into high altitude sensor. Conducted flight test to demonstrate target detection capability. Finalized the design and initiate fabrication of an engineering model for an improved three-dimensional laser detection and ranging system which has improved range and resolution capability to support automated/assisted target recognition of obscured and urban targets.			
(U) In FY 2008: Begin airborne experiments demonstrating multi-function active/passive electro-optical/infrared demonstration system to detect, locate, and identify difficult targets in both obscured and urban environments for intelligence, surveillance, and reconnaissance applications. Perform fabrication and testing of high-resolution, three-dimensional laser radar for high confidence target identification coupled with passive spectral imaging for low false alarm rate detection utilizing advanced change detection and spatial-spectral discrimination techniques.			

Exhibit R-2a, RDT&E Project Justification		DATE February 2008		
BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE		
03 Advanced Technology Development (ATD)	0603203F Advanced Aerospace Sensors	665A Advanced Aerospace Sensors Technology		
(U) B. Accomplishments/Planned Program (\$ in Millions)		<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
Perform concept demonstration of multispectral/polarimetric focal plane array device for enhanced low contrast target discrimination. Complete fabrication of improved three-dimensional laser detection and ranging system and conduct testing of the engineering model.				
(U) In FY 2009: Continue airborne experiments demonstrating multi-function active/passive electro-optical/infrared demonstration system to detect, locate, and identify difficult targets in both obscured and urban environments for intelligence, surveillance, and reconnaissance applications. Characterize end-to-end performance of high-resolution, three-dimensional laser radar for high confidence target identification coupled with passive spectral imaging for low false alarm rate detection utilizing advanced change detection and spatial-spectral discrimination techniques. Complete development of multispectral/polarimetric focal plane array device for enhanced low contrast target discrimination, and design airborne sensor module for enhancement of multi-function demonstration system.				
(U) MAJOR THRUST: Develop electro-optical sensor technologies to detect and locate camouflaged and concealed targets for aerospace intelligence, surveillance, and reconnaissance applications. Note: This effort ends in FY 2007.		4.928	0.000	0.000
(U) In FY 2007: Completed fabrication and testing of demonstration system for high-altitude aircraft incorporating reflective and emissive spectral sensing capability for day and night operations. Performed flight characterization and supported transition to acquisition center.				
(U) In FY 2008: Not Applicable.				
(U) In FY 2009: Not Applicable.				
(U) MAJOR THRUST: Develop technologies to maximize positional accuracy, timing accuracy, and exploitation techniques to improve offensive and defensive combat capabilities.		2.291	2.298	1.798
(U) In FY 2007: Demonstrated critical experiments using virtual flight test simulation to characterize assured reference technologies for net centric warfare. Developed sensor phenomenology-based georegistration for imagery and performed lab tests of multi-intelligence georegistration.				
(U) In FY 2008: Develop worldwide ultra-accurate positioning system technologies to optimize time sensitive targeting, battlespace awareness, and persistent intelligence, surveillance, and reconnaissance capabilities. Continue to develop multi-sensor phenomenology-based georegistration for imagery and perform lab tests of multi-intelligence georegistration.				
(U) In FY 2009: Demonstrate worldwide ultra-accurate positioning system technologies to optimize time sensitive targeting, battlespace awareness, and persistent intelligence, surveillance, and reconnaissance capabilities. Continue to develop multi-sensor phenomenology-based georegistration for imagery and perform lab tests of multi-intelligence				

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE

0603203F Advanced Aerospace
Sensors

PROJECT NUMBER AND TITLE

665A Advanced Aerospace Sensors
Technology(U) **B. Accomplishments/Planned Program (\$ in Millions)**

georegistration.

FY 2007FY 2008FY 2009

(U)

(U) MAJOR THRUST: Develop, test, evaluate, and demonstrate lightweight, low power, compact radio-frequency sensors to detect, track, and target high-value, time-critical targets that are difficult to detect through either stealth or concealment and enable persistent intelligence, surveillance, and reconnaissance from an unmanned aerial vehicle. Develop and validate long-range intelligence, surveillance, and reconnaissance sensor technologies and techniques for the detection and track of advanced air and ground targets. Advanced target characteristics include targets with low radar cross section, concealment capabilities, or electronic counter-countermeasures. Note: The growing emphasis in this thrust in FY 2008 and FY 2009 is due to the increased focus on multi-intelligence radio-frequency systems.

3.886

4.748

9.765

(U) In FY 2007: Continued demonstration of the radio-frequency sensors of an integrated electro-optical/radio-frequency sensor suite for unmanned aerial vehicles with severe size, weight, and power constraints, to enable single platform persistent intelligence, surveillance, and reconnaissance capabilities compatible with a system of systems architecture. Developed highly integrated receiver-aperture technologies for improved functionality and greatly reduced size, weight, and power. Continued experiments with the ground test bed providing input into a design for an airborne multi-intelligence experiment. Continued radar systems engineering support fostering the transition of developed enabling technologies and concepts to weapon systems and intelligence, surveillance, and reconnaissance assets. Developed program for threat analysis/mitigation of passive multistatic, multi-intelligence sensing.

(U) In FY 2008: Continue demonstration of the radio-frequency sensors of an integrated electro-optical/radio-frequency sensor suite (for unmanned aerial vehicles with severe size, weight, and power constraints), to enable single platform persistent intelligence, surveillance, and reconnaissance capabilities compatible with a system of systems architecture. Continue experiments with the ground test bed providing input into the required operation and controls for an airborne multi-intelligence experiment. Continue radar systems engineering support fostering the transition of developed enabling technologies and concepts to weapon systems and intelligence, surveillance, and reconnaissance assets. Initiate a radar system analysis for improved air and ground target detection and tracking using cross-cued, dual-band radar.

(U) In FY 2009: Continue demonstration of the radio-frequency sensors of an integrated electro-optical/radio-frequency sensor suite for unmanned aerial vehicles with severe size, weight, and power constraints, to enable single platform persistent intelligence, surveillance, and reconnaissance capabilities compatible with a system of systems architecture. Enhance the ground test bed with the inclusion of electro-optical sensing modes, and provide input into

Exhibit R-2a, RDT&E Project Justification		DATE February 2008		
BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE		
03 Advanced Technology Development (ATD)	0603203F Advanced Aerospace Sensors	665A Advanced Aerospace Sensors Technology		
(U) B. Accomplishments/Planned Program (\$ in Millions)		<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
the required design for an integrated electro-optical/radio-frequency sensor suite, including required data processing and exploitation. Continue sensor systems engineering support fostering the transition of developed enabling technologies and concepts to weapon systems and intelligence, surveillance, and reconnaissance assets. Continue experiments with the ground test bed providing input into a design for an airborne multi-intelligence experiment. Continue systems analysis for improved air and ground target detection and tracking using cross-cued, dual-band radar coupled with electronic support sensors.				
(U) MAJOR THRUST: Develop weapons guidance-quality track radar performance in advanced jamming environments. Develop and demonstrate advanced radar signal processing techniques to mitigate clutter and jamming interference and improve detection and tracking of difficult targets in hostile environments.		0.849	0.930	0.767
(U) In FY 2007: Demonstrated and evaluated novel space-time adaptive processing techniques that are robust to heterogeneous data. Demonstrated and evaluated multi-sensor waveform transmission and signal processing techniques on selected advanced computing architectures.				
(U) In FY 2008: Demonstrate and evaluate multi-sensor waveform transmission and signal processing techniques on selected advanced computing architectures. Implement novel space-time adaptive processing techniques that are robust to heterogeneous data. Implement tactical sensor network operations on the developed advanced computer architectures used for algorithm/waveform analysis.				
(U) In FY 2009: Demonstrate the surveillance performance of homogeneous sensor networks and newly developed adaptive processing algorithms and waveforms in heterogeneous conditions, including clutter and jamming interference.				
(U) CONGRESSIONAL ADD: Precision Image Tracking and Registration Program.		0.996	0.000	0.000
(U) In FY 2007: Conducted Congressionally-directed effort for the Precision Image and Tracking Registration Program.				
(U) In FY 2008: Not Applicable.				
(U) In FY 2009: Not Applicable.				
(U) CONGRESSIONAL ADD: Tactical Air Communication Nodes (TACNODES).		0.996	3.179	0.000
(U) In FY 2007: Conducted Congressionally-directed effort for TACNODES.				
(U) In FY 2008: Conduct Congressionally-directed effort for TACNODES.				
(U) In FY 2009: Not Applicable.				
(U)				

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY 03 Advanced Technology Development (ATD)	PE NUMBER AND TITLE 0603203F Advanced Aerospace Sensors	PROJECT NUMBER AND TITLE 665A Advanced Aerospace Sensors Technology
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(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) Total Cost	17.892	17.880	16.542

(U) <u>C. Other Program Funding Summary (\$ in Millions)</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to</u>	<u>Total Cost</u>
	<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Complete</u>	
(U) Related Activities:									
(U) PE 0602204F, Aerospace Sensors.									
(U) PE 0603205F, Flight Vehicle Technology.									
(U) PE 0603707F, Weather Systems Advanced Development.									
(U) PE 0603500F, Multi-Disciplinary Advanced Development Space Technology.									
(U) PE 0602111N, Weapons Technology.									
(U) PE 0602232N, Space and Electronic Warfare (SEW) Technology.									
(U) PE 0604249F, LANTIRN Night Precision Attack.									
(U) PE 0603270F, Electronic Combat Technology.									
(U) A Memorandum of Agreement has been established between Air Force Research Laboratory and Defense Advanced Research Projects Agency to jointly develop the technology required to detect high-value, time-critical targets in a variety of									

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE

**0603203F Advanced Aerospace
Sensors**

PROJECT NUMBER AND TITLE

**665A Advanced Aerospace Sensors
Technology****(U) C. Other Program Funding Summary (\$ in Millions)**

environments.

- (U) This project has been coordinated through the Reliance 21 process to harmonize efforts and eliminate duplication.

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY				PE NUMBER AND TITLE			PROJECT NUMBER AND TITLE		
03 Advanced Technology Development (ATD)				0603203F Advanced Aerospace Sensors			69DF Target Attack and Recognition Technology		
Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
69DF Target Attack and Recognition Technology	27.015	32.220	30.130	25.921	25.709	28.589	29.102	0.000	0.000
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project develops and demonstrates advanced technologies for attack management, fire control, and target identification and recognition. This includes developing and demonstrating integrated and cooperative fire control techniques to provide for adverse-weather precision air strikes against multiple targets per pass and at maximum weapon launch ranges. Specific fire control technologies under development include attack management, sensor fusion, automated decision aids, advanced tracking for low radar cross section threats, and targeting using both on-board and off-board sensor information. This project also evaluates targeting techniques to support theater missile defense efforts in surveillance and attack. These fire control technologies will provide force multiplication and reduce warfighter exposure to hostile fire. This project also develops and demonstrates target identification and recognition technologies for positive, high confidence cueing, recognition, and identification of airborne and ground-based, high-value, time-critical targets at longer ranges than are currently possible. The goal is to apply these technologies to tactical air-to-air and air-to-surface weapon systems so they are able to operate in all weather conditions, during day or night, and in high-threat, multiple target environments. Model-based vision algorithms and target signature development techniques are the key to target identification and recognition. This project is maturing these technologies in partnership with the Defense Advanced Research Projects Agency, and evaluating the techniques to support theater missile defense efforts in surveillance and attack. Fire control and recognition technologies developed and demonstrated in this project are high leverage efforts, providing for significant advancements in operational capabilities largely through software improvements readily transitionable to new and existing weapon systems. Note: Funding in individual Major Thrusts in this project decrease in FY 2008 and FY 2009 as 1., technology is transitioned to operational platforms, and 2., several Major Thrusts are created as outgrowths of other work in the project for better management and oversight.

(U) B. Accomplishments/Planned Program (\$ in Millions)

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) MAJOR THRUST: Develop and test an automatic target recognition system for tracking and identifying moving and stationary ground targets for use in strike and reconnaissance platforms. Note: The reduced emphasis in this thrust in FY 2009 is due to the transition of the technology to the warfighter.	4.540	5.212	0.332
(U) In FY 2007: Continued multi-spiral development of a radar based air-to-ground moving target algorithm for tactical and reconnaissance platforms. Refined this capability for integration into candidate radar systems and platform specific product development roadmaps. Provided transition plans of the moving target algorithm technology to operational strike and reconnaissance platforms.			
(U) In FY 2008: Perform a real-time laboratory demonstration of a radar based air-to-ground moving target algorithm for tactical and reconnaissance platforms. Assess performance against scenarios of interest to the warfighter as would be integrated into candidate radar systems. Provide support to the transition of the moving target algorithm technology to operational strike and reconnaissance platforms as necessary.			

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE

0603203F Advanced Aerospace
Sensors

PROJECT NUMBER AND TITLE

69DF Target Attack and Recognition
Technology(U) **B. Accomplishments/Planned Program (\$ in Millions)**FY 2007FY 2008FY 2009

(U) In FY 2009: Continue providing support to the transition of the moving target algorithm technology to operational strike and reconnaissance platforms.

(U)

(U) MAJOR THRUST: Develop and assess multi-sensor automatic target recognition for intelligence, surveillance, reconnaissance, strike, and weapon systems.

4.813

3.889

2.141

(U) In FY 2007: Continued to assess the performance of Air Force and the Defense Advanced Research Projects Agency multi-sensor automatic target recognition fusion algorithms using the Air Force automatic target recognition test and evaluation facility for application to intelligence, surveillance, reconnaissance, strike, and weapon systems. Continued characterizing both single and multiple sensor contributions from radar and electro-optical (including hyperspectral imaging) sensors with automated exploitation. Collected, processed, archived, and distributed research-and-development sensor data for automated exploitation technology development and assessment. Supported automated exploitation technology development and assessment with collaborative computing environment. Completed development of synthetic data generation capability to augment collected research, development, and operational data sets. Augmented the Department of Defense wide repository of research-and-development sensor data with multi-sensor imagery and tracking data collected at warfighter-sponsored exercises. Continued to show impact of automated multi-sensor automatic target recognition and fusion capability in terms of timeline reduction for time-critical targeting to image analysts and decision-makers in the experimental Air Operations Centers. Initiated modeling of existing and emergent sensor systems for assessing automated exploitation technologies in simulated operational environments. Initiated assessment of moving target tracking and identification approaches for multiple sensor types. Initiated evaluation of technology enhancements for post-conflict force protection, stability, and security operations.

(U) In FY 2008: Begin spiral development and assessment of multi-sensor automatic target recognition fusion algorithms. Assessment of technology supporting intelligence, surveillance, reconnaissance, strike, and weapon systems will occur in the Air Force automatic target recognition test and evaluation facility. Continue spiral development and validation of synthetic data generation capability critically needed to augment collected research, development, and operational data sets. Critical examination of target, scene and scenario data to determine independence and interdependence of features to support development of an optimum data fusion exploitation capability. Enhance the Air Force automatic target recognition test and evaluation facility and data sets as required to support enhanced automatic target recognition fusion capabilities.

(U) In FY 2009: Continue spiral development and assessment of multi-sensor automatic target recognition fusion algorithms. Continued assessment of technology supporting intelligence, surveillance, reconnaissance, strike, and

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE

0603203F Advanced Aerospace
Sensors

PROJECT NUMBER AND TITLE

69DF Target Attack and Recognition
Technology(U) **B. Accomplishments/Planned Program (\$ in Millions)**FY 2007FY 2008FY 2009

weapon systems using the Air Force automatic target recognition test and evaluation facility. Continue spiral development and validation of synthetic data generation capability critically needed to augment collected research, development, and operational data sets. Develop automatic target recognition fusion sensor data exploitation capability utilizing analysis and experimentation of data independence and interdependence of features to support development of an optimum data fusion exploitation capability. Enhance the Air Force automatic target recognition test and evaluation facility and data sets as required to support enhanced automatic target recognition fusion capabilities. Determine technology shortfalls and develop automatic target recognition fusion technologies to overcome these shortfalls.

(U)

(U) MAJOR THRUST: Develop and demonstrate a moderate-confidence automatic target recognition and advanced cueing capability for stationary and moving targets.

8.370

8.053

6.887

(U) In FY 2007: Further developed high-confidence combat identification capability to determine which combination of sensors, modes, and fusion processing techniques provide a high-confidence combat identification capability for stationary and moving ground targets. Furthered the technology demonstration effort of promising near-term, multi-sensor technologies and fusion processing techniques. Continued critical experiments of advanced multi-sensor, multi-platform technologies and fusion processing techniques for strike and intelligence, surveillance, and reconnaissance assets. Further characterized studies of advanced stationary and moving target multi-sensor data to determine utility for automatic target recognition, automatic target cueing, and combat identification. Further refined tool development to support sensor system, sensor management, and system performance analyses. Continued advanced multi-sensor data collections on stationary and moving targets.

(U) In FY 2008: Develop and evaluate an initial design of multi-sensor fusion algorithms that use change detection techniques to improve target detection and reduce false alarms for higher clutter areas. Develop and evaluate an initial design of a three-dimensional laser-detection-and-ranging automatic target recognition algorithm designed to achieve high confidence identification against targets in various degrees of clutter. Develop and evaluate an initial design of a laser vibrometry algorithm that provide the ability to determine target state (for example, engine on/off) and provide some level of counter denial and deception capability. Develop and evaluate an initial design of a sensor management suite that provides target cue prioritizations and look geometry optimization for three-dimensional laser-detection-and-ranging sensors. Develop and evaluate an initial set of exploitation tools that are optimized for use with three-dimensional laser-detection-and-ranging and laser vibrometry sensors. Enhance automatic target recognition evaluation test facility and data sets as necessary to support program requirements.

(U) In FY 2009: Incorporate improvements in the initial design of the multi-sensor fusion algorithms for improved

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE

0603203F Advanced Aerospace
Sensors

PROJECT NUMBER AND TITLE

69DF Target Attack and Recognition
Technology(U) **B. Accomplishments/Planned Program (\$ in Millions)**FY 2007FY 2008FY 2009

detection that were previously evaluated. Incorporate improvements in the initial design of the three-dimensional laser-detection-and-ranging automatic target recognition algorithms that were previously evaluated. Incorporate improvements in the initial design of the laser vibrometry algorithms that were previously evaluated. Incorporate improvements in the initial design of the sensor management suite that were previously evaluated. Incorporate improvements in the initial set of laser sensor exploitation tools that were previously evaluated. Enhance automatic target recognition evaluation test facility and data sets as necessary to support program requirements.

(U)

(U) MAJOR THRUST: Develop and demonstrate an automatic target recognition capability integrated with advanced georegistration techniques and innovative change detection algorithms.

5.287

2.616

1.386

(U) In FY 2007: Continued to utilize the advanced recognition capability test bed to integrate and upgrade time-critical targeting capability to support the transition to the warfighter of technology products that detect concealed targets and improve ability to dynamically track time-critical targets. Continued development of an autonomous multi-sensor management and data exploitation system supporting an all-weather mission for tactical platforms, including unmanned aerial vehicles. Initiated design and conduct concept demonstration of a concealed target identification sensor and exploitation capability. Initiated the development of an advanced tracking capability that utilizes advanced radar features to fingerprint and associate vehicle observations and integrates multiple radar sensors to maintain continuous track through difficult terrain and in dense traffic.

(U) In FY 2008: Continue spiral assessment and development of automatic target recognition, automatic target cueing, geo-registration, and change-detection technology. Assess technology supporting time critical targeting systems in the Air Force automatic target recognition test and evaluation facility. Continue spiral development and validation of synthetic data generation capabilities critically needed to augment collected research, development, and operational data sets. Interim demonstration and evaluation of concealed target identification sensing and exploitation technologies. Interim demonstration and evaluation of advanced tracking and multi-sensor track maintenance technology in a militarily significant scenario. Enhance the Air Force automatic target recognition test and evaluation facility and data sets as required to support time-critical targeting capabilities.

(U) In FY 2009: Determine need to continue spiral assessment and development of automatic target recognition, automatic target cueing, geo-registration, and change detection technology. Continue assessment of technology supporting time critical targeting systems in the Air Force automatic target recognition test and evaluation facility. Continue spiral development and validation of synthetic data generation capability critically needed to augment collected research, development, and operational data sets. Demonstrate time-critical targeting, advanced target tracking and multi-sensor track maintenance capabilities. Enhance the Air Force automatic target recognition test

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE

0603203F Advanced Aerospace
Sensors

PROJECT NUMBER AND TITLE

69DF Target Attack and Recognition
Technology

(U) B. Accomplishments/Planned Program (\$ in Millions)	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
and evaluation facility and data sets as required to support enhanced time-critical targeting capabilities. Determine technology shortfalls and develop emerging time-critical targeting and advanced target tracking technologies to overcome these shortfalls.			
(U) MAJOR THRUST: Develop an "identify friend, foe or neutral" air-to-ground capability using cooperative and non-cooperative identification techniques.	2.610	2.646	2.523
(U) In FY 2007: Finalized design studies and initiate critical experiments to verify improved ground target identification capabilities resulting from ground target database enhancements, identification algorithm enhancements, and advanced radio-frequency tags. Refined advanced identification algorithms and laboratory test with operational sensor data to measure improved confidence and reliability of target identification. Finalized radio-frequency tag design and conducted simulation testing to confirm improved pilot and system operator situation awareness, verify friendly identification confirmations, and performed initial interoperability assessments. Improved exploitation tools to allow automatic screening of large volumes of intelligence, surveillance, and reconnaissance imagery. Developed technology for wide area detection, tracking, and identification against difficult, asymmetric targets at long range. Developed and integrated emerging technologies to enable small unmanned aerial vehicles with electro-optical and infrared sensors to provide persistent intelligence, surveillance, and reconnaissance .			
(U) In FY 2008: Integrate and demonstrate improved ground target identification capabilities through enhanced target databases, identification algorithm advancements and radio-frequency tags in a laboratory environment. Assess maturity of technology via a combination of exercises and scientific analysis by the Air Force automatic target recognition evaluation test facility. Initiate spiral assessment and development of an "identify friend, foe or neutral" air-to-ground capability, enhancing test facilities and target databases as necessary. Plan operational exercise support.			
(U) In FY 2009: Continue to integrate and demonstrate improved ground target identification capabilities through enhanced target databases, identification algorithm advancements and radio-frequency tags in an operational environment. Assess performance of technology to support warfighter integration with operational systems. Continue refinement of identification algorithms and target databases as necessary to support transition of technology.			
(U) MAJOR THRUST: Develop wide angle, continuous staring, multi-sensor/multi-wavelength sensing, and automated exploitation technology that provides detection, tracking and identification of numerous objects of possible military significance over very large ground areas at sensor data update rates. Note: This work is an outgrowth of other work	0.000	5.830	6.000

UNCLASSIFIED

Exhibit R-2a, RDT&E Project Justification		DATE February 2008		
BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE		
03 Advanced Technology Development (ATD)	0603203F Advanced Aerospace Sensors	69DF Target Attack and Recognition Technology		
(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u>		<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
within this project.				
(U) In FY 2007: Not Applicable.				
(U) In FY 2008: Design and breadboard the individual waveband sensors required to support the persistent staring and automated exploitation capability. Collect data required to support the development, testing and validation of the automated exploitation of the wide-angle, continuous-staring capability. Assess the maturity of the technology through scientific analyses conducted the Air Force automatic target recognition test and evaluation facility.				
(U) In FY 2009: Design and develop engineering model of the multi-sensor, multi-wavelength wide-angle continuously-staring capability building upon the technologies developed during the individual component stage. Integrate and demonstrate the wide-angle, continuously-staring component technologies. Assess the maturity of the technology via a combination of exercises and scientific analyses in the Air Force automatic target recognition test and evaluation facility. Initiate spiral development of wide angle, continuous staring exploitation algorithms, phenomenological modeling, target and scenario databases necessary to support transition to the warfighter. Initiate SAF Interest Item to develop Gotcha Radar, Night Stare, and related electro-optical, infrared, and synthetic aperture radar staring sensor technologies and algorithms.				
(U) MAJOR THRUST: Develop an advanced suite of sensors with automatic target recognition, fusion, and target tracking, all working in concert to provide a high confidence identification capability. Note: This work is an outgrowth of other work within this project.		0.000	0.000	10.861
(U) In FY 2007: Not Applicable.				
(U) In FY 2008: Not Applicable.				
(U) In FY 2009: Design and test an advanced aimpoint tracking capability. Develop and test automatic target recognition capability using electro-optical sensor data. Build upon previous synthetic aperture radar automatic target recognition capability to develop a high-confidence exploitation of synthetic aperture radar data. Develop an advanced capability to fuse information and exploitation results from multiple sensors. Initiate spiral high confidence identification development of algorithm phenomenological modeling, target and scenario databases necessary to support technology development. Assess maturity of technology during the spiral process via the Air Force automatic target recognition test and evaluation facility and other sensor test facilities.				
(U) CONGRESSIONAL ADD: National Operational Signature Production and Research Capability (Combat Identification Signature Center).		1.395	0.000	0.000
(U) In FY 2007: Conducted Congressionally-directed effort for National Operational Signature Production and Research				

Exhibit R-2a, RDT&E Project Justification	DATE February 2008
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BUDGET ACTIVITY 03 Advanced Technology Development (ATD)	PE NUMBER AND TITLE 0603203F Advanced Aerospace Sensors	PROJECT NUMBER AND TITLE 69DF Target Attack and Recognition Technology
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(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
Capability (Combat Identification Signature Center).			
(U) In FY 2008: Not Applicable.			
(U) In FY 2009: Not Applicable.			
(U)			
(U) CONGRESSIONAL ADD: Active Unmanned Air Vehicle (UAV) Phenomenology (AUP) & ART Technology Transition.	0.000	3.974	0.000
(U) In FY 2007: Not Applicable.			
(U) In FY 2008: Conduct Congressionally-directed effort for Active Unmanned Air Vehicle (UAV) Phenomenology (AUP) & ART Technology Transition.			
(U) In FY 2009: Not Applicable.			
(U)			
(U) Total Cost	27.015	32.220	30.130

(U) <u>C. Other Program Funding Summary (\$ in Millions)</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to Complete</u>	<u>Total Cost</u>
	<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>		
(U) Related Activities:									
(U) PE 0602204F, Aerospace Sensors.									
(U) PE 0603253F, Advanced Sensor Integration.									
(U) PE 0603500F, Multi-Disciplinary Advanced Space Technology.									
(U) PE 0603762E, Sensor and Guidance Technology.									
(U) PE 0603270F, Electronic Combat Technology.									
(U) Theater Missile Defense System Program Office.									
(U) Low Altitude Night Targeting and Infrared Navigation									

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE

**0603203F Advanced Aerospace
Sensors**

PROJECT NUMBER AND TITLE

**69DF Target Attack and Recognition
Technology****(U) C. Other Program Funding Summary (\$ in Millions)**

(LANTIRN) System Program
Office.

- (U) This project has been coordinated through the Reliance 21 process to harmonize efforts and eliminate duplication.

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification

DATE
February 2008

BUDGET ACTIVITY 03 Advanced Technology Development (ATD)				PE NUMBER AND TITLE 0603203F Advanced Aerospace Sensors			PROJECT NUMBER AND TITLE 88SP Advanced Space Sensors		
Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
88SP Advanced Space Sensors	11.727	12.232	10.244	6.658	6.807	8.112	7.811	0.000	0.000
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

Note: In FY 2007, efforts were transferred from PE 0603500F, Multidisciplinary Advanced Development Space Technology, Project 5034, Advanced Space Sensors, in order to more effectively manage and provide oversight of the efforts.

(U) A. Mission Description and Budget Item Justification

This project develops and demonstrates space sensor technologies, including radio frequency sensors; intelligence, surveillance, and reconnaissance sensors; electro-optical sensors; laser warning sensors; targeting and attack radar sensors; and electronic counter-countermeasures and communications. By developing multi-function radar, laser, electronic combat, and electronic counter-countermeasures technologies for space applications, this project provides space platforms with the capability to precisely detect, track, and target air- and ground-based, high-value, time-critical targets, while remaining invulnerable to hostile and natural threats.

(U) B. Accomplishments/Planned Program (\$ in Millions)

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) MAJOR THRUST: Reduce technology risk for space sensor platform payload components and exploitation of infrastructure integration.	0.698	0.452	0.842
(U) In FY 2007: Integrated space-sensor technologies into a complete radar payload simulation test bed with selected hardware in the loop and demonstrate system design feasibility.			
(U) In FY 2008: Develop approach to design responsive space payload capabilities while retaining hardware implementation feasibility. Define payload to bus satellite interface requirements and standards.			
(U) In FY 2009: Develop "plug-and-play" satellite critical experiment, to including full simulation.			
(U) MAJOR THRUST: Develop and demonstrate technologies to maximize global positioning system jam resistance, positional accuracy, timing accuracy, and exploitation techniques to improve offensive and defensive combat capabilities.	1.079	1.289	2.200
(U) In FY 2007: Developed space-based distributed position, navigation, and timing technologies to detect, identify and locate global positioning system threats. Developed multi-ship virtual flight test simulation technology to assess networked clusters of unmanned aerial vehicles, intelligence, surveillance, and reconnaissance platforms, and space-based platforms.			
(U) In FY 2008: Demonstrate space-based distributed position, navigation, and timing technologies to detect, identify, and locate global positioning system threats. Demonstrate multi-ship virtual flight test simulation technology to assess networked clusters of unmanned aerial vehicles, intelligence, surveillance, and reconnaissance platforms, and space-based platforms.			
(U) In FY 2009: Design space-based distributed position, navigation, and timing technologies to achieve optimal sensor			

Exhibit R-2a, RDT&E Project Justification		DATE February 2008		
BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE		
03 Advanced Technology Development (ATD)	0603203F Advanced Aerospace Sensors	88SP Advanced Space Sensors		
(U) B. Accomplishments/Planned Program (\$ in Millions)		<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
fusion for space situational awareness. Design multi-ship virtual flight test simulation technology to assess world-wide distributed position, navigation, and timing architectures for disparate platforms for space situational awareness.				
(U) MAJOR THRUST: Develop electro-optical sensor component technology to advance multiple space mission areas. Develop new sensor components, topologies and architectures for space.		1.578	1.610	1.520
(U) In FY 2007: Fabricated advanced space environment phenomenology sensor components.				
(U) In FY 2008: Conduct experimental space flight of sensor components to test in space environment. Initiate data collection, testing and system evaluation with relevant space environment phenomenology.				
(U) In FY 2009: Complete experimental space flight of sensor components to test in space environment. Complete data collection, testing and system evaluation. Initiate lab-based integration testing with embedded satellite components.				
(U) MAJOR THRUST: Develop advanced laser communication component and sub-system technology to support a network-level topology for airborne intelligence, surveillance, and reconnaissance		5.000	6.349	5.000
(U) In FY 2007: Began development of an integrated wideband radio-frequency/electro-optical communication terminal and shared-aperture antenna for evaluation and testing in an air-network layer. Continued development of technologies for radio-frequency/electro-optical shared apertures to service high-bandwidth communication needs. Continued testing applicability of shared apertures to maintaining air-network link connectivity under adverse weather conditions. Expanded flight demonstrations of radio-frequency, optical, and combined radio-frequency/optical communication terminal technologies for air-network layers.				
(U) In FY 2008: Continue development of an integrated wideband radio-frequency/electro-optical communication terminal and shared aperture antenna. Begin evaluation and testing of the integrated terminal and antenna in an air network layer. Begin maturation of technologies for integration into communication architecture. Continue flight demonstrations of radio-frequency, optical, and combined radio-frequency/optical communication terminal technologies for air-network layers.				
(U) In FY 2009: Continue maturation of technologies for integration into airborne network architecture. Conduct ground and flight tests of laser communication system. Develop the advanced free space optical modem focusing on compact packaging for airborne terminal rack rack installations. Integrate optical terminal with radio-frequency communications gear to enable testing of hybrid free space optical and radio-frequency communications terminal for intelligence, surveillance, and reconnaissance relay missions. Demonstrate hybrid free space optical/radio-frequency failsafe/failback operations in airborne tests. Note: this effort ends in FY09.				

Exhibit R-2a, RDT&E Project Justification	DATE February 2008
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BUDGET ACTIVITY 03 Advanced Technology Development (ATD)	PE NUMBER AND TITLE 0603203F Advanced Aerospace Sensors	PROJECT NUMBER AND TITLE 88SP Advanced Space Sensors
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(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) MAJOR THRUST: Develop and demonstrate a geodesic phased array antenna to achieve enhanced satellite operations over current reflector antennas. Improve operational capacity and efficiency to support satellite control network.	3.372	2.532	0.682
(U) In FY 2007: Analyzed system requirements and complete the design of the multi-beam geodesic dome phased array antenna. Finalized radio-frequency and mechanical designs of the geodesic dome panels to demonstrate critical performance characteristics. Completed evaluation of the transmit/receive modules, the radiating element, beam former array panels, and the antenna resource manager computer.			
(U) In FY 2008: Fabricate transmit/receive modules, radiating elements, beam former array panels for the geodesic phased array antenna dome sub-sector to be used in the advanced technology demonstration.			
(U) In FY 2009: Fully characterize the advanced technology demonstrator sub-sector and demonstrate with operational satellites.			
(U) Total Cost	11.727	12.232	10.244

(U) <u>C. Other Program Funding Summary (\$ in Millions)</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to</u>	<u>Total Cost</u>
	<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Complete</u>	
(U) Related Activities:									
(U) PE 0602204F, Aerospace Sensors.									
(U) PE 0602500F, Multi-Disciplinary Space Technology.									
(U) PE 0603500F, Multi-Disciplinary Advanced Development Space Technology.									
(U) PE 0603270F, Electronic Combat Technology.									
(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.									

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE

0603203F Advanced Aerospace
Sensors

PROJECT NUMBER AND TITLE

88SP Advanced Space Sensors

(U) D. Acquisition Strategy

Not Applicable.

UNCLASSIFIED

PE NUMBER: 0603211F
 PE TITLE: Aerospace Technology Dev/Demo

Exhibit R-2, RDT&E Budget Item Justification	DATE February 2008
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BUDGET ACTIVITY 03 Advanced Technology Development (ATD)	PE NUMBER AND TITLE 0603211F Aerospace Technology Dev/Demo
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Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
Total Program Element (PE) Cost	45.443	66.884	44.918	83.204	69.231	86.163	99.803	Continuing	TBD
486U Advanced Aerospace Structures	7.188	2.384	0.000	0.000	0.000	0.000	0.000	Continuing	TBD
4920 Flight Vehicle Tech Integration	35.569	64.500	44.918	83.204	69.231	86.163	99.803	Continuing	TBD
99SP Advanced Structures Space Vehicles	2.686	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	TBD

Note: In FY 2007, Project 6399SP, Advanced Structures for Space Vehicles, efforts were transferred from PE 0603500F, Multidisciplinary Advanced Space Technology, Project 635062, Advanced Structures for Space Vehicles, order to effectively manage and provide oversight of the efforts. Funds for the FY 2007 Congressionally-directed Short Take Off and Landing Herk 1 Continuation in the amount of \$1.594 were moved into PE 0603211F, Aerospace Technology Dev/Demo, from PE 0401115F, C-130 Airlift Squadron, for execution.

(U) A. Mission Description and Budget Item Justification

This program demonstrates advanced aerospace vehicle technologies. Advanced aerospace structures are demonstrated to sustain and enhance the capability of current and future aerospace vehicles. Aerospace vehicle technology integration is accomplished through integration of various technologies to include avionics, advanced propulsion, and weapons systems for demonstration in near-realistic operational environments. Note: In FY 2008, Congress added \$0.8 million for Big Antennas Small Structures Efficient Tactical (BASSET) unmanned air vehicle, and \$1.6 million for Titanium Structures Initiative.

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

(U) B. Program Change Summary (\$ in Millions)

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) Previous President's Budget	36.286	64.922	56.345
(U) Current PBR/President's Budget	45.443	66.884	44.918
(U) Total Adjustments	9.157	1.962	
(U) Congressional Program Reductions			
Congressional Rescissions		-0.438	
Congressional Increases		2.400	
Reprogrammings	10.064		
SBIR/STTR Transfer	-0.907		
(U) <u>Significant Program Changes:</u>			
(U) C. Performance Metrics			
Under Development			

Exhibit R-2a, RDT&E Project Justification

DATE
February 2008

BUDGET ACTIVITY 03 Advanced Technology Development (ATD)				PE NUMBER AND TITLE 0603211F Aerospace Technology Dev/Demo			PROJECT NUMBER AND TITLE 486U Advanced Aerospace Structures		
Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
486U Advanced Aerospace Structures	7.188	2.384	0.000	0.000	0.000	0.000	0.000	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) **A. Mission Description and Budget Item Justification**
 This project develops and demonstrates affordable aerospace vehicle technologies to sustain the existing fleet, reduce the cost of aircraft ownership, and enhance the capability of current and future aerospace vehicles. Sustainment of the existing fleet through extended operational service life with innovative technology application will lead to reduced operations and support costs, and increased operational readiness. Analytical certification will reduce the cost associated with component replacement by allowing and certifying new designs under reduced test requirements. Development of capability enhancing technologies will expand the operational envelope and increase survivability in high threat environments. Demonstration of these technologies will restore structural integrity, extend structural life, enhance the capability, and reduce the life cycle costs of fielded aircraft.

(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) CONGRESSIONAL ADD: Design Manual for Titanium Honeycomb Sandwich Composite Structure.	1.065	0.000	0.000
(U) In FY 2007: Conducted Congressionally-directed effort to design manual for titanium honeycomb sandwich composite structure.			
(U) In FY 2008: Not Applicable.			
(U) In FY 2009: Not Applicable.			
(U) CONGRESSIONAL ADD: Wright Brothers Institute - Capabilities Analysis Phase 2.	1.647	0.000	0.000
(U) In FY 2007: Conducted Congressionally-directed effort for capabilities planning support.			
(U) In FY 2008: Not Applicable.			
(U) In FY 2009: Not Applicable.			
(U) CONGRESSIONAL ADD: 3-D Woven/Braided Composites.	0.980	0.000	0.000
(U) In FY 2007: Conducted Congressionally-directed effort for 3-D woven/braided composites.			
(U) In FY 2008: Not Applicable.			
(U) In FY 2009: Not Applicable.			
(U) CONGRESSIONAL ADD: Advanced Aerospace Titanium Structures (AATS) Initiative.	0.980	1.589	0.000
(U) In FY 2007: Conducted Congressionally-directed AATS effort.			
(U) In FY 2008: Conduct Congressionally-directed AATS effort.			
(U) In FY 2009: Not Applicable.			

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY 03 Advanced Technology Development (ATD)	PE NUMBER AND TITLE 0603211F Aerospace Technology Dev/Demo	PROJECT NUMBER AND TITLE 486U Advanced Aerospace Structures
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(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U)			
(U) CONGRESSIONAL ADD: Advanced Aluminum Aerostructures (A3I) Initiative.	1.258	0.000	0.000
(U) In FY 2007: Conducted Congressionally-directed A3I effort, last funded by Congress in FY 2005.			
(U) In FY 2008: Not Applicable.			
(U) In FY 2009: Not Applicable.			
(U)			
(U) CONGRESSIONAL ADD: Large Scale Affordable Composite Structures.	1.258	0.000	0.000
(U) In FY 2007: Conducted Congressionally-directed effort for large-scale affordable composite structures.			
(U) In FY 2008: Not Applicable.			
(U) In FY 2009: Not Applicable.			
(U)			
(U) CONGRESSIONAL ADD: Big Antennas Small Structures Efficient Tactical (BASSET) Unmanned Aerial Vehicles.	0.000	0.795	0.000
(U) In FY 2007: Not Applicable.			
(U) In FY 2008: Conduct Congressionally-directed effort for big antennas small structures efficient tactical unmanned aerial vehicles.			
(U) In FY 2009: Not Applicable.			
(U) Total Cost	7.188	2.384	0.000

(U) <u>C. Other Program Funding Summary (\$ in Millions)</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to Complete</u>	<u>Total Cost</u>
	<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>		
(U) Related Activities:									
(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.									
(U) <u>D. Acquisition Strategy</u>									
Not Applicable.									

Exhibit R-2a, RDT&E Project Justification

DATE
February 2008

BUDGET ACTIVITY 03 Advanced Technology Development (ATD)				PE NUMBER AND TITLE 0603211F Aerospace Technology Dev/Demo			PROJECT NUMBER AND TITLE 4920 Flight Vehicle Tech Integration			
Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total	
4920 Flight Vehicle Tech Integration	35.569	64.500	44.918	83.204	69.231	86.163	99.803	Continuing	TBD	
Quantity of RDT&E Articles	0	0	0	0	0	0	0			

- (U) **A. Mission Description and Budget Item Justification**
 This project integrates and demonstrates advanced flight vehicle technologies that will improve the performance and supportability of existing and future manned and unmanned aerospace vehicles. System level integration brings together the aerospace vehicle technologies along with avionics, propulsion, and weapon systems for demonstration in a near-realistic operational environment. Integration and technology demonstrations reduce the risk and time required to transition technologies into operational aircraft. This program provides proven aerospace vehicle technologies for all-weather, day/night operations with improved performance and affordability.
- (U) **B. Accomplishments/Planned Program (\$ in Millions)**
- | | | | |
|---|----------------|----------------|----------------|
| | <u>FY 2007</u> | <u>FY 2008</u> | <u>FY 2009</u> |
| (U) MAJOR THRUST: Develop autonomous flight controls for safe flight and cooperative operations between manned and unmanned air platforms. | 5.239 | 6.299 | 6.485 |
| (U) In FY 2007: Completed ground simulation and flight demonstration of key hardware and software systems for adaptive, fault tolerant, autonomous unmanned air vehicle airborne control. Initiated development of situational awareness and control technologies for automated air base ground operations for unmanned air vehicles. | | | |
| (U) In FY 2008: Further develop situational awareness and control technologies for automated air base ground operations for unmanned air vehicles. Initiated electromagnetic threat tolerant control systems technologies for air base ground operations for unmanned air vehicles. | | | |
| (U) In FY 2009: Conduct ground demonstrations of situational awareness and control technologies for unmanned air vehicles operating in and around air bases. Develop and demonstrate cooperative teaming of small unmanned air vehicles in complex, low altitude environments. Conduct evaluation of validation and verification tools and process for affordable certification of autonomous unmanned air vehicle flight control software. | | | |
| (U) MAJOR THRUST/CONGRESSIONAL ADD: Develop, simulate, and demonstrate integrated technologies to improve the performance of manned and unmanned platforms. In FY 2008, increased emphasis being placed on demonstration efforts related to the composite affordability initiative. | 12.481 | 41.149 | 17.139 |
| (U) In FY 2007: Initiated development of a simulation environment to enable evaluation of network centric technologies for improved capabilities for high speed operational concepts. Conducted Congressionally-directed efforts for STOL Herk 1. | | | |
| (U) In FY 2008: Conduct flight demonstration of extensive laminar flow on swept wing test article. Complete wind tunnel testing of gust load alleviation and body freedom flutter suppression of high altitude, long endurance platforms. Complete integration of data streams and analysis tools; graphical user interfaces; database/model | | | |

Exhibit R-2a, RDT&E Project Justification		DATE February 2008		
BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE		
03 Advanced Technology Development (ATD)	0603211F Aerospace Technology Dev/Demo	4920 Flight Vehicle Tech Integration		
(U) B. Accomplishments/Planned Program (\$ in Millions)		<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
updates; validation of model and selection criteria; and identification of model correction factors. Develop and integrate aircraft components that capitalize upon unitized advanced materials that are lightweight and affordable into an X-type cargo aircraft. Develop approaches that would reduce the tooling required to fabricate aircraft components. Begin flight demonstration efforts for an X-type cargo aircraft.				
(U) In FY 2009: Complete flight demonstration of extensive laminar flow on swept wing test article. Conduct and complete flight demonstration of an X-type aircraft comprised of advanced materials for weight reduction, surface smoothness, corrosion, and fatigue elimination. Continue development of a simulation environment to enable evaluation of network centric technologies for improved capabilities for high speed operational concepts.				
(U)				
(U) MAJOR THRUST: Develop analytical certification methods and capability to reduce the need for physical testing in the certification of structural components resulting in reduced acquisition cost for new systems and reduced support costs for future and legacy systems. Demonstrate reduced support costs for future systems by incorporation of advanced monitoring capabilities. Note: In FY 2008, the demonstration efforts real-time diagnostic and prognostics health monitoring demonstration efforts suspended because of the need for additional Applied Research efforts.		8.614	0.000	0.000
(U) In FY 2007: Continued demonstration of improved sustainment technologies for existing aging aircraft and future aerospace vehicle structures to reduce operations and support costs and extend usable structural lives. Continued demonstration of real-time diagnostic and prognostics health monitoring tools for thermal protected systems, tanks, structures, and subsystems to enable rapid turn around and high temperature operations.				
(U) In FY 2008: Not Applicable.				
(U) In FY 2009: Not Applicable.				
(U)				
(U) MAJOR THRUST: Develop aircraft structures that have embedded components, which have previously been separate components that were attached to the air platforms. Note: The FY 2008 and out year increase in funding is due to the demonstration efforts related to flight testing of large X band antenna embedded in a load bearing airframe structure.		6.170	14.003	13.160
(U) In FY 2007: Assessed results from flight demonstration of concepts with high multi-element antenna arrays embedded in load-bearing structure to increase antenna performance improvement and reduced vehicle weight, cost, and volume. Continued demonstration of concepts for very large, low frequency antenna arrays embedded in load-bearing structure to enable new antenna capabilities and increased performance, while reducing vehicle weight, cost, and volume.				
(U) In FY 2008: Complete structural demonstration of low band antenna structure. Asses and refine development of				

Exhibit R-2a, RDT&E Project Justification	DATE February 2008
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BUDGET ACTIVITY 03 Advanced Technology Development (ATD)	PE NUMBER AND TITLE 0603211F Aerospace Technology Dev/Demo	PROJECT NUMBER AND TITLE 4920 Flight Vehicle Tech Integration
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(U) B. Accomplishments/Planned Program (\$ in Millions)	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
multi-functional integrated structures to reduce cost, weight, while improving performance of future air platforms. Complete fabrication and flight test a large X band electronically-scanned antenna array embedded in a load-bearing structure.			
(U) In FY 2009: Complete and assess test results from the flight demonstration of the large X band electronically scanned antenna array embedded in a load-bearing structure.			
(U) MAJOR THRUST: Develop adaptive structures to provide in-flight modifications offering improved performance over a wide range of flight conditions and mission profiles.	3.065	3.049	8.134
(U) In FY 2007: Further refined integrated thermal airframe structures including thermal protection systems, attachments, seals, joining technologies, hot primary structure, and structural health monitoring for high-speed vehicle applications. Continued development and demonstration of highly efficient wing concepts integrating active aero elastic design concepts, adaptive structures, and aerodynamic flow control technologies to enable viable long range and long endurance air vehicle concepts.			
(U) In FY 2008: Develop passive and active leading edge cooling systems for ultra, high-speed vehicles. Develop and validate integration methodologies for component level leading edge test articles. Complete development and demonstration of highly efficient wing concepts integrating active aero elastic design concepts.			
(U) In FY 2009: Demonstrate passive and active thermal protection systems for leading edge of high-speed vehicle components. Assess results from demonstrations of advanced efficient wings concepts integrating active aeroelastic design concepts and adaptive structures. Note: The FY 2008 and out year increase in funding is due to the demonstration efforts related to integrated airframe and structural health management for high speed vehicle applications.			
(U) Total Cost	35.569	64.500	44.918

(U) C. Other Program Funding Summary (\$ in Millions)	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to</u>	<u>Total Cost</u>
	<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Complete</u>	
(U) Related Activities:									
(U) PE 0602201F, Aerospace Vehicle Technologies.									
(U) PE 0604015F, Next Generation Bomber.									

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE

**0603211F Aerospace Technology
Dev/Demo**

PROJECT NUMBER AND TITLE

4920 Flight Vehicle Tech Integration**(U) C. Other Program Funding Summary (\$ in Millions)**

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

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification

DATE
February 2008

BUDGET ACTIVITY 03 Advanced Technology Development (ATD)				PE NUMBER AND TITLE 0603211F Aerospace Technology Dev/Demo			PROJECT NUMBER AND TITLE 99SP Advanced Structures Space Vehicles		
Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
99SP Advanced Structures Space Vehicles	2.686	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

Note: In FY 2007, Project 6399SP, Advanced Structures for Space Vehicles, efforts were transferred from PE 0603500F, Multidisciplinary Advanced Space Technologies, Project 635062, Advanced Structures for Space Vehicles, in order to effectively manage and provide oversight of the efforts. In FY 2008, the remaining efforts in Project 6399SP were transferred into Project 4920 within this PE, as the planned efforts were not space unique.

(U) A. Mission Description and Budget Item Justification

This project identifies, develops, and demonstrates the technologies to enable advanced access-to-space aerospace vehicles that deliver revolutionary capability, operability, responsiveness, and cost-effectiveness. Enabling technologies include thermal protection, structures, vehicle systems, configurations, aerodynamics, and controls. Technology demonstration includes multi-disciplinary system level integration of the enabling technologies.

(U) B. Accomplishments/Planned Program (\$ in Millions)

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) MAJOR THRUST: Develop the airframe and payload technologies required to enable horizontal launch of reusable high altitude aerospace vehicles.	2.686	0.000	0.000
(U) In FY 2007: Continued developing the airframe and payload technologies required to enable next generation reusable access to space systems including the thermal protection, structural, configuration, and vehicle and payload system technologies that enable aerospace vehicles to exhibit revolutionary capability, operability, responsiveness, and cost-effectiveness.			
(U) In FY 2008: Not Applicable.			
(U) In FY 2009: Not Applicable.			
(U) Total Cost	2.686	0.000	0.000

(U) C. Other Program Funding Summary (\$ in Millions)

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to</u>	<u>Total Cost</u>
	<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Complete</u>	
(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.									

(U) D. Acquisition Strategy

Not Applicable.

UNCLASSIFIED

PE NUMBER: 0603216F

PE TITLE: Aerospace Propulsion and Power Technology

Exhibit R-2, RDT&E Budget Item Justification	DATE February 2008
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BUDGET ACTIVITY 03 Advanced Technology Development (ATD)	PE NUMBER AND TITLE 0603216F Aerospace Propulsion and Power Technology
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Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
Total Program Element (PE) Cost	150.123	142.543	170.856	189.246	174.017	135.561	129.752	Continuing	TBD
10SP Space Rocket Prop Demo	26.778	34.079	23.532	32.443	38.523	35.265	35.417	0.000	0.000
2480 Aerospace Fuels	17.979	8.666	11.387	12.203	10.646	8.416	8.546	Continuing	TBD
3035 Aerospace Power Technology	13.800	14.379	8.864	9.545	9.623	9.719	9.561	Continuing	TBD
4921 Aircraft Propulsion Subsystems Int	27.413	24.696	42.383	39.537	53.046	21.284	20.137	Continuing	TBD
4922 Space & Missile Rocket Propulsion	4.652	4.703	5.082	2.094	2.847	5.465	4.122	Continuing	TBD
5098 Advanced Aerospace Propulsion	32.839	21.741	22.984	24.306	14.945	23.271	21.731	Continuing	TBD
681B Advanced Turbine Engine Gas Generator	26.662	34.279	56.624	69.118	44.387	32.141	30.238	Continuing	TBD

Note: In FY 2007, a portion of the funding in Projects 2480 and 4921 was shifted to Project 5098. In FY 2007, Project 10SP, Space Rocket Propulsion Demonstration, was transferred from PE 0603500F, Multi-Disciplinary Advanced Development Space Technology, Project 5033, Rocket Propulsion Demonstration, in order to more effectively manage and provide oversight of the efforts. The funding in this PE has been increased due to emphasis on component development in support of adaptive cycle technologies, alternative hydrocarbon jet fuel, improved fuel efficiency, highly efficient embedded turbine engines, and small heavy fueled engines.

(U) A. Mission Description and Budget Item Justification

This program develops and demonstrates technologies to achieve enabling and revolutionary advances in turbine, advanced cycle, and rocket propulsion, as well as electrical power thermal management, and fuels. The program has seven projects, each focusing on technologies with a high potential to enhance the performance of existing and future Air Force weapons systems. Aerospace Fuels and Atmospheric Propulsion develops and demonstrates improved hydrocarbon fuels and advanced propulsion systems for high-speed/hypersonic flight. Aerospace Power Technologies develops and demonstrates power and thermal management systems for weapons and aircraft as part of Integrated Vehicle Energy Technology (INVENT). Advanced Turbine Engine Gas Generator (ATEGG) develops and demonstrates core turbine engine technologies for current and future aircraft propulsion systems. Aerospace Propulsion Subsystem Integration (APSI) integrates the engine cores demonstrated in ATEGG with low-pressure components into demonstrator engines. Turbine engine propulsion projects within this program are part of Versatile Affordable Advanced Turbine Engine (VAATE). A portion of the Fuels, ATEGG, and APSI projects supports adaptive cycle technology demonstrations which develop component technology for an adaptive cycle engine architecture that provides optimized performance, fuel efficiency, and durability for widely varying mission needs. Advanced Aerospace Propulsion develops the scramjet propulsion cycle to a technology readiness level appropriate for in-flight demonstration and for full integration with other engine cycles (including turbine and rocket based). Space and Missile Rocket Technology develops and demonstrates innovative rocket propulsion technologies, propellants, and manufacturing techniques. Space and Rocket Propulsion Demonstration develops and demonstrates advanced and innovative low-cost rocket turbomachinery and components, low-cost space launch propulsion system technologies, and advanced propellants for launch and orbit transfer propulsion. Rocket propulsion projects within this program are part of Integrated High Payoff Rocket Propulsion Technology (IHPRPT), which includes the area of Technology for the Sustainment of Strategic Systems. Note: In FY 2008, Congress added \$2.0 million for Bi-Polar Wafer-Cell Metal Hydride Batteries; \$1.0 million for Ceramic Matrix Composite (CMC) Airfoil Enhancements; \$6.4 million for a Family of Motors Capability Demonstration; \$1.0 million for FRESH Field Renewable Energy

Exhibit R-2, RDT&E Budget Item Justification

DATE

February 2008

BUDGET ACTIVITY

03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE

0603216F Aerospace Propulsion and Power Technology

System Hybrids; \$5.5 million for Silicon Carbide Power Electronics for More Electric Aircraft; \$1.2 million for the Texas Research Institute for Environmental Studies; \$3.6 million for VAATE Small Turbofan engine technology; and \$4.8 million for a VAATE High Speed Turbine Demonstrator. 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) **B. Program Change Summary (\$ in Millions)**

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) Previous President's Budget	145.891	117.990	163.066
(U) Current PBR/President's Budget	150.123	142.543	170.856
(U) Total Adjustments	4.232	24.553	
(U) Congressional Program Reductions			
Congressional Rescissions			
Congressional Increases		25.500	
Reprogrammings	7.634		
SBIR/STTR Transfer	-3.402		
(U) <u>Significant Program Changes:</u>			
Not Applicable.			

C. Performance Metrics

(U) Under Development.

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY			PE NUMBER AND TITLE				PROJECT NUMBER AND TITLE		
03 Advanced Technology Development (ATD)			0603216F Aerospace Propulsion and Power Technology				10SP Space Rocket Prop Demo		
Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
10SP Space Rocket Prop Demo	26.778	34.079	23.532	32.443	38.523	35.265	35.417	0.000	0.000
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

Note: In FY 2007, efforts transferred from PE 0603500F, Aerospace Propulsion and Power Technology, Project 5033, Space Rocket Propulsion Demonstration, to this Project in order to more effectively manage and provide oversight of the efforts.

(U) **A. Mission Description and Budget Item Justification**

This project develops and demonstrates advanced and innovative low-cost rocket turbomachinery and components, low-cost space launch propulsion technologies, and advanced propellants for launch and orbit transfer propulsion. Additionally, this project develops technologies for the Technology for Sustainment of Strategic Systems Phase 1. Characteristics such as environmental acceptability, affordability, reliability, responsiveness, reduced weight, and reduced operation and launch costs are emphasized. Increased life and performance of propulsion systems are key goals. This project also develops chemical, electrical, and solar rocket propulsion technologies for station-keeping and on-orbit maneuvering applications. Technology areas investigated include ground demonstrations of compact, lightweight, advanced propulsion technologies, higher efficiency energy conversion systems (derived from an improved understanding of combustion fundamentals), and high-energy propellants. Technological advances developed in this program could improve the performance of expendable payload capabilities by approximately 20 percent, and reduce launch, operations, and support costs by approximately 30 percent. Responsiveness and operability of propulsion systems will be enhanced for reusable launch systems. Technology advances could also lead to seven-year increase in satellite on-orbit time, a 50 percent increase in satellite maneuvering capability, a 25 percent reduction in orbit transfer operational costs, and a 15 percent increase in satellite payload. The efforts in this project contribute to Integrated High Payoff Rocket Propulsion Technology (IHRPT), a joint Department of Defense, National Aeronautics and Space Administration, and industry effort to focus rocket propulsion technology on national space launch needs.

(U) **B. Accomplishments/Planned Program (\$ in Millions)**

- (U) MAJOR THRUST: Develop liquid rocket propulsion technology for current and future space launch vehicles. Note:
In FY 2009, a portion of the funding was moved to support higher Air Force priorities.
- (U) In FY 2007: Completed testing of advanced lightweight thrust chamber and nozzle technologies. Conducted scale-up of advanced cryogenic upper stage technologies including higher efficiency energy conversion systems. Completed hardware design for advanced cryogenic upper stage technologies - turbopumps and thrust chambers. Began studies for advanced hydrocarbon engine technologies for future reusable launch vehicles.
- (U) In FY 2008: Begin hardware fabrication for advanced cryogenic upper stage technologies - turbopumps and thrust chambers. These components will be used to validate modeling, simulation, and analysis tools being developed. Begin preparations for testing of these components. Start component and engine designs for advanced hydrocarbon engine technologies for future reusable launch vehicles. Initiate an advanced manufacturing technology demo aimed at materials and processes to support the hydrocarbon engine technology development effort. Initiate advanced hydrocarbon fuels scale-up effort to prove out advanced hydrocarbons as fuels or additives to rocket engine fuels and

FY 2007FY 2008FY 2009

20.351

22.177

17.884

Exhibit R-2a, RDT&E Project Justification		DATE February 2008		
BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE		
03 Advanced Technology Development (ATD)	0603216F Aerospace Propulsion and Power Technology	10SP Space Rocket Prop Demo		
(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u>		<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
for potential use in future reusable launch vehicles.				
(U) In FY 2009: Complete advanced cryogenic upper stage hardware fabrication and begin testing components to validate and verify modeling and simulation tools developed. Develop hydrocarbon engine components for integration and demonstration in an advanced hydrocarbon engine concept for future reusable launch vehicles. Continue material manufacturing scale-up effort to support hydrocarbon boost demonstration program. Continue advanced hydrocarbon fuel/additive scale-up and proof efforts.				
(U) MAJOR THRUST: Develop solar electric propulsion technologies for existing and future satellites, upper stages, orbit transfer vehicles, and satellite formation flying, station keeping, and repositioning.		5.088	4.435	3.765
(U) In FY 2007: Developed electric propulsion systems for orbit-transfer by developing high-power Hall thrusters capable of Low Earth Orbit to Geosynchronous Orbit transfer. Began component integration for the high-power Hall thruster demonstration. Completed test flight of the advanced small satellite propulsion demonstration unit for a microsatellite demonstration. Supported test flight of propulsive attitude control system on microsatellite demonstration. Initiated hardware scale-up for an advanced multi-mode (high thrust or high efficiency) propulsion system for satellites. Developed satellite sensors to analyze satellite thruster interactions.				
(U) In FY 2008: Continue development of electric propulsion systems for orbit-transfer by developing high-power Hall thrusters capable of Low Earth Orbit to Geosynchronous Orbit transfer. Continue component integration for the high-power Hall thruster demonstration. Continue hardware scale-up for an advanced multi-mode (high thrust or high efficiency) propulsion system for satellites. Complete development of satellite sensors to analyze satellite thruster interactions.				
(U) In FY2009: Continue development of electric propulsion systems for orbit-transfer by developing high-power Hall thrusters capable of Low Earth Orbit to Geosynchronous Orbit transfer. Conduct and complete testing of the high-power Hall thruster demonstration. Continue hardware scale-up for an advanced multi-mode (high thrust or high efficiency) propulsion system for satellites. Continue demonstration of advanced chemical propulsion system for satellites.				
(U) MAJOR THRUST: Develop electric and advanced chemical based monopropellant propulsion technologies for future satellite propulsion systems.		1.339	1.109	1.883
(U) In FY 2007: Began development of an advanced monopropellant thruster and complete development of monopropellant thruster technologies.				
(U) In FY 2008: Continue development of an advanced monopropellant thruster.				

Exhibit R-2a, RDT&E Project Justification	DATE February 2008
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BUDGET ACTIVITY 03 Advanced Technology Development (ATD)	PE NUMBER AND TITLE 0603216F Aerospace Propulsion and Power Technology	PROJECT NUMBER AND TITLE 10SP Space Rocket Prop Demo
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(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) In FY 2009: Continue development of an advanced monopropellant thruster technologies.			
(U) CONGRESSIONAL ADD: Family of Motors Capability Demonstration	0.000	6.358	0.000
(U) In FY 2007: Not Applicable.			
(U) In FY 2008: Scale-up and test of solid rocket motor component technologies to provide data on viability of a family of motors construct.			
(U) In FY 2009: Not Applicable.			
(U) Total Cost	26.778	34.079	23.532
(U) <u>C. Other Program Funding Summary (\$ in Millions)</u>			
	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
	<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>
	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>
	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>
		<u>FY 2013</u>	<u>Cost to</u>
		<u>Estimate</u>	<u>Complete</u>
			<u>Total Cost</u>
(U) Not Applicable.			
(U) <u>D. Acquisition Strategy</u>			
Not Applicable.			

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY			PE NUMBER AND TITLE				PROJECT NUMBER AND TITLE		
03 Advanced Technology Development (ATD)			0603216F Aerospace Propulsion and Power Technology				2480 Aerospace Fuels		
Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
2480 Aerospace Fuels	17.979	8.666	11.387	12.203	10.646	8.416	8.546	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

Note: The funding in this project has been increased due to emphasis on component development in support of adaptive cycle technologies, alternative hydrocarbon jet fuel, and improved fuel efficiency.

(U) **A. Mission Description and Budget Item Justification**

This project develops and demonstrates improved hydrocarbon fuels and advanced, novel aerospace propulsion technologies, including technologies for high-speed/hypersonic flight and technology to increase turbine engine operational reliability, durability, mission flexibility, and performance while reducing weight, fuel consumption, and cost of ownership. The advanced fuel emphasis is on developing and demonstrating new thermally stable, high-heat sink, and controlled chemically reacting fuels for a conventional turbine engine, turbine-based combined cycle engines, and other advanced propulsion systems. The project also develops and demonstrates fuel system components that minimize cost, reduce maintenance, and improve performance of future aerospace systems. The advanced propulsion emphasis is on demonstrating concepts for combined cycle, ramjet, and scramjet engines. This project is integrated into Versatile Affordable Advanced Turbine Engine (VAATE). A portion of this project supports the demonstration of adaptive cycle technologies. This project develops component technology for an adaptive cycle engine architecture that provides optimized performance, fuel efficiency, and durability for widely varying mission needs.

(U) **B. Accomplishments/Planned Program (\$ in Millions)**

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) MAJOR THRUST: Demonstrate thermally stable fuels and fuel system hardware concepts to enhance cooling capacity (performance), minimize fuel coking, and reduce fuel system maintenance. Identify, develop, and demonstrate technologies that enable the use of domestic fuel sources for military energy needs. Determine fuel cooling requirements and specifications for an adaptive cycle engine architecture. Design, fabricate, and test key thermal management technologies, including high heat sink fuels, cooled cooling air systems, and high temperature/thermally efficient fuel pumps for mission adaptive engines. Note: Decreased funding in FY 2009 and out due to emphasis on component development in support of adaptive cycle technologies.	3.929	3.960	1.936
(U) In FY 2007: Studied, tested, and demonstrated advanced high heat sink fuels including those produced from alternative energy resources and hardware concepts that can increase engine performance at high temperatures, improve fuel system durability, and reduce maintenance due to fuel degradation in aircraft and engine hardware. Initiated demonstrations of fuel performance at fuel temperatures in the supercritical regime.			
(U) In FY 2008: Continue demonstrations of fuel combustion performance at fuel temperatures in the supercritical regime, as might be encountered in an engine employing a cooled cooling air system. Demonstrate engine durability benefits from the use of alternative fuels. Develop relationship between alternate fuel composition and key properties, including low temperature viscosity and thermal/storage stability. Improve physical property models for alternative fuels. Develop relationship between fuel/material interactions and fuel (and material) structure.			

Exhibit R-2a, RDT&E Project Justification		DATE February 2008		
BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE		
03 Advanced Technology Development (ATD)	0603216F Aerospace Propulsion and Power Technology	2480 Aerospace Fuels		
(U) B. Accomplishments/Planned Program (\$ in Millions)		<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) In FY 2009: Continue demonstration of engine and airframe durability and performance benefits from the use of alternative fuels. Continue development of knowledge base needed for Air Force-wide certification of alternative fuels, especially biofuels. Continue demonstration of cooled cooling air systems and other advanced aircraft thermal management systems. Determine fuel structure changes required to increase specific gravity to 0.775. Determine elastomer swell agents capable of increasing swell to typical JP-8 levels. Begin determination of new specification requirements for biomass-derived alternative fuels. Develop key thermal management technologies, including high heat sink fuels, cooled cooling air systems, and high temperature/thermally efficient fuel pumps.				
(U) MAJOR THRUST: Determine fuel cooling requirements and specifications for advanced aircraft sensors and directed energy weapons that will meet the needs of evolving manned systems and unmanned aerial vehicle (UAVs). Note: In FY 2008 funding decreases due to higher Air Force priorities.		2.081	0.972	3.872
(U) In FY 2007: Demonstrated advanced low temperature and enhanced performance fuels for UAV applications focusing on technologies that expand the flight envelope, range, or duration of UAVs to include advanced thermal management concepts.				
(U) In FY 2008: Continue to demonstrate advanced low temperature and enhanced performance fuels for UAV applications and the Highly Efficient Embedded Turbine Engine (HEETE), focusing on advanced thermal management technologies that expand the flight envelope, range, or duration of UAVs.				
(U) In FY 2009: Demonstrate an advanced UAV/HEETE thermal management system that includes a cooled cooling air system, as well as advanced approaches for ensuring fuel flow in wing tanks under high altitude, long endurance conditions.				
(U) MAJOR THRUST: Develop and demonstrate efficacy of low-cost, environmentally friendly fuel additives to reduce soot particulate emissions from gas turbine engines using advanced research combustors and small turbine engines. Note: In FY 2007, funding from this Project was moved to support higher Air Force priorities in Project 5098, Advanced Aerospace Propulsion, in this PE. Funding shift caused delay in development of this effort.		2.081	0.972	0.569
(U) In FY 2007: Demonstrated advanced additives to reduce soot and nitrogen oxides emissions in advanced propulsion concepts including combined cycle engines.				
(U) In FY 2008: Demonstrate advanced particulate measurement diagnostics suitable for full-scale engine testing. Initiate demonstration of fuel/combustor concepts that reduce both soot and NOx.				
(U) In FY 2009: Continue to demonstrate advanced particulate measurement diagnostics suitable for full-scale engine testing. Continue demonstration of fuel/combustor concepts that reduce both soot and NOx.				

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY 03 Advanced Technology Development (ATD)	PE NUMBER AND TITLE 0603216F Aerospace Propulsion and Power Technology	PROJECT NUMBER AND TITLE 2480 Aerospace Fuels		
(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u>		<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U)				
(U) MAJOR THRUST: Develop and demonstrate enhancements to fuel system technology. Note: In FY 2007, funding from this Project was moved to support higher Air Force priorities in Project 5098, Advanced Aerospace Propulsion, in this PE. Funding shift caused delay in development of this effort.		1.387	0.972	1.025
(U) In FY 2007: Designed, developed, and demonstrated hardware and fuel system simulators to evaluate key high temperature fuel system components of reusable aerospace vehicles focusing on aerospace vehicles with advanced and combined cycle engines that require high levels of cooling.				
(U) In FY 2008: Develop combined cycle engine cooling systems, utilizing 2nd-generation endothermic fuels and other advanced fuels.				
(U) In FY 2009: Continue development and demonstration of combined cycle engine cooling systems and technologies utilizing 2nd-generation endothermic fuels and other advanced fuels.				
(U)				
(U) MAJOR THRUST: Identify, develop, and demonstrate low-cost approaches to reducing the fuel logistics footprint for the Expeditionary Air Force. Note: In FY 2008, funding from this Project was moved to support higher Air Force priorities in Project 5098, Advanced Aerospace Propulsion, in this PE. Funding shift caused delay in development of this effort.		2.080	0.598	1.025
(U) In FY 2007: Demonstrated advanced nano-technology fuel additives, nano-technology fuel sensors, and novel detection and mitigation technologies for biological growth.				
(U) In FY 2008: Develop model for growth and spread of biological materials through fuel handling systems. Continue to demonstrate advanced nano-technology fuel additives, nano-technology fuel sensors, and novel detection and mitigation technologies for biological growth.				
(U) In FY 2009: Develop ability to model spread of biological materials through fuel handling systems. Initiate demonstration of advanced additives to mitigate biological growth in conventional and alternative aerospace fuels.				
(U)				
(U) MAJOR THRUST: Assured Fuels Initiative: Characterize and demonstrate the use of alternative hydrocarbon jet fuel to comply with Air Force certifications and standards for jet fuels. Note: Funding re-directed within BPAC in FY 2009 due to increased emphasis on development of alternative hydrocarbon jet fuel.		0.000	0.000	2.960
(U) In FY 2007: Not Applicable.				
(U) In FY 2008: Not Applicable.				
(U) In FY 2009: Determine fuel structure changes required to increase specific gravity to 0.775. Determine elastomer swell agents capable of increasing swell to typical JP-8 levels. Begin determination of new specification				

Exhibit R-2a, RDT&E Project Justification	DATE February 2008
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BUDGET ACTIVITY 03 Advanced Technology Development (ATD)	PE NUMBER AND TITLE 0603216F Aerospace Propulsion and Power Technology	PROJECT NUMBER AND TITLE 2480 Aerospace Fuels
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(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
requirements for biomass-derived alternative fuels.			
(U)			
(U) CONGRESSIONAL ADD: Assured Fuels Process Demonstration Unit.	4.476	0.000	0.000
(U) In FY 2007: Developed capability to investigate relationship between alternative jet fuel production processes and resulting fuel properties. Researched effects of feedstock (coal, biomass, etc.) on resulting jet fuel properties.			
(U) In FY 2008: Not Applicable.			
(U) In FY 2009: Not Applicable.			
(U)			
(U) CONGRESSIONAL ADD: Flexible JP-8 Military Fuel Certification.	1.945	0.000	0.000
(U) In FY 2007: Supported development of lean process for certifying non-petroleum-derived jet fuels for Air Force systems. Procured and tested non-petroleum fuels as required for certification.			
(U) In FY 2008: Not Applicable.			
(U) In FY 2009: Not Applicable.			
(U)			
(U) CONGRESSIONAL ADD: Texas Research Institute for Environmental Studies.	0.000	1.192	0.000
(U) In FY 2007: Not Applicable.			
(U) In FY 2008: Continue with the development of a small (air-portable) municipal wastewater treatment system.			
(U) In FY 2009: Not Applicable.			
(U)			
(U) Total Cost	17.979	8.666	11.387

(U) <u>C. Other Program Funding Summary (\$ in Millions)</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to Complete</u>	<u>Total Cost</u>
	<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>		
(U) Related Activities:									
(U) PE 0602203F, Aerospace Propulsion.									
(U) PE 0602102F, Materials.									
(U) PE 0602204F, Aerospace Sensors.									
(U) PE 0603112F, Advanced Materials for Weapons Systems.									

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE

**0603216F Aerospace Propulsion and
Power Technology**

PROJECT NUMBER AND TITLE

2480 Aerospace Fuels**(U) C. Other Program Funding Summary (\$ in Millions)**

(U) This project has been coordinated through the Reliance 21 process to harmonize efforts and eliminate duplication.

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification

DATE
February 2008

BUDGET ACTIVITY 03 Advanced Technology Development (ATD)				PE NUMBER AND TITLE 0603216F Aerospace Propulsion and Power Technology			PROJECT NUMBER AND TITLE 3035 Aerospace Power Technology		
Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
3035 Aerospace Power Technology	13.800	14.379	8.864	9.545	9.623	9.719	9.561	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

- (U) **A. Mission Description and Budget Item Justification**
 This project develops and demonstrates electrical power, thermal management, and distribution for aerospace applications. This technology enhances reliability and survivability, and reduces vulnerability, weight, and life cycle costs for manned and unmanned aerospace vehicles. The electrical power system components developed are projected to provide a two- to five-fold improvement in aircraft reliability and maintainability, and a 20 percent reduction in power system weight. This project also develops and demonstrates electrical power and thermal management technologies to enable solid state high power density sources.
- (U) **B. Accomplishments/Planned Program (\$ in Millions)**
- | | | | |
|---|----------------|----------------|----------------|
| | <u>FY 2007</u> | <u>FY 2008</u> | <u>FY 2009</u> |
| (U) MAJOR THRUST: Develop electrical power and thermal management component subsystem technologies for integration with directed energy weapons (DEW). These technologies will enable the delivery of high power for operation of DEW. Note: In FY 2008 and FY 2009, the efforts in this thrust are reduced due to higher Air Force priorities. | 0.869 | 0.237 | 0.000 |
| (U) In FY 2007: Completed design and performed modeling and simulation of a megawatt non-superconducting low duty cycle generator system tailored to directed energy weapons. | | | |
| (U) In FY 2008: Perform test of high power megawatt class low duty cycle power generation technology. | | | |
| (U) In FY 2009: Not Applicable. | | | |
| (U) | | | |
| (U) MAJOR THRUST: Develop power generation/conditioning/distribution component, energy storage, and thermal management components and subsystem technologies for integration into current and future high power aircraft. These technologies will improve aircraft self-sufficiency, reliability, maintainability, supportability, and system weight/volume ratios, while reducing life cycle costs and enabling new capabilities. Note: In FY 2006 the efforts within this thrust were transferred from other efforts within this project due higher priorities. Efforts will resume in FY 2009. | 0.000 | 0.000 | 3.900 |
| (U) In FY 2007: Not Applicable. | | | |
| (U) In FY 2008: Not Applicable. | | | |
| (U) In FY 2009: Begin design of high temperature demonstrator and fabrication of key components. | | | |
| (U) | | | |
| (U) MAJOR THRUST: Develop electrical power and thermal management components and subsystem technologies for special purpose applications. Note: In FY 2008, this activity will be completed. | 1.413 | 2.255 | 0.000 |
| (U) In FY 2007: Investigated alternative energy storage/generation systems for low power applications. | | | |

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Exhibit R-2a, RDT&E Project Justification		DATE February 2008		
BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE		
03 Advanced Technology Development (ATD)	0603216F Aerospace Propulsion and Power Technology	3035 Aerospace Power Technology		
(U) B. Accomplishments/Planned Program (\$ in Millions)		<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) In FY 2008: Develop and fabricate high power density and high energy density fuel cell and battery energy storage and power and thermal management/distribution components and subsystems. Deliver for field tests to demonstrate a 50% weight reduction.				
(U) In FY 2009: Not Applicable.				
(U) MAJOR THRUST: Develop analytical tools and subsystems for multi-megawatt superconducting electrical power systems including power generation, conditioning, thermal management, and dynamic interaction. Note: In FY 2009, efforts in this thrust closed out due to higher Air Force priorities.		3.151	3.443	0.000
(U) In FY 2007: Began detailed design of megawatt class power demonstrator and began fabrication of key components.				
(U) In FY 2008: Design and fabricate multi-megawatt superconducting power and thermal management components.				
(U) In FY 2009: Not applicable.				
(U) MAJOR THRUST: Develop power and thermal management components and subsystems technologies for fielded and future high power aircraft systems applications. These technologies will enable efficient power and thermal management acquisition, storage, and transport for power on demand with increased system reliability and affordability. Note: In FY 2009, the efforts within this thrust were transferred from other efforts within this Project due to increased emphasis on component and subsystem development in support of high power aircraft systems.		0.000	0.000	4.964
(U) In FY 2007: Not Applicable.				
(U) In FY 2008: Not Applicable.				
(U) In FY 2009: Investigate, design, and develop efficient, lightweight, wide temperature range, rugged/robust power electronics, motor controls, actuators, heat exchangers, and thermal management components and subsystems.				
(U) CONGRESSIONAL ADD: Field Renewable Energy System Hybrids (FRESH) Li Ion Battery Program.		0.973	0.993	0.000
(U) In FY 2007: Developed Li-Ion battery powered field renewable energy systems.				
(U) In FY 2008: Investigate, design, and develop lightweight rechargeable batteries for airman portable power applications enabling carry of lightweight energy systems in the field for sustained operations using renewable/portable energy sources. Focus is on decreasing size/weight of batteries; increasing energy density, and extreme environmental functionality, and implementing state-of-charge communication.				
(U) In FY 2009: Not Applicable.				
(U) CONGRESSIONAL ADD: Development of Bi-Polar Wafer-cell NI-MH Battery.		0.973	1.987	0.000

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY 03 Advanced Technology Development (ATD)	PE NUMBER AND TITLE 0603216F Aerospace Propulsion and Power Technology	PROJECT NUMBER AND TITLE 3035 Aerospace Power Technology
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(U) B. Accomplishments/Planned Program (\$ in Millions)	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) In FY 2007: Evaluated the viability of advanced nickel-metal hydride battery technology to provide an environmental minimum/no maintenance replacement for existing vented nickel-cadmium and valve regulated lead-acid batteries for military aircraft applications.			
(U) In FY 2008: Modify the existing Ni-MH battery bipolar wafer cell design and chemistry for use with Li-ion technology for potential application in the F-35 aircraft in both the 28 V and the 270 V batteries. Demonstrate and deliver a prototype 28 V Li-ion cell pack			
(U) In FY 2009: Not Applicable.			
(U) CONGRESSIONAL ADD: Silicon Carbide (SiC) Power Electronics for More Electric Aircraft.	6.421	5.464	0.000
(U) In FY 2007: Extended the present state-of-the-art on 600V, bias-enhanced, power junction field effect transistor (JFET) technologies. Evaluated new device physics, device designs, and device fabrication technology to continue the development of low specific on-resistance power JFET and rectifier devices.			
(U) In FY 2008: Extend development of JFET technologies beyond FY 2007 accomplishments to large area devices rated at 800 and 1200V for enhancement mode VJFETs with low specific on-resistance.			
(U) In FY 2009: Not Applicable.			
(U) Total Cost	13.800	14.379	8.864

(U) C. Other Program Funding Summary (\$ in Millions)	<u>FY 2007</u> <u>Actual</u>	<u>FY 2008</u> <u>Estimate</u>	<u>FY 2009</u> <u>Estimate</u>	<u>FY 2010</u> <u>Estimate</u>	<u>FY 2011</u> <u>Estimate</u>	<u>FY 2012</u> <u>Estimate</u>	<u>FY 2013</u> <u>Estimate</u>	<u>Cost to</u> <u>Complete</u>	<u>Total Cost</u>
(U) Related Activities:									
(U) PE 0602201F, Aerospace Flight Dynamics.									
(U) PE 0602203F, Aerospace Propulsion.									
(U) PE 0602605F, Directed Energy Technology.									
(U) PE 0603605F, Advanced Weapons Technology.									
(U) This project has been coordinated through the Reliance 21 process to									

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE

0603216F Aerospace Propulsion and
Power Technology

PROJECT NUMBER AND TITLE

3035 Aerospace Power Technology

(U) **C. Other Program Funding Summary (\$ in Millions)**

harmonize efforts and eliminate
duplication.

(U) **D. Acquisition Strategy**

Not Applicable.

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY 03 Advanced Technology Development (ATD)				PE NUMBER AND TITLE 0603216F Aerospace Propulsion and Power Technology			PROJECT NUMBER AND TITLE 4921 Aircraft Propulsion Subsystems Int			
Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total	
4921 Aircraft Propulsion Subsystems Int	27.413	24.696	42.383	39.537	53.046	21.284	20.137	Continuing	TBD	
Quantity of RDT&E Articles	0	0	0	0	0	0	0			

Note: In FY 2009, The funding in this project has been increased due to emphasis on component development in support of adaptive cycle technologies.

(U) **A. Mission Description and Budget Item Justification**

This project develops and demonstrates technology to increase turbine engine operational reliability, durability, mission flexibility, and performance, while reducing weight, fuel consumption, and cost of ownership. This project includes Aerospace Propulsion Subsystems Integration (APSI), which includes demonstrator engines such as Joint Technology Demonstrator Engine for manned systems and Joint Expendable Turbine Engine Concept for unmanned air vehicle and cruise missile applications. Demonstrator engines integrate core (high-pressure spool) technology developed under Advanced Turbine Engine Gas Generator project with engine (low-pressure spool) technology such as fans, turbines, engine controls, mechanical systems, exhaust nozzles, and augmentors. Additionally, these efforts include activities under national Propulsion Safety And Readiness (PSAR). This project also focuses on integration of inlets, nozzles, engine/airframe compatibility, and power and thermal management subsystems technologies. APSI provides aircraft with potential for longer range and higher cruise speeds with lower specific fuel consumption, surge power for successful engagements, high sortie rates with reduced maintenance, reduced life cycle cost, and improved survivability, resulting in increased mission effectiveness. Technologies developed are applicable to sustained high-speed vehicles and responsive space launch. APSI supports goals of Versatile Affordable Advanced Turbine Engine (VAATE), which is focused on improving propulsion capabilities while at the same time reducing cost of ownership. Anticipated technology advances include turbine engine improvements providing approximately twice the range for a sustained supersonic combat aircraft, doubling time on station with 10 times power output for surveillance aircraft, and propulsion for a high speed supersonic missile with double the range for time sensitive targets. VAATE provides continuous technology transition for military turbine engine upgrades and derivatives, and has added dual-use benefit of enhancing United States turbine engine industry's international competitiveness. A portion of this project supports demonstration of adaptive cycle technologies, which develop component technology for an adaptive cycle engine architecture that provides optimized performance, fuel efficiency, and durability for widely varying mission needs.

(U) **B. Accomplishments/Planned Program (\$ in Millions)**

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) MAJOR THRUST: Design, fabricate, and demonstrate durability and integration technologies for turbofan/turbojet engines. These technologies will improve durability, supportability, and affordability of current and future Air Force aircraft.	1.285	0.817	1.696
(U) In FY 2007: Fabricated agile combat support engine technologies to increase durability of components to include advanced aerodynamics for fans, turbines, mechanical systems, interactions between the inlet and fan, and controls/accessories.			
(U) In FY 2008: Begin testing agile combat support engine technologies to increase durability of components to include advanced aerodynamics for fans, turbines, mechanical systems, interactions between the inlet and fan, and controls/accessories.			
(U) In FY 2009: Complete testing and begin validation of engine life models for engine components for agile combat			

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE

0603216F Aerospace Propulsion and
Power Technology

PROJECT NUMBER AND TITLE

4921 Aircraft Propulsion Subsystems
Int(U) **B. Accomplishments/Planned Program (\$ in Millions)**

support technologies. Initiate design of advanced features for durable fans, turbines, mechanical systems, interactions between the inlet and fan, and controls/accessories.

(U)

(U) MAJOR THRUST: Design, fabricate, and test advanced component technologies for improved performance and fuel consumption of turbofan/turbojet engines for fighters, bombers, sustained supersonic and hypersonic cruise vehicles, surveillance aircraft and transports. Each of these component technology innovations can be applied to a significant part of the Air Force's engine inventory and offer potentially significant performance enhancements to future aircraft engines enabling faster, more responsive systems with longer range and greater payload. Design, fabricate, and test advanced component technologies for improved performance, fuel consumption, durability, and cost for mission adaptive engines in full-engine environments. Note: In FY 2009, increased funding is for final assembly and substantial testing that will begin on large demonstrator engines.

(U) In FY 2007: Enhanced advanced designs and began fabrication and testing for lightweight high bypass engine (utilizes a hollow fan and radial compressor) capable of operating as primary propulsion or in a lift mode. Enhanced advanced engine designs for a sustained supersonic engine using variable cycle features, an advanced fan, improved turbine using cooled metal and cooled ceramic matrix composites (CMCs), and lightweight CMC cases and ducts.

(U) In FY 2008: Finish testing of lightweight high bypass engine components (utilizes a hollow fan and radial compressor) capable of operating as primary propulsion or in a lift mode. Begin fabrication and assembly of advanced engine designs for a supersonic engine using variable cycle features, advanced fan, improved turbine using cooled metal and cooled CMCs, advanced augmentor, and lightweight CMC cases and ducts. Begin and finish preliminary design of advanced adaptive cycle (third air stream) engine technologies, including an advanced fan, high work variable low turbine for long dwell time, controls, inlet integration, and advanced exhaust nozzle for subsonic to sustained supersonic flight. Begin detailed design and procurement of long lead hardware for an advanced adaptive cycle (third air stream) engine technologies, including an advanced fan, high work variable low turbine for long dwell time, controls, inlet integration, and advanced exhaust nozzle for subsonic to sustained supersonic flight.

(U) In FY 2009: Finish assembly and begin testing of engine designs for a supersonic and subsonic engine using variable cycle features, an advanced fan, improved turbine using cooled metal and cooled CMCs, advanced augmentor, and lightweight CMC cases and ducts. Initiate design of high bypass ultra fuel efficient engine. Finish detailed design of advanced adaptive cycle (third air stream) engine technologies, including an advanced fan, high work variable low turbine for long dwell time, controls, inlet integration, and advanced exhaust nozzle for subsonic to sustained supersonic flight. Finish detailed design and initiate fabrication of advanced fan, high work variable low

FY 2007FY 2008FY 2009

9.138

8.830

33.906

UNCLASSIFIED

Exhibit R-2a, RDT&E Project Justification		DATE February 2008		
BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE		
03 Advanced Technology Development (ATD)	0603216F Aerospace Propulsion and Power Technology	4921 Aircraft Propulsion Subsystems Int		
(U) B. Accomplishments/Planned Program (\$ in Millions)		<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
turbine for long dwell time, controls, inlet integration, and advanced exhaust nozzle for subsonic to sustained supersonic flight. Initiate preliminary design for a high bypass/high overall pressure ratio engine for improved fuel consumption.				
(U) MAJOR THRUST: Design, fabricate, and test advanced component technologies for limited life engines. These technologies improve performance, durability, and affordability of engines for missile and unmanned air vehicles (UAVs), and subsonic to hypersonic weapon applications. Note: In FY 2008 and out, increased funding is to conduct component hardware fabrication and engine testing.		3.855	6.704	6.781
(U) In FY 2007: Fabricated advanced high temperature cooled turbine blade and combustor for UAV applications. Began fabrication of advanced components for technologies for intelligent and durability engine testing to include an advanced fan/compressor, a ceramic turbine, turbine with new advanced cooling approach, and oil-less bearings for missile applications.				
(U) In FY 2008: Finish fabrication of engine components of advanced high temperature cooled turbine blade and combustor for UAV applications. Finish fabrication and begin assembly of advanced components for technologies for engine testing to include an advanced lightweight fan/compressor, turbines with new advanced cooling approaches, oil-less bearings and high through flow combustors for missile applications. Begin testing of advanced components for technologies for engine testing to include an advanced light weight fan/compressor, turbines with new advanced cooling approaches, oil-less bearings and high thru flow combustors for missile applications.				
(U) In FY 2009: Finish testing of advanced components for technologies for engine testing to include an advanced light weight fan/compressor, turbines with new advanced cooling approaches, oil-less bearings and high thru flow combustors for missile applications. Initiate design of a higher specific thrust low cost high mach expendable turbine engine for improved fuel efficiency improving range. Initiate low spool components for fuel efficient subsonic unmanned turbofan engines.				
(U) CONGRESSIONAL ADD: Versatile Affordable Advance Turbine Engine (VAATE)-Small Turbofan (STF). This add in FY 2007 was previously titled XTC58F Technology Versatile Affordable Advanced Turbine Engine Program (Note: Only for the XTC 58F/1 demonstrator program).		7.784	3.576	0.000
(U) In FY 2007: Established conceptual design of highly efficient embedded turbine engine based around small turbofan core. Designed and evaluated high pressure compressor rig; improved bearings, improved seals, and thermal barrier coating for the high pressure turbine. Assessed integration issues such as incorporation of variable exhaust nozzle.				
(U) In FY 2008: This effort will add additional high pressure turbine component test time, additional engine core test				

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY 03 Advanced Technology Development (ATD)	PE NUMBER AND TITLE 0603216F Aerospace Propulsion and Power Technology	PROJECT NUMBER AND TITLE 4921 Aircraft Propulsion Subsystems Int
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(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
time, conceptual studies for Revolutionary Hunter-Killer core applications with air framers, and cover hardware costs.			
(U) In FY 2009: Not Applicable.			
(U)			
(U) CONGRESSIONAL ADD: Versatile Affordable Advance Turbine Engine (VAATE), High Speed Turbine Demonstrator. This add in FY 2007 was previously titled Acceleration VAATE Advanced Supersonic Cruise Missile Engine (formerly VAATE Advanced Supersonic Cruise Missile Engine).	5.351	4.769	0.000
(U) In FY 2007: Defined and developed Long Range Strike Mach 4+ expendable turbine engine technologies.			
(U) In FY 2008: Develop an advanced variable nozzle, continue hardware materials process development, and continue risk reduction efforts for the high speed engine demonstrator.			
(U) In FY 2009: Not Applicable.			
(U) Total Cost	27.413	24.696	42.383

(U) <u>C. Other Program Funding Summary (\$ in Millions)</u>	<u>FY 2007</u> <u>Actual</u>	<u>FY 2008</u> <u>Estimate</u>	<u>FY 2009</u> <u>Estimate</u>	<u>FY 2010</u> <u>Estimate</u>	<u>FY 2011</u> <u>Estimate</u>	<u>FY 2012</u> <u>Estimate</u>	<u>FY 2013</u> <u>Estimate</u>	<u>Cost to</u> <u>Complete</u>	<u>Total Cost</u>
(U) Related Activities									
(U) PE 0602201F, Aerospace Flight Dynamics.									
(U) PE 0602203F, Aerospace Propulsion.									
(U) PE 0603003A, Aviation Advanced Technology.									
(U) This project has been coordinated through the Reliance 21 process to harmonize efforts and eliminate duplication.									
(U) <u>D. Acquisition Strategy</u> Not Applicable.									

Exhibit R-2a, RDT&E Project Justification

DATE
February 2008

BUDGET ACTIVITY 03 Advanced Technology Development (ATD)							PE NUMBER AND TITLE 0603216F Aerospace Propulsion and Power Technology		PROJECT NUMBER AND TITLE 4922 Space & Missile Rocket Propulsion	
Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total	
4922 Space & Missile Rocket Propulsion	4.652	4.703	5.082	2.094	2.847	5.465	4.122	Continuing	TBD	
Quantity of RDT&E Articles	0	0	0	0	0	0	0			

(U) A. Mission Description and Budget Item Justification

This project develops and demonstrates technologies for sustainment of strategic systems (including solid boost/missile propulsion, Post Boost Control, and aging and surveillance efforts) and tactical rockets. Characteristics such as environmental acceptability, affordability, reliability, reduced weight, and reduced operation and launch costs are emphasized. Increased life and performance of propulsion systems are key goals. Technology areas investigated include ground demonstrations of compact, lightweight, advanced propulsion systems, higher efficiency energy conversion systems (derived from an improved understanding of combustion fundamentals), and high-energy propellants. Technological advances developed in this program are being accomplished in two phases to improve the performance of expendable systems' payload capabilities by approximately 25 percent (Phase I)/35 percent (Phase II) and reduce hardware and operation costs by approximately 25 percent (Phase I)/35 percent (Phase II). Aging and Surveillance efforts could reduce lifetime prediction uncertainties for individual motors by 50 percent, enabling motor replacement for cause. This program is part of the Technologies for the Sustainment of Strategic Systems program and supports Integrated High Payoff Rocket Propulsion Technology (IHRPT).

(U) B. Accomplishments/Planned Program (\$ in Millions)

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) MAJOR THRUST: Develop and demonstrate missile propulsion and Post Boost Control Systems (PBCS) technologies for ballistic missiles. Note: In FY 2008, this effort will be completed.	3.629	0.658	0.000
(U) In FY 2007: Completed testing the first of two motors for the Missile Propulsion Demonstration.			
(U) In FY 2008: Complete testing of the second of two motors for the Missile Propulsion Demonstration.			
(U) In FY 2009: Not Applicable.			
(U) MAJOR THRUST: Develop and demonstrate missile propulsion, PBCS, aging, and surveillance technologies for strategic systems. Efforts support Technology for Sustainment of Strategic Systems (TSSS). Note: In FY 2008 and out, funding increase supports build up and testing in a full-scale missile propulsion demonstration.	0.558	2.352	3.354
(U) In FY 2007: Completed modeling and simulation tools development for analyzing and developing missile components. Began development of subcomponents to test the accuracy of the previously developed modeling and simulation tools and updated the models with the resulting data for use in an upcoming missile propulsion demonstration.			
(U) In FY 2008: Continue development of subcomponents to test the accuracy of the previously developed modeling and simulation tools and update the models with the resulting data for use in an upcoming missile propulsion demonstration.			
(U) In FY 2009: Complete sub-scale component developments providing sub-scale validation of modeling and			

Exhibit R-2a, RDT&E Project Justification	DATE February 2008
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BUDGET ACTIVITY 03 Advanced Technology Development (ATD)	PE NUMBER AND TITLE 0603216F Aerospace Propulsion and Power Technology	PROJECT NUMBER AND TITLE 4922 Space & Missile Rocket Propulsion
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(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
simulation tools. Initiate full-scale demonstration of advanced missile propulsion components, advanced solid propellants, and advanced modeling and simulation tools.			
(U) MAJOR THRUST: Develop and demonstrate aging and surveillance technologies for strategic systems to reduce lifetime prediction uncertainties for individual motors by 50 percent, enabling motor replacement for cause. Efforts support Technology for Sustainment of Strategic Systems (TSSS). Note: FY 2008 and out, funding increased to conduct demonstrations of aging and surveillance technologies.	0.465	1.693	1.728
(U) In FY 2007: Initiated scale-up activities for an advanced service life prediction program integrating existing and advanced sensors, models, and tools to predict service life of a solid rocket motor on a motor-by-motor basis.			
(U) In FY 2008: Continue scale-up activities for an advanced service life prediction program integrating existing and advanced sensors, models, and tools to be able to predict the service life of a solid rocket motor on a motor-by-motor basis.			
(U) In FY 2009: Begin full-scale demonstration of advanced aging and surveillance tools for solid rocket motors to validate and verify modeling and simulation tools and component technologies.			
(U) Total Cost	4.652	4.703	5.082

(U) <u>C. Other Program Funding Summary (\$ in Millions)</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to Complete</u>	<u>Total Cost</u>
	<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>		
(U) Related Activities:									
(U) PE 0602102F, Materials.									
(U) PE 0602203F, Aerospace Propulsion.									
(U) PE 0602601F, Spacecraft Technology.									
(U) PE 0603401F, Advanced Spacecraft Technology.									
(U) PE 0603500F, Multi-Disciplinary Advanced Development Space Technology.									
(U) PE 0603853F, Evolved									

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE

**0603216F Aerospace Propulsion and
Power Technology**

PROJECT NUMBER AND TITLE

**4922 Space & Missile Rocket
Propulsion****(U) C. Other Program Funding Summary (\$ in Millions)**

Expendable Launch Vehicle
Program.

(U) PE 0603114N, Power Projection
Advanced Technology.

(U) This project has been
coordinated through the
Reliance 21 process to
harmonize efforts and eliminate
duplication.

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification

DATE
February 2008

BUDGET ACTIVITY 03 Advanced Technology Development (ATD)				PE NUMBER AND TITLE 0603216F Aerospace Propulsion and Power Technology			PROJECT NUMBER AND TITLE 5098 Advanced Aerospace Propulsion		
Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
5098 Advanced Aerospace Propulsion	32.839	21.741	22.984	24.306	14.945	23.271	21.731	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

Note: Funding is higher in FY 2007 and FY 2009 to support ground demonstrations and fabrication of test vehicles for flight demonstrations.

(U) A. Mission Description and Budget Item Justification

This project develops and demonstrates, via ground and flight tests, scramjet propulsion cycle to a technology readiness level appropriate for full integration with other engine cycles (including turbine and rocket-based) to provide the Air Force with transformational military capabilities. The primary focus is on hydrocarbon-fueled, scramjet engine. Multi-cycle engines will provide propulsion systems for possible application to support aircraft and weapon platforms operating over a range of Mach 0 to 8+. Efforts include scramjet flow-path optimization to enable operation over the widest possible range of Mach numbers, active combustion control to assure continuous positive thrust (even during mode transition), robust flame-holding to maintain stability through flow distortions, and maximized volume-to-surface area to minimize thermal load imposed by the high-speed engine. Thermal management plays a vital role in scramjet and combined cycle engines, including considerations for protecting low speed propulsion systems (e.g., turbine engines) during hypersonic flight.

(U) B. Accomplishments/Planned Program (\$ in Millions)

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) MAJOR THRUST: Develop and demonstrate technologies for a hydrocarbon-fueled scramjet with robust operation over a range of Mach 4 to 8.	32.839	21.741	22.984
(U) In FY 2007: Completed engine and vehicle designs and conducted vehicle critical design review. Fabricated and tested flight clearance engine and initiated fabrication of flight engines. Established flight test profiles and margins. Initiated fabrication of air vehicle flight hardware and began flight test preparations at supporting test centers.			
(U) In FY 2008: Complete fabrication of air vehicle flight hardware and finalize flight test preparations at supporting test centers (Air Force Flight Test Center and Point Mugu Test Center).			
(U) In FY 2009: Conduct integrated air vehicle/propulsion flight tests and conduct post test data reduction and reporting.			
(U) Total Cost	32.839	21.741	22.984

(U) C. Other Program Funding Summary (\$ in Millions)

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to</u>	<u>Total Cost</u>
	<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Complete</u>	
(U) Related Activities:									
(U) PE 0602102F, Materials.									
(U) PE060203F, Aerospace Propulsion.									

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE

**0603216F Aerospace Propulsion and
Power Technology**

PROJECT NUMBER AND TITLE

**5098 Advanced Aerospace
Propulsion****(U) C. Other Program Funding Summary (\$ in Millions)**

(U) This project will be coordinated through the Reliance 21 process to harmonize efforts and eliminate duplication.

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification

DATE
February 2008

BUDGET ACTIVITY 03 Advanced Technology Development (ATD)				PE NUMBER AND TITLE 0603216F Aerospace Propulsion and Power Technology			PROJECT NUMBER AND TITLE 681B Advanced Turbine Engine Gas Generator		
Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
681B Advanced Turbine Engine Gas Generator	26.662	34.279	56.624	69.118	44.387	32.141	30.238	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

Note: In FY 2008 and out, funding has been increased in FY 2008 and out due to emphasis on component development in support of adaptive cycle demonstrations, highly efficient embedded turbine engines, and small heavy fueled engines.

(U) **A. Mission Description and Budget Item Justification**

This project develops and demonstrates technology to increase turbine engine operational reliability, durability, mission flexibility, and performance while reducing weight, fuel consumption, and cost of ownership. The objective is to provide continued evolution of technologies into an advanced gas generator in which performance, cost, durability, reparability, and maintainability can be assessed in a realistic engine environment. The gas generator, or core, is the basic building block of the engine and nominally consists of a compressor, a combustor, a high-pressure turbine, mechanical systems, and core subsystems. Experimental core engine demonstration validates engineering design tools and enhances rapid, low-risk transition of key engine technologies into engineering development, where they can be applied to derivative and/or new systems. These technologies are applicable to a wide range of military and commercial systems including aircraft, missiles, land combat vehicles, ships, and responsive space launch. Component technologies are demonstrated in a core (sub-engine). This project also assesses impact of low spool components (such as inlet systems, fans, low pressure turbines, and exhaust systems) and system level technologies (such as integrated power generators and thermal management systems) on core engine performance and durability in "core-centric engine" demonstration. The core performances of this project are validated on demonstrator engines in Project 4921 of this PE. Efforts are part of Versatile Affordable Advanced Turbine Engines (VAATE). A portion of this project supports the demonstration of adaptive cycle technologies, which develop component technology for an adaptive cycle engine architecture that provides optimized performance, fuel efficiency, and durability for widely varying mission needs.

(U) **B. Accomplishments/Planned Program (\$ in Millions)**

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) MAJOR THRUST: Design, fabricate, and demonstrate performance predictions in core engines, using innovative engine cycles and advanced materials to provide greater durability, improved performance, and reduced fuel consumption for turbofan/turbojet engines for fighters, attack aircraft, bombers, sustained supersonic and combined cycle hypersonic cruise vehicles, and large transports. Each of these technology innovations can be applied to a significant part of the Air Force's engine inventory and offer potentially significant performance enhancements to future aircraft engines, thus enabling new capabilities for faster, survivable, durable, more responsive systems with longer range and greater payloads for long range strike capability. Note: In FY 2009, funding increased to complete hardware fabrication and conduct engine demonstrations.	21.088	21.303	45.299
(U) In FY 2007: Completed detailed design and began fabrication of advanced core engine technologies, including advanced turbine blade materials incorporating next generation cooling schemes, novel coatings to reduce combustor and turbine heat loads, ceramic turbine components, and systems for active control, thermal management, and power			

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE

0603216F Aerospace Propulsion and Power Technology

PROJECT NUMBER AND TITLE

681B Advanced Turbine Engine Gas Generator

(U) **B. Accomplishments/Planned Program (\$ in Millions)**FY 2007FY 2008FY 2009

extraction. Completed preliminary design and risk reduction planning for a tip turbine concept, including a novel compression system, innovative annular combustor, and advanced rotating seals. Designed and began fabrication of unique compression system components.

(U) In FY 2008: Complete fabrication and initiate instrumentation and assembly of advanced core engine components, including advanced turbine blade materials incorporating next generation cooling schemes, novel coatings to reduce combustor and turbine heat loads, ceramic turbine components, and systems for active control, thermal management, and power extraction. Complete detailed design and initiate fabrication for a tip turbine concept, including a novel compression system, innovative annular combustor, and advanced rotating seals. Complete design and fabrication of unique compression system components. Initiate preliminary design of high temperature capable, durable compressor, combustor, and turbine for sustained supersonic long range strike core engine.

(U) In FY 2009: Complete assembly and demonstration of advanced core engine components, including advanced turbine blade materials incorporating next generation cooling schemes, novel coatings to reduce combustor and turbine heat loads, ceramic turbine components, and systems for active control, thermal management, and power extraction. Complete fabrication and initiate performance demonstration of a tip turbine concept, including a novel compression system, innovative annular combustor, and advanced rotating seals. Complete fabrication, assembly and experimental demonstration of unique compression system components. Complete preliminary design of high temperature capable, durable compressor, combustor, and turbine for sustained supersonic long range strike core engine.

(U) MAJOR THRUST: Design, fabricate, and demonstrate high overall pressure ration cores to provide increased durability and affordability with lower fuel consumption for turbofan/turboshaft engines for long endurance high altitude unmanned air vehicles for persistent intelligence surveillance reconnaissance, intertheater/intratheater transports, subsonic Unmanned Air Systems (UAS), and powered munitions. Note: In FY 2008 and out, funding in this effort has been increased due to emphasis on component development in support of highly efficient embedded turbine engines and small heavy fueled engines.

3.433

11.983

11.325

(U) In FY 2007: Completed detailed design and initiated fabrication of core components for highly efficient core engine concept with advanced core technologies including high efficiency, high pressure ratio, high temperature capability compressor, high efficiency, high heat release combustor, and high work, high cooling effectiveness turbine with an integrated thermal management system and advanced mechanical systems. Completed experimental demonstration of multi-Service heavy fuel engine technologies for future rotorcraft.

(U) In FY 2008: Complete fabrication and initiate assembly of highly efficient core engine components concept with

Exhibit R-2a, RDT&E Project Justification		DATE February 2008		
BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE		
03 Advanced Technology Development (ATD)	0603216F Aerospace Propulsion and Power Technology	681B Advanced Turbine Engine Gas Generator		
(U) B. Accomplishments/Planned Program (\$ in Millions)		<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
advanced core technologies including high efficiency, high pressure ratio, high temperature capability compressor, high efficiency, high heat release combustor, and high work, high cooling effectiveness turbine with an integrated thermal management system and advanced mechanical systems. Create preliminary design of UAS small versatile affordable advanced core engine technologies including an efficient high pressure compressor, a high heat release combustor, and high performance turbine, and systems for thermal management and advanced power extraction.				
(U) In FY 2009: Complete assembly and demonstrate a highly efficient core engine concept with advanced core technologies including high efficiency, high pressure ratio, high temperature capability compressor, high efficiency, high heat release combustor, and high work, high cooling effectiveness turbine with an integrated thermal management system and advanced mechanical systems. Initiate design of higher pressure ratio core components. Conduct preliminary design of core for highly efficient core engine concept with advanced core technologies including high efficiency, high pressure ratio, high temperature capability compressor, high efficiency, high heat release combustor, and high work, high cooling effectiveness turbine with an integrated thermal management system and advanced mechanical systems. Complete design, initiate hardware fabrication, and continue selective risk reduction experimental demonstrations of UAS small versatile affordable advanced core engine technologies including a high heat release combustor, durable high performance turbine, and systems for thermal management and advanced power extraction.				
(U) CONGRESSIONAL ADD: Versatile Affordable Advanced Turbine Engines (VAATE) (Note: only for project 681B).		2.141	0.000	0.000
(U) In FY 2007: Identified and evaluated engine control issues and effects of rapidly drawing large amounts of power off the engine. Assessed viability of a new combustor configuration, an advanced turbine cooling concept, and an advanced high pressure compressor rotor.				
(U) In FY 2008: Not Applicable.				
(U) In FY 2009: Not Applicable.				
(U) CONGRESSIONAL ADD: Ceramic Matric Composite (CMC) Airfoil Capability Enhancements		0.000	0.993	0.000
(U) In FY 2007: Not Applicable.				
(U) In FY 2008: This program will demonstrate CMC airfoil fabrication capability enhancements for application to advanced aerospace gas turbines. Focus will be on design, fabrication, and testing of critical airfoil sub-elements.				
(U) In FY 2009: Not Applicable.				
(U) Total Cost		26.662	34.279	56.624

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE

0603216F Aerospace Propulsion and Power Technology

PROJECT NUMBER AND TITLE

681B Advanced Turbine Engine Gas Generator

(U) **C. Other Program Funding Summary (\$ in Millions)**

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to</u>	<u>Total Cost</u>
	<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Complete</u>	

(U) Related Activities:

(U) PE 0602201F, Aerospace Flight Dynamics.

(U) PE 0602203F, Aerospace Propulsion.

(U) PE 0603003A, Aviation Advanced Technology.

(U) This project has been coordinated through the Reliance 21 process to harmonize efforts and eliminate duplication.

(U) **D. Acquisition Strategy**

Not Applicable.

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PE NUMBER: 0603231F

PE TITLE: Crew Systems and Personnel Protection Technology

Exhibit R-2, RDT&E Budget Item Justification

DATE

February 2008

BUDGET ACTIVITY

03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE

0603231F Crew Systems and Personnel Protection Technology

Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
Total Program Element (PE) Cost	39.503	38.406	26.630	32.630	30.534	33.017	34.942	Continuing	TBD
2830 Decision Effectiveness Technology	26.580	29.420	18.295	23.906	22.205	23.588	25.724	Continuing	TBD
4924 Warfighter Readiness Technology	9.149	6.209	6.050	5.737	5.301	6.062	5.896	Continuing	TBD
5020 Bioeffects & Protection Technology	3.774	2.777	2.285	2.987	3.028	3.367	3.322	Continuing	TBD

Note: FY 2008 funding totals do not include \$0.3 million FY 2008 GWOT requirements still pending Congressional consideration. Funds for the FY 2008 Congressionally-directed Virtual Medical Trainer in the amount of \$2.4 million are in the process of being moved to the Defense Health Program from PE 0603231F, Crew Systems and Personnel Protection Technology, for execution.

(U) A. Mission Description and Budget Item Justification

This program develops and demonstrates technologies to enhance human performance and effectiveness and to enable the aerospace force. State-of-the-art advances are made to train personnel, protect and sustain warfighters, and improve human interfaces with weapon systems. The Decision Effectiveness Technology project develops and demonstrates warfighter capability enhancing technologies that promote effective decision-making, control, and mission execution in the emerging network-enabled operational environments. The Warfighter Readiness Technology project develops and demonstrates advanced training, simulation, and mission rehearsal technologies. The Bioeffects and Protection Technology project develops and demonstrates advanced technologies to provide laser eye protection, assure the safety of personnel involved with test, deployment, and operation of high-energy laser weapons, enhance capabilities for sustained operations in extreme environments, and deliver novel, tailored bio-taggant and identification/neutralization capabilities to meet specific AF special operations needs. Note: In FY 2008, Congress added \$1.0 million for Variable Transmittance Visor, \$2.4 million for Virtual Medical Trainer, \$1.6 million for Battlefield Automatic Life Status Monitor (BALSM), \$2.7 million for Low Cost/Improved Performance for Helmet Display and Life Support Technologies, and \$2.4 million for Water Purification with Fused Carbon Nanotube Nanostructured Material. This program is in Budget Activity 3, Advanced Technology Development, since it develops and demonstrates technologies to protect and enhance the performance of Air Force personnel in operational environments.

Exhibit R-2, RDT&E Budget Item Justification

DATE

February 2008

BUDGET ACTIVITY

03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE

0603231F Crew Systems and Personnel Protection Technology

(U) **B. Program Change Summary (\$ in Millions)**

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) Previous President's Budget	43.890	28.558	29.376
(U) Current PBR/President's Budget	39.503	38.406	26.630
(U) Total Adjustments	-4.387	9.848	
(U) Congressional Program Reductions			
Congressional Rescissions		-0.252	
Congressional Increases		10.100	
Reprogrammings	-3.518		
SBIR/STTR Transfer	-0.869		
(U) <u>Significant Program Changes:</u>			
Not Applicable.			

C. Performance Metrics
Under Development.

Exhibit R-2a, RDT&E Project Justification

DATE
February 2008

BUDGET ACTIVITY 03 Advanced Technology Development (ATD)				PE NUMBER AND TITLE 0603231F Crew Systems and Personnel Protection Technology			PROJECT NUMBER AND TITLE 2830 Decision Effectiveness Technology		
Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
2830 Decision Effectiveness Technology	26.580	29.420	18.295	23.906	22.205	23.588	25.724	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

Note: Funds for the FY 2008 Congressionally-directed Virtual Medical Trainer in the amount of \$2.4 million are in the process of being moved to the Defense Health Program from PE 0603231F, Crew Systems and Personnel Protection Technology, for execution.

(U) A. Mission Description and Budget Item Justification

This project develops and demonstrates warfighter capability enhancing technologies and information operations technologies that promote effective decision-making, control, and mission execution in the emerging network-enabled operational environment. Included are advanced technologies that improve the ability of battlefield airmen to rapidly assimilate critical information and make timely and correct decisions, display technologies and decision aids that enhance time-critical strikes, and warfighter interface technologies that simplify and speed critical operations in air operation centers and battle management platforms. The project also develops technologies that enhance logistics functions, improve the fidelity and accuracy of large-scale military simulations, protect deployed personnel, improve human effectiveness during aerospace and cyber operations, support development of novel, tailored bio-taggant and identification/neutralization capabilities, develop aircrew system technologies to support long duration missions, and improve the manhunt capabilities of AF special operations. The ultimate goal is to assure warfighter decision effectiveness in AF operations.

(U) B. Accomplishments/Planned Program (\$ in Millions)

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) MAJOR THRUST: Develop and demonstrate human-centered tools for the Air Force Information Operations (IO) and Intelligence, Surveillance and Reconnaissance (ISR) communities. Provide the IO/ISR/Cyber warrior with tailored decision support systems, guidelines for effective selection of IO/ISR/Cyber warriors, IO/ISR/Cyber simulators and training systems, enhanced decision-making tools, and automated tools to reduce ever-increasing data load and improve mission accomplishment.	2.778	1.682	2.685
(U) In FY 2007: Developed maturing IO/ISR tools, methods, and technology to gain, exploit, defend, and attack information. Matured and developed IO capabilities enhancement technology. Developed and demonstrated tools and techniques to improve operator performance for ISR planning and analysis. Began to develop ISR optimal displays and enhanced exploitation for ISR operators. Began to develop advanced training methodologies and tools for ISR operators.			
(U) In FY 2008: Develop and demonstrate the utility and effectiveness of ISR operator planning tools. Continue development and demonstration of operator-aiding technologies to exploit data from new ISR sensors and reduce data overload. Expand IO/ISR training research and evaluate new regimens to address training for new ISR missions. Develop Influence Operations technologies and facilitate transition into follow-on IO/ISR operator workload optimization development.			
(U) In FY 2009: Design advanced IO/ISR/Cyber technologies and demonstrate next-generation IO/ISR/Cyber operator			

Exhibit R-2a, RDT&E Project Justification		DATE February 2008		
BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE		
03 Advanced Technology Development (ATD)	0603231F Crew Systems and Personnel Protection Technology	2830 Decision Effectiveness Technology		
(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u>		<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
workstation capabilities to operationally integrate/normalize AF non-kinetic capabilities with kinetic operations. Continue development of operator-aiding and training tools for IO/ISR/Cyber operators. Initiate advanced Cyber influence development.				
(U) MAJOR THRUST: Develop and demonstrate human effectiveness technologies to improve combat effectiveness reporting, situation assessment updates, and decision support for Combined Air and Space Operations Centers (CAOC).		3.650	1.938	1.891
(U) In FY 2007: Commenced field tests of the visualization tools in an operational environment or exercise. Developed additional tools, including spatial audio and voice-over-Internet-protocol communication, to allow more advanced collaboration within the strategy division and with other groups in the CAOC.				
(U) In FY 2008: Develop a predictive analysis tool based on continuous and dynamic operational effects assessment. Based on operator field test results, develop enhancements that foster command level interaction with the visualization tool for rapid and actionable decision-making.				
(U) In FY 2009: Integrated visualization tools with other collaborative tools to create a seamless flow of operational assessment data into strategy planning data. Demonstrate a final visually-oriented, unified strategy planning and assessment support tool in a simulated CAOC.				
(U) MAJOR THRUST: Develop and demonstrate technologies to interface between ground controllers and multiple machine components through unified visual and auditory displays. Technologies address ground controller-specific requirements leading to faster mission execution timelines, reduced targeting and fratricide errors, and increased situational awareness through positional awareness of friend and foe in combat zones. Develop technologies permitting supervisory-level interfaces between ground controllers and multiple, highly autonomous unmanned aerial vehicles (UAV). Employ real-time wargaming simulations and field tests to quantify the decision-making benefits from advanced control/display portrayal concepts that optimize net-centric information flow to system operators.		3.935	3.651	3.933
(U) In FY 2007: Completed development and demonstration of advanced interface technologies between ground controllers and multiple machine components through unified visual and auditory displays. Demonstrated UAV interfaces featuring intelligent agent search patterns in the ground controller operational environment. Demonstrated operator headgear incorporating basic operator status reporting and wearable displays. Demonstrated user independent speech recognition and language translation customized for ground controller equipment and Terminal Attack Control (TAC) earplug microphones.				

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE

0603231F Crew Systems and
Personnel Protection Technology

PROJECT NUMBER AND TITLE

2830 Decision Effectiveness
Technology(U) **B. Accomplishments/Planned Program (\$ in Millions)**FY 2007FY 2008FY 2009

- (U) In FY 2008: Commence a spiral development to extend the capabilities of the advanced interface technologies that link ground controllers with multiple machine components through unified visual and auditory displays. Demonstrate in an operational setting improved human interaction with transmission of target data, in order to improve speed and accuracy while offering a common situation display for Joint services interoperability. Provide human factors design updates to battlefield air operations kit components, providing faster setup and deployment of micro-UAV as well as integrated power management for wearable components. Demonstrate user-independent speech recognition and language translation customized for ground controller equipment and TAC earplug microphones. Begin hardware and software implementation of a supervisory control station technology baseline. Begin concept development for a next-generation supervisory control station, and plan to assess projected benefits in terms of operator mission performance and overall usability relative to the technology baseline station.
- (U) In FY 2009: Continue to develop and demonstrate human systems integration concepts for ground controllers and other battlefield airmen. Demonstrate technologies for three-dimensional audio navigation in visually obscured environments while improving team situational awareness by geo-location of voice communications. Incorporate a geo-located survival guide into a wearable computer, and demonstrate its value in an operationally relevant environment. Develop and incorporate an advanced battlefield air traffic control capability in the combat controller's software suite. Incorporate intelligent agent technology to improve battlefield airmen situational awareness in a dynamic wartime scenario. Complete hardware and software implementation of a supervisory control station technology baseline and a next-generation supervisory control station. Plan a technology demonstration program using real-time system simulation and field testing in spiral demonstration phases. Establish the scope of simulation and test activities, select experimental variables, determine key performance measures and commence the assessment.
- (U) MAJOR THRUST: Develop and demonstrate decision-aiding technologies that assist the Joint Forces Commander (JFC)/Joint Forces Air Component Commander (JFACC) to rapidly assess the battlefield situation, predict the most likely adversary behaviors, and select and prioritize the appropriate courses of action.
- (U) In FY 2007: Began first spiral development cycle of a decision aid that will support global military operations by providing a common global picture, fully integrating military planning, operations, and supporting intelligence. Enabled real-time reachback to operational and intelligence knowledge sources.
- (U) In FY 2008: Complete the first spiral development of CPE decision aids and simulation based on global strike and global persistent attack missions. Plan a technology demonstration program to evaluate benefits and utility of tools. Expand the scope of the scenario-based cognitive work to include non-traditional warfare such as humanitarian relief

0.970

1.843

2.225

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY 03 Advanced Technology Development (ATD)	PE NUMBER AND TITLE 0603231F Crew Systems and Personnel Protection Technology	PROJECT NUMBER AND TITLE 2830 Decision Effectiveness Technology		
		FY 2007	FY 2008	FY 2009
(U) B. Accomplishments/Planned Program (\$ in Millions)				
and global war on terrorism. Begin a cognitive work analysis with this expanded scope.				
(U) In FY 2009: Integrate tools developed in first spiral into identified technology demonstration program. Evaluate the CPE decision aids and simulation tools in the technology demonstration environment. Refine tools and begin the second spiral development cycle informed by the results of the technology demonstration with humanitarian relief and global war on terrorism emphases. Identify exercise to evaluate the expanded benefits and utility of the decision aid tools and simulation. Plan a technology demonstration program.				
(U)				
(U) MAJOR THRUST: Develop and demonstrate advanced visual display technologies to provide integrated day/night capability to reduce pilot workload and enhance mission performance. Note: In FY 2007, this effort was discontinued to align work with higher AF priorities.		0.242	0.000	0.000
(U) In FY 2007: Completed technology contribution to incorporate night agile laser protection in airborne displays.				
(U) In FY 2008: Not Applicable.				
(U) In FY 2009: Not Applicable.				
(U)				
(U) MAJOR THRUST: Develop and demonstrate novel, tailored bio-taggant and identification/neutralization capabilities to meet specific AF needs to enhance force protection and enable air operations commanders to maintain operations tempo.		1.137	1.493	1.552
(U) In FY 2007: Evaluated the capabilities of emerging aptamer technologies to enhance bio-taggant capabilities. Began development of these DNA-based identification and neutralization technologies that will lead to affordable and reliable techniques for special forces to locate, identify, track, and counter enemy activities.				
(U) In FY 2008: Select the best emerging technologies for bio-taggant and threat neutralization applications and begin to develop those technologies into fieldable counterproliferation capabilities. Aptamer based technology will also be used to enhance the effectiveness of the cold plasma and directed energy technologies. Develop the capability to attach quantum dots and mixed-metal nanoparticles to aptamers to serve as taggants for biological agents.				
(U) In FY 2009: Further develop the selected technologies and refine application to mission need to include incorporation of quantum dot and mixed-metal nanoparticle technologies. Develop models of optimal insertion/distribution of bio-taggants in target areas.				
(U)				
(U) MAJOR THRUST: Develop and demonstrate intelligent software agents, realistic human and organizational behavior models, and advanced job performance aiding technologies. Computer agents and models add realism and fidelity to large-scale synthetic environments and war games, and provide intelligence analysts a way to model		3.538	4.490	1.166

Exhibit R-2a, RDT&E Project Justification	DATE February 2008
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BUDGET ACTIVITY 03 Advanced Technology Development (ATD)	PE NUMBER AND TITLE 0603231F Crew Systems and Personnel Protection Technology	PROJECT NUMBER AND TITLE 2830 Decision Effectiveness Technology
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(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
collected data. Job aiding technologies provide command and control operators with automated access to a manageable amount of multi-source critical information to avoid operator overload and to support fast and accurate decision-making during mobility operations. Note: Decreased emphasis in FY 2009 reflects completion of advanced demonstration effort in FY 2008.			
(U) In FY 2007: Began a series of critical experiments toward modeling a society as a complex system of systems. Transitioned work-centered collaborative planning and decision-making software to the Air Mobility Command. Developed composable command and control (C2) human computer interface elements that can be assembled via computer network into a rapidly reconfigurable C2 system. Conducted initial laboratory experiments on composable C2 modules.			
(U) In FY 2008: Continue to develop and experiment with system-of-systems societal modeling, increasing the complexity and degree of dynamic change. Expand development of work-centered collaborative planning, analysis, and decision-making software tools into the unstructured C2 work environment of dynamic mission re-synchronization. Investigate the value of implementing human-computer interfaces as services or as service layers of an enterprise architecture.			
(U) In FY 2009: Continue to develop human behavior modeling of individuals and groups in highly dynamic situations. Continue to experiment with system-of-systems societal modeling, using increasingly complex scenarios. Demonstrate how information flows through and is modified by a society. Develop design reference scenarios to be used as standards for evaluating different modeling approaches. Continue to evaluate promising models and modeling approaches.			
(U) MAJOR THRUST: Develop and demonstrate logistics technologies for improved deployment operations and improved system supportability. These technologies will improve the efficiency and effectiveness of AF deployments and mobility operations in support of Agile Combat Support initiatives and Air Expeditionary Force concepts.	1.965	1.221	0.895
(U) In FY 2007: Completed development and application of technology to automatically collect and update critical information required to effectively manage logistics resources in support of combat operations. Completed design and development of very fast, easy-to-use dynamic planning/replanning capabilities for adaptive logistics. Worked to define coalition C2 information requirements to support cross-cultural planning and coordination. Began work on defining requirements for emergency response logistics needs.			
(U) In FY 2008: Evaluate methods for organizational impact analysis of new information and network-based tools to support collaborative logistics. Collect human-centric performance data from critical experiments and joint exercises			

UNCLASSIFIED

Exhibit R-2a, RDT&E Project Justification		DATE February 2008		
BUDGET ACTIVITY 03 Advanced Technology Development (ATD)	PE NUMBER AND TITLE 0603231F Crew Systems and Personnel Protection Technology	PROJECT NUMBER AND TITLE 2830 Decision Effectiveness Technology		
		<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) B. Accomplishments/Planned Program (\$ in Millions)				
to benchmark improvements in maintenance, transportation, and supply functions in contingency support.				
(U) In FY 2009: Develop organizational-level change templates for effective applications of net-based logistics operations. Validate these change templates in operational settings (e.g., airlift control centers, logistics readiness centers) for effective implementation of advanced automation technologies.				
(U)				
(U) MAJOR THRUST: Develop and demonstrate cognitive-based analytic and design methods and computer software tools for C2 operations to synchronize personnel in distributed locations with a shared understanding of the C2 battlespace. Increasingly, C2 personnel operate in a complex information environment that inhibits situation understanding and complicates operational decision-making. This decision support technology exploits an emerging work-centered user interface concept having the potential to rapidly configure common visualizations of C2 operations and streamline decision-making.		2.443	1.426	1.933
(U) In FY 2007: Began to analyze the work aiding requirements for specific distributed C2 users, such as for rapid course of action development teams supporting global operations. Began to apply the work-centered user interface concept to develop shared visualizations and decision support for synchronizing global operations involving distributed C2 resources, such as for the dynamic management of air refueling operations.				
(U) In FY 2008: Continue to analyze the work aiding requirements for specific distributed C2 users such as for rapid course of action development teams supporting global operations, to include coverage both for planning and execution. Conduct experiments to test and evaluate the ability of the work-centered user interface services approach to provide effective visualizations and decision support for global C2 operations.				
(U) In FY 2009: Refine the methods and techniques to decrease the analysis, design and development time of providing work-centered support services for global C2 operations. Demonstrate in a simulation of global C2 operations that geographically distributed personnel can develop a shared situation understanding of the C2 battlespace.				
(U)				
(U) MAJOR THRUST: Develop and demonstrate human protective system technologies for extended missions. Technologies will improve aircrew comfort, resulting in increased performance. Note: In FY 2008, this effort is discontinued to align work with higher AF priorities.		0.657	0.751	0.000
(U) In FY 2007: Researched optimizing seat system technologies to improve safety, comfort, and performance. Developed and evaluated candidate seat system optimization technologies that reduce aircrew fatigue and discomfort, while maintaining spinal alignment. Extended design concepts to ensure accommodation of the full aircrew population.				

UNCLASSIFIED

Exhibit R-2a, RDT&E Project Justification		DATE February 2008		
BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE		
03 Advanced Technology Development (ATD)	0603231F Crew Systems and Personnel Protection Technology	2830 Decision Effectiveness Technology		
(U) B. Accomplishments/Planned Program (\$ in Millions)		<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) In FY 2008: Validate system specification through testing of candidate seat system designs. Continue research and development of seat system technologies to improve performance, safety, and comfort. Demonstrate performance of candidate seat system optimization technologies.				
(U) In FY 2009: Not Applicable.				
(U) MAJOR THRUST: Develop and demonstrate technologies for improved force protection, the maintenance of peak warfighter performance in known toxic environments, and the identification of difficult-to-detect enemy threats. Develop capabilities for real-time human monitoring in the field and the identification of toxic substance exposure before the warfighters' health and combat effectiveness are compromised. Develop model-based threat awareness, health status, visualization, risk assessment technologies, and intent of human adversaries. Note: This major thrust is a continuation of previous work in PE 0602202F.		0.000	0.892	2.015
(U) In FY 2007: Not Applicable.				
(U) In FY 2008: Begin development of detection technologies to identify kidney and liver organ selective degradation using streamlined, yet robust, assay procedures and biomarkers. Generate selection criteria and integration algorithms that fuse varied biomarker data. Multiple specific biomarkers will allow for early detection of low level toxic exposure of deployed forces.				
(U) In FY 2009: Continue development of biomarker based detection technologies. Develop methods for collecting human biosample input in the field. Develop new concepts for lightweight monitoring devices that are operable by non-medical personnel for demonstration of the analysis and detection techniques. These technologies will identify potentially threatening toxic exposures to warfighters to protect AF personnel. Develop predictive human models for threat detection and exposure. Develop enhanced anthropometric visualization techniques that integrate heterogeneous sensor data of potential adversaries.				
(U) CONGRESSIONAL ADD: Air Force Advanced Micro-Compression Sock (AFAMS).		0.975	0.000	0.000
(U) In FY 2007: Conducted Congressionally-directed effort for AFAMS.				
(U) In FY 2008: Not Applicable.				
(U) In FY 2009: Not Applicable.				
(U) CONGRESSIONAL ADD: Variable Transmittance Visor.		0.975	0.993	0.000
(U) In FY 2007: Conducted Congressionally-directed effort for Variable Transmittance Visor.				
(U) In FY 2008: Conduct Congressionally-directed effort for Variable Transmittance Visor.				

UNCLASSIFIED

Exhibit R-2a, RDT&E Project Justification			DATE February 2008		
BUDGET ACTIVITY 03 Advanced Technology Development (ATD)	PE NUMBER AND TITLE 0603231F Crew Systems and Personnel Protection Technology	PROJECT NUMBER AND TITLE 2830 Decision Effectiveness Technology			
(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u>			<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) In FY 2009: Not Applicable.					
(U)					
(U) CONGRESSIONAL ADD: Phasor-Bird Helmet Tracker (previously titled Next Generation Helmet Tracking and Display Technology).			1.268	0.000	0.000
(U) In FY 2007: Conducted Congressionally-directed effort for Phasor-Bird Helmet Tracker.					
(U) In FY 2008: Not Applicable.					
(U) In FY 2009: Not Applicable.					
(U)					
(U) CONGRESSIONAL ADD: Field Deployable Influenza Genotyping System.			0.975	0.000	0.000
(U) In FY 2007: Conducted Congressionally-directed effort for Field Deployable Influenza Genotyping System.					
(U) In FY 2008: Not Applicable.					
(U) In FY 2009: Not Applicable.					
(U)					
(U) CONGRESSIONAL ADD: Low Cost/Improved Performance for Helmet Display and Life Support Technologies.			1.072	2.683	0.000
(U) In FY 2007: Conducted Congressionally-directed effort for Low Cost Improved Performance Helmet Display.					
(U) In FY 2008: Conduct Congressionally-directed effort for Low Cost/Improved Performance for Helmet Display and Life Support Technologies.					
(U) In FY 2009: Not Applicable.					
(U)					
(U) CONGRESSIONAL ADD: Virtual Medical Trainer.			0.000	2.384	0.000
(U) In FY 2007: Not Applicable.					
(U) In FY 2008: Conduct Congressionally-directed effort for Virtual Medical Trainer.					
(U) In FY 2009: Not Applicable.					
(U)					
(U) CONGRESSIONAL ADD: Battlefield Automatic Life Status Monitor (BALSM).			0.000	1.589	0.000
(U) In FY 2007: Not Applicable.					
(U) In FY 2008: Conduct Congressionally-directed effort for BALSM.					
(U) In FY 2009: Not Applicable.					
(U)					
(U) CONGRESSIONAL ADD: Water Purification with Fused Carbon Nanotube Nanostructured Material.			0.000	2.384	0.000
(U) In FY 2007: Not Applicable.					

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY 03 Advanced Technology Development (ATD)	PE NUMBER AND TITLE 0603231F Crew Systems and Personnel Protection Technology	PROJECT NUMBER AND TITLE 2830 Decision Effectiveness Technology
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(U) B. Accomplishments/Planned Program (\$ in Millions)	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) In FY 2008: Conduct Congressionally-directed effort for Water Purification with Fused Carbon Nanotube Nanostructured Material.			
(U) In FY 2009: Not Applicable.			
(U)			
(U) Total Cost	26.580	29.420	18.295

(U) C. Other Program Funding Summary (\$ in Millions)	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to</u>	<u>Total Cost</u>
	<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Complete</u>	
(U) Related Activities:									
(U) PE 0602202F, Human Effectiveness Applied Research.									
(U) PE 0604706F, Life Support Systems.									
(U) This project has been coordinated through the Reliance 21 process to harmonize efforts and eliminate duplication.									
(U) D. Acquisition Strategy									
Not Applicable.									

Exhibit R-2a, RDT&E Project Justification

DATE
February 2008

BUDGET ACTIVITY 03 Advanced Technology Development (ATD)				PE NUMBER AND TITLE 0603231F Crew Systems and Personnel Protection Technology			PROJECT NUMBER AND TITLE 4924 Warfighter Readiness Technology		
Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
4924 Warfighter Readiness Technology	9.149	6.209	6.050	5.737	5.301	6.062	5.896	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project develops and demonstrates advanced training, simulation, and mission rehearsal technologies that will improve warfighter capabilities and mission readiness by enhancing operator and team performance skills. This effort includes the development of technologies that enable integration of computer models, live weapon systems, and weapon system simulators to portray the global battlespace, including all-weather, day/night flight operations, C2, force protection, and aerospace operations. This project develops and demonstrates advanced training and simulation technologies that will improve warfighter readiness by enhancing mission training and mission rehearsal capabilities. Development and effective use of the global battlespace requires advances in training systems and in interconnection, information, visual, and representation technologies. The resulting mission training and rehearsal capabilities will enhance the mission essential competencies of combat and combat support individuals and teams that comprise the aerospace force.

(U) B. Accomplishments/Planned Program (\$ in Millions)

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) MAJOR THRUST: Advance aerospace and organizational behavior models for integrated warfighter training and rehearsal. These computer agents and models will add realism operations, C2, force protection, and air base defense warfighters. Technologies will increase training effectiveness and efficiency, and decrease time to mission qualification.	2.974	3.088	2.692
(U) In FY 2007: Developed interface parameters to link DMO mission training centers and live training ranges. Developed a proof of concept joint close air support schoolhouse simulation environment. Developed preliminary exercise planning and analysis shells to enable a robust scenario authoring capability that reduces training development time. Developed performance measurement/monitoring technologies and methods for a deployable training environment. Performed a small-footprint training demonstration in a persistent wargaming environment. Initiated development of functional requirements for managing learning in distributed training contexts.			
(U) In FY 2008: Develop integrated methods for assessing and tracking performance in live, virtual, and constructive environments. Develop and demonstrate integrated readiness assessment for air-to-air, air-to-ground, close air support, and C2. Demonstrate interface and training capability between DMO and live range exercises. Continue development of scenario authoring shells amenable for guiding training and learning in virtual and live contexts. Develop integrated methods for evaluating the impact of different levels of fidelity in simulation environments on performance and readiness. Finalize the development of functional requirements for managing learning in distributed training contexts.			
(U) In FY 2009: Demonstrate adaptive training within DMO using embedded knowledge and skills assessment. Develop common tools for mission planning, briefing, and after action review that function across air combat,			

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE

0603231F Crew Systems and
Personnel Protection Technology

PROJECT NUMBER AND TITLE

4924 Warfighter Readiness
Technology

(U) B. Accomplishments/Planned Program (\$ in Millions)	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
<p>ground operations, and combat operations and planning in an AOC. Complete integration and evaluation of joint close air support (JCAS) environment for schoolhouse training. Demonstrate and validate technology alternatives for in-garrison and field deployable JCAS training and rehearsal system. Initiate development of specifications for integrating forward deployed battlefield coordination and command simulation with JCAS schoolhouse training. Demonstrate embedded training and performance assessment in a deployed combat training environment. Demonstrate integrated deployed DMO capability in large scale Live, Virtual, and Constructive (LVC) event. Demonstrate quantitative methods for certifying simulation fidelity and readiness training capabilities.</p>			
<p>(U) MAJOR THRUST: Develop a low-cost, deployable visual simulation system with sufficient image resolution and performance capable of supporting the imaging of high-resolution fast-moving targets, high-density terrain, texture, surround imagery, and helmet-mounted sights. This technology will provide the warfighter realistic air-to-air and air-to-ground visual simulation environments to support aircrew training during expeditionary deployments and at mission training centers.</p> <p>(U) In FY 2007: Began development of advanced, ultra resolution head-mounted and deployable Compact Immersive Visual Environment (CIVE) proof-of-concept display components. Began engineering and human factors analyses of the display components.</p> <p>(U) In FY 2008: Continue engineering and human factors analyses of the CIVE display and image generation components to assess feasibility of new scanning architectures, image fidelity and stability, portability, resolution, size, weight, transport delay, and user acceptance.</p> <p>(U) In FY 2009: Develop CIVE head-mounted and compact off-the-head display/image generation proof of concept component demonstrations. Begin human factors analyses and technology performance evaluations of the concept demonstrations.</p>	1.142	1.276	1.192
<p>(U) MAJOR THRUST: Develop and demonstrate training technologies and techniques to optimize night vision device-aided night operations. These technologies could reduce the cost of Night Vision Goggle (NVG) qualification and increase combat capability. Note: In FY 2007, this effort terminated due to higher AF priorities.</p> <p>(U) In FY 2007: Developed NVG simulator scenarios and related performance metrics for advanced NVG employment training. Developed geo-specific databases and database modification tools for desktop NVG visualization training. Test simulated panoramic NVG in DMO testbed. Developed untethered NVG simulation for NVG video and head position by application of broadband wireless technology. Demonstrated head position driven simulated NVG imagery viewable by multiple viewers in an open space.</p>	0.716	0.000	0.000

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE

0603231F Crew Systems and
Personnel Protection Technology

PROJECT NUMBER AND TITLE

4924 Warfighter Readiness
Technology(U) **B. Accomplishments/Planned Program (\$ in Millions)**FY 2007FY 2008FY 2009

(U) In FY 2008: Not Applicable.

(U) In FY 2009: Not Applicable.

(U)

(U) MAJOR THRUST: Develop and demonstrate a high-fidelity DMO training and rehearsal capability for operators in an Air and Space Operations Center (AOC). Link AOC operational mission requirements and performance metrics to develop team learning environments for AOC units. Develop and demonstrate high-fidelity, interactive Electronic Warfare (EW) training technologies for use with live-virtual-constructive training networks for future threat systems/capabilities and advanced sensor platforms and weapons systems. These technologies provide AF, Joint, and coalition warfighters with more realistic EW mission training and rehearsal environments that accurately represent 21st century threats, thereby increasing operational readiness and capability.

2.075

1.845

2.166

(U) In FY 2007: Developed a proof-of-concept multiteam competency-based training package with performance assessment system capability for the AOC. Developed initial competency-based scenario selection guidelines and conducted a proof-of-concept test of competency-based scenario training capability for operational planners.

(U) In FY 2008: Develop competency-based training requirements for team and functional areas within strategy and plans divisions including IO and ISR teams. Develop optimum training and mission rehearsal strategies to employ information simulation into AOC weapon systems planning tools. Survey instructional methods for employment in targeted training of mission-essential knowledge and skills and develop most capable method(s) for integration. Begin the design and development of architectures and hardware that integrate live EW range data into shared networked simulations. Begin the development of a simulation of an advanced fighter-specific EW sensor suite for DMO application. Demonstrate guiding a single EW training illuminator on a live electronic combat range with fully integrated, computer-generated, and live forces.

(U) In FY 2009: Develop integrated strategy and plans division trainer based on competency-based training requirements and optimum mission rehearsal strategies. Develop integration methods for fielded and emerging systems and applications. Develop team, inter-team and division-level event specifications for mission qualification training and continuation training scenarios. Validate environment approaches through exercise simulations, data capture, and analysis to define quality of experience, spectrum of training capability, and performance assessment capabilities. Complete live EW range integration into DMO. Develop a simulation of an advanced platform-specific EW sensor suite for DMO. Develop a proof-of-concept desktop system integrating multiple EW suite simulations with a synthetic threat environment featuring advanced missile fly out models and basic directed energy threats. Begin measuring and validating improvements in EW training using these technologies and techniques. Begin the development of methods for improved, embedded EW training capability on airborne aircraft and design systems and

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY 03 Advanced Technology Development (ATD)	PE NUMBER AND TITLE 0603231F Crew Systems and Personnel Protection Technology	PROJECT NUMBER AND TITLE 4924 Warfighter Readiness Technology
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(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
demonstrate these technologies during a live-fly exercise at an EW training range.			
(U) CONGRESSIONAL ADD: Authentic Tactical Flight Simulator for JSF.	1.267	0.000	0.000
(U) In FY 2007: Conducted Congressionally-directed effort for Authentic Tactical Flight Simulator for JSF.			
(U) In FY 2008: Not Applicable.			
(U) In FY 2009: Not Applicable.			
(U) CONGRESSIONAL ADD: Database Integration Tools.	0.975	0.000	0.000
(U) In FY 2006: Conducted Congressionally-directed effort for Database Integration Tools.			
(U) In FY 2008: Not Applicable.			
(U) In FY 2009: Not Applicable.			
(U) Total Cost	9.149	6.209	6.050

(U) <u>C. Other Program Funding Summary (\$ in Millions)</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to</u>	<u>Complete</u>	<u>Total Cost</u>
	<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>
(U) Related Activities:										
(U) PE 0602202F, Human Effectiveness Applied Research.										
(U) PE 0604227F, Distributed Mission Training.										
(U) This project has been coordinated through the Reliance 21 process to harmonize efforts and eliminate duplication.										
(U) <u>D. Acquisition Strategy</u>										
Not Applicable.										

Exhibit R-2a, RDT&E Project Justification

DATE
February 2008

BUDGET ACTIVITY 03 Advanced Technology Development (ATD)				PE NUMBER AND TITLE 0603231F Crew Systems and Personnel Protection Technology			PROJECT NUMBER AND TITLE 5020 Bioeffects & Protection Technology			
Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total	
5020 Bioeffects & Protection Technology	3.774	2.777	2.285	2.987	3.028	3.367	3.322	Continuing	TBD	
Quantity of RDT&E Articles	0	0	0	0	0	0	0			

- (U) **A. Mission Description and Budget Item Justification**
 This project integrates and demonstrates technologies to provide protection against directed energy threats and hazards, without compromising performance, vigilance, or mission effectiveness, and man-portable technologies for the neutralization of threats. Development and demonstration efforts focus on advanced technologies for laser eye protection (LEP), preventing injurious exposures of personnel involved with test and evaluation of high power microwave or high-energy laser weapons, and enabling operational employment of these systems. It also develops tools and guidelines for testing and deploying high power microwave and high-energy laser systems and technologies to enhance personnel safety and effectiveness in aerospace operations. Biobehavioral performance capabilities are developed and demonstrated to enable sustained and enhanced operations in extreme environments to include surge, night, global, information warfare, C2, and other operations.
- (U) **B. Accomplishments/Planned Program (\$ in Millions)**
- | | <u>FY 2007</u> | <u>FY 2008</u> | <u>FY 2009</u> |
|--|----------------|----------------|----------------|
| (U) MAJOR THRUST: Develop and demonstrate multiwavelength LEP technologies for aircrew and ground personnel to provide protection against any laser hazard or threat in a single device. Note: This effort completed in FY 2007. | 0.572 | 0.000 | 0.000 |
| (U) In FY 2007: Completed development of integrated eye protection technologies. Demonstrated and delivered second-generation LEP goggles for Special Operations air and ground forces, assessing human factors and mission compatibility. | | | |
| (U) In FY 2008: Not Applicable. | | | |
| (U) In FY 2009: Not Applicable. | | | |
| (U) MAJOR THRUST: Develop and demonstrate technologies that permit safe testing, deployment, and use of high energy laser weapons and systems. | 0.782 | 0.902 | 0.875 |
| (U) In FY 2007: Combined modeling and experimental measurement of additional multiple-wavelength exposures to airborne laser wavelength and other near-infrared laser beams to define the relative damage thresholds of the combined exposures when compared to their single-wavelength counterparts. | | | |
| (U) In FY 2008: Release laser range safety software tool including dynamic bi-directional reflectivity distribution function to support live fire test of major systems. Initiate validation, verification, and accreditation package for new software package. Continue assessment of probabilistic risk assessment for use with laser hazard assessment. | | | |
| (U) In FY 2009: Complete validation, verification, and accreditation package for laser range safety tool. Release collateral hazard assessment software tool to enable analysis of tactical uses for high-energy laser systems. | | | |
| (U) MAJOR THRUST: Develop and demonstrate technologies to assess bioeffects and protection from radio frequency | 0.000 | 0.882 | 1.142 |

Exhibit R-2a, RDT&E Project Justification		DATE February 2008		
BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE		
03 Advanced Technology Development (ATD)	0603231F Crew Systems and Personnel Protection Technology	5020 Bioeffects & Protection Technology		
(U) B. Accomplishments/Planned Program (\$ in Millions)		<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(RF) systems, including terahertz technologies. Note: This major thrust is a continuation of previous work in PE 0602202F.				
(U) In FY 2007: Not Applicable.				
(U) In FY 2008: Initiate program to develop solutions for both laser and other non-ionizing radiation to personnel. Integrate laser solutions into solutions for RF, microwave, terahertz, and other regimes of electromagnetic radiation for personnel protection.				
(U) In FY 2009: Continue to develop laser and RF and other non-ionizing protective solutions for personnel protection. Develop bioeffects-based fire-control algorithms for directed energy weapons. Continue integration of laser protective technologies with those for RF, microwave, terahertz, and other regimes of electromagnetic radiation for personnel protection. Establish preliminary design specifications for directed energy protective equipment. Continue long-term studies of RF weapon systems effects.				
(U) MAJOR THRUST: Develop and demonstrate ability to support testing of counterforce technologies and to enable man-portable threat neutralization capabilities.		0.823	0.635	0.268
(U) In FY 2007: Refined and downselected neutralization devices, developed simulant testing capabilities, and integrated with threat detection technologies. Demonstrated most promising man-portable threat neutralization technologies in simulated environments.				
(U) In FY 2008: Begin developing technologies that will provide the capability to neutralize threats without leaving evidence for special applications. Develop technologies to enable safe return and avoid contaminating aircraft or other equipment.				
(U) In FY 2009: Continue development of technologies that will provide the capability to neutralize threats without evidence for special applications. Improve technologies to enable safe return and avoid contaminating aircraft or other equipment.				
(U) MAJOR THRUST: Develop a fatigue management capability to alleviate the negative effects of fatigue on human performance in aerospace operations. Results will extend and enhance human performance and survivability in sustained and continuous (24/7) mission environments for all aviation, C2, special operations, maintenance, and space operators. Note: This effort completes in FY 2008.		0.622	0.358	0.000
(U) In FY 2007: Integrated biobehavioral performance model for selected military tasks, such as airlift/tanker crew scheduling and special forces mission planning.				
(U) In FY 2008: Complete development and demonstrate quantitative biobehavioral performance management tools to				

Exhibit R-2a, RDT&E Project Justification							DATE February 2008		
BUDGET ACTIVITY 03 Advanced Technology Development (ATD)			PE NUMBER AND TITLE 0603231F Crew Systems and Personnel Protection Technology			PROJECT NUMBER AND TITLE 5020 Bioeffects & Protection Technology			
(U)	<u>B. Accomplishments/Planned Program (\$ in Millions)</u>						<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
	provide scheduling solutions and operational risk management calculations to extend and enhance human performance in sustained and continuous (24/7) military operations.								
(U)	In FY 2009: Not Applicable.								
(U)	CONGRESSIONAL ADD: Full Spectrum Laser Eye Protection.						0.975	0.000	0.000
(U)	In FY 2007: Conducted Congressionally-directed effort for Full Spectrum Laser Eye Protection.								
(U)	In FY 2008: Not Applicable.								
(U)	In FY 2009: Not Applicable.								
(U)	Total Cost						3.774	2.777	2.285
(U)	<u>C. Other Program Funding Summary (\$ in Millions)</u>								
		<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to</u>
		<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Complete</u>
(U)	PE 0602102F, Materials.								
(U)	PE 0602202F, Human Effectiveness Applied Research.								
(U)	PE 0603112F, Advanced Materials for Weapon Systems.								
(U)	PE 0603319F, Airborne Laser Program.								
(U)	PE 0604706F, Life Support Systems.								
(U)	This project has been coordinated through the Reliance 21 process to harmonize efforts and eliminate duplication.								
(U)	<u>D. Acquisition Strategy</u>								
	Not Applicable.								

UNCLASSIFIED

PE NUMBER: 0603270F
 PE TITLE: Electronic Combat Technology

Exhibit R-2, RDT&E Budget Item Justification	DATE February 2008
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BUDGET ACTIVITY 03 Advanced Technology Development (ATD)	PE NUMBER AND TITLE 0603270F Electronic Combat Technology
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Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
Total Program Element (PE) Cost	27.599	26.762	21.056	16.740	18.312	25.609	24.124	Continuing	TBD
2432 Defensive System Fusion Technology	6.186	7.050	5.878	4.907	5.623	8.627	6.532	Continuing	TBD
431G RF Warning & Countermeasures Tech	8.643	7.691	6.788	5.946	5.269	6.860	8.065	Continuing	TBD
691X EO/IR Warning & Countermeasures Tech	12.770	12.021	8.390	5.887	7.420	10.122	9.527	Continuing	TBD

Note: Funds for the FY 2008 Congressionally-directed Innovative Polymeric Materials for Three-Dimensional (3-D) Microdevice Construction in the amount of \$1.0 million are in the process of being moved from PE 0603270F, Electronic Combat Technology, to PE 0602102F, Materials, for execution. FY 2008 funding totals do not include \$5.325 million in FY 2008 GWOT requirements still pending Congressional consideration.

(U) A. Mission Description and Budget Item Justification

This program develops and demonstrates technologies to support Air Force electronic combat warfighting capabilities. The program focuses on developing components, subsystems, and technologies with potential aerospace combat, special operations, and airlift electronic combat applications in three project areas. The first project develops and demonstrates technologies for integrating electronic combat sensors and systems into a fused and seamless whole. The second project develops and demonstrates advanced technologies for radio-frequency (RF) electronic combat suites. The third project develops and demonstrates advanced warning and countermeasure technologies to defeat electro-optical (EO), infrared (IR), and laser threats to aerospace platforms. Note: In FY 2008 Congress added \$1.7 million for Advanced Threat Alert Advanced Technology Development and \$1.5 million for BLADES. 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) B. Program Change Summary (\$ in Millions)

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) Previous President's Budget	28.528	23.743	21.287
(U) Current PBR/President's Budget	27.599	26.762	21.056
(U) Total Adjustments	-0.929	3.019	
(U) Congressional Program Reductions		-0.004	
Congressional Rescissions		-0.177	
Congressional Increases		4.200	
Reprogrammings	-0.288	-1.000	
SBIR/STTR Transfer	-0.641		

(U) Significant Program Changes:

Not Applicable.

Exhibit R-2, RDT&E Budget Item Justification

DATE

February 2008

BUDGET ACTIVITY

03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE

0603270F Electronic Combat Technology

C. Performance Metrics
Under Development.

Exhibit R-2a, RDT&E Project Justification

DATE
February 2008

BUDGET ACTIVITY 03 Advanced Technology Development (ATD)				PE NUMBER AND TITLE 0603270F Electronic Combat Technology			PROJECT NUMBER AND TITLE 2432 Defensive System Fusion Technology			
Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total	
2432 Defensive System Fusion Technology	6.186	7.050	5.878	4.907	5.623	8.627	6.532	Continuing	TBD	
Quantity of RDT&E Articles	0	0	0	0	0	0	0			

- (U) **A. Mission Description and Budget Item Justification**
 This project develops and demonstrates technologies for integrating electronic combat sensors and electronic combat system fusion. It develops advanced algorithms and assessment techniques needed to evaluate and enable combat aircraft operations in multi-spectral threat and countermeasure environments. It also matures technologies required for command-and-control warfare, standoff jamming, and electronic support measures for the denial, disruption, and suppression of adversary air defense operations. Technologies included are: advanced components and techniques needed to jam enemy radars; advanced standoff jammer technologies; and electronic collection methods to inform field commanders of changes in the electronic environment.
- (U) **B. Accomplishments/Planned Program (\$ in Millions)**
- | | | | |
|---|----------------|----------------|----------------|
| | <u>FY 2007</u> | <u>FY 2008</u> | <u>FY 2009</u> |
| (U) MAJOR THRUST: Develop and integrate advanced sensor receiver and processing technologies. Note: This effort completes in FY 2007. | 0.836 | 0.000 | 0.000 |
| (U) In FY 2007: Completed risk reduction for defensive sensors using multiple information sources for situational awareness in the Air Force Integrated Demonstrations and Applications Laboratory. Completed Integrated Demonstrations and Applications Laboratory risk reduction evaluations and demonstrations that evolve and optimize network electronic attack techniques on disparate platforms. Performed demonstrations of advanced multiplatform digital receiver and processor technologies that provide the warfighter with multispectral warning, identification, and threat response for current and next generation aerospace platforms. | | | |
| (U) In FY 2008: Not Applicable. | | | |
| (U) In FY 2009: Not Applicable. | | | |
| (U) MAJOR THRUST: Develop affordable radio-frequency and electro-optical emitter warning concepts and techniques. Develop techniques for coordination and management of multiple jamming nodes against integrated air defense systems. Conduct integrated electronic warfare and information operations simulations and demonstrations for the deception and defeat of integrated air defense system threats. | 5.350 | 5.361 | 5.878 |
| (U) In FY 2007: Completed brassboard demonstration of advanced threat alert and jamming subsystem for combat aircraft to increase survivability against advanced, integrated radio-frequency, electro-optical, and infrared air defense systems. Performed final flight tests to validate advanced jamming techniques for a significantly improved digital threat warning and response capability. | | | |
| (U) In FY 2008: Complete maturation demonstration of advanced threat alert and jamming subsystem for combat aircraft to increase survivability against advanced, integrated radio-frequency, electro-optical, and infrared air | | | |

Exhibit R-2a, RDT&E Project Justification

DATE
February 2008

BUDGET ACTIVITY 03 Advanced Technology Development (ATD)	PE NUMBER AND TITLE 0603270F Electronic Combat Technology	PROJECT NUMBER AND TITLE 2432 Defensive System Fusion Technology
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(U) B. Accomplishments/Planned Program (\$ in Millions)	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
defense systems. Investigate electronic warfare battle management strategies and technical protocols for control of multiple jamming nodes working in coordination against an integrated air defense system in the overall context of non-traditional intelligence, surveillance, reconnaissance, and strike operations. Develop and demonstrate technical protocols for the integration of electronic warfare, command-and-control warfare, and information operations against an integrated air defense system.			
(U) In FY 2009: Conduct analyses and initial demonstrations of electronic warfare battle management strategies in the Air Force Integrated Demonstrations and Applications Laboratory and Virtual Combat Laboratory simulation facilities. Continue to develop and demonstrate technical protocols for the integration of electronic warfare, command-and-control warfare, and information operations against an integrated air defense system. Develop and mature key technologies essential for Airborne Electronic Attack risk reduction.			
(U) CONGRESSIONAL ADD: Advanced Threat Alert Advanced Technology Development.	0.000	1.689	0.000
(U) In FY 2007: Not Applicable.			
(U) In FY 2008: Conduct Congressionally-directed effort for Advanced Threat Alert Advanced Technology Development.			
(U) In FY 2009: Not Applicable.			
(U) Total Cost	6.186	7.050	5.878

(U) C. Other Program Funding Summary (\$ in Millions)	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to Complete</u>	<u>Total Cost</u>
	<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>		
(U) Related Activities:									
(U) PE 0602204F, Aerospace Sensors.									
(U) PE 0603203F, Advanced Aerospace Sensors.									
(U) PE 0603500F, Multi-disciplinary Advanced Space Technology.									
(U) PE 0604270F, Electronic Warfare (EW) Development.									
(U) This project has been									

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE

**0603270F Electronic Combat
Technology**

PROJECT NUMBER AND TITLE

**2432 Defensive System Fusion
Technology****(U) C. Other Program Funding Summary (\$ in Millions)**

coordinated through the
Reliance 21 process to
harmonize efforts and eliminate
duplication.

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification

DATE
February 2008

BUDGET ACTIVITY 03 Advanced Technology Development (ATD)				PE NUMBER AND TITLE 0603270F Electronic Combat Technology			PROJECT NUMBER AND TITLE 431G RF Warning & Countermeasures Tech		
Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
431G RF Warning & Countermeasures Tech	8.643	7.691	6.788	5.946	5.269	6.860	8.065	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project develops and demonstrates advanced technologies for radio-frequency electronic combat suites to enhance the survivability of aerospace vehicles and to provide crew situational awareness. One major area addresses technologies for missile/threat warning, radio-frequency receivers, electronic combat pre-processors, advanced sorting/pre-processing algorithms, and expert software for applications on existing and future electronic combat systems. Another major technology area focuses on the development and demonstration of subsystems and components for generating on-board/off-board radio-frequency countermeasure techniques. This includes the development of electronic countermeasures techniques as well as advanced electronic countermeasures technologies such as antennas, power amplifiers, and preamplifiers.

(U) B. Accomplishments/Planned Program (\$ in Millions)

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) MAJOR THRUST: Develop wide-band, multi-mode, multi-function apertures for electronic warfare applications (i.e., threat detection, threat avoidance, suppression of enemy air defenses, surveillance, and reconnaissance). Note: This effort completes in FY 2008.	1.425	1.148	0.000
(U) In FY 2007: Tested critical subsystems of an efficient, low-frequency, wide-band aperture, and fabricate array compatible with unmanned aerial vehicles.			
(U) In FY 2008: Complete integration and test of array compatible with unmanned aerial vehicles.			
(U) In FY 2009: Not Applicable.			
(U) MAJOR THRUST: Develop aerospace platform self-protection and support jamming technologies and techniques to counter advanced radio-frequency threats associated with current and future aerospace weapon systems. Develop coordinated, multi-player radar jamming techniques for deception and neutralization of early warning and surveillance networks to enable all-platform operations in defended adversary airspace. Develop new electronic attack techniques fusing advanced digital signal processing receivers with digital technique generators.	6.222	6.543	6.788
(U) In FY 2007: Continued developing self-protection countermeasures effective against advanced future surface to air missile systems. Completed laboratory and field-testing of innovative, networked radio-frequency countermeasure techniques against advanced target engagement radars. Completed development of advanced countermeasures techniques and technology to defeat an advanced integrated air defense system. Continued developing anti-jam techniques and technologies for advanced radio-frequency sensor systems. Completed demonstration of electronic support cross-cueing capabilities of a multi-intelligence sensor suite including the effects of electromagnetic interference and platform compatibility to provide precision location and identification with increased probability of			

UNCLASSIFIED

Exhibit R-2a, RDT&E Project Justification	DATE February 2008
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BUDGET ACTIVITY 03 Advanced Technology Development (ATD)	PE NUMBER AND TITLE 0603270F Electronic Combat Technology	PROJECT NUMBER AND TITLE 431G RF Warning & Countermeasures Tech
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	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u>			
intercept.			
(U) In FY 2008: Provide hardware simulation and analysis support to multi-intelligence sensor needs for accurate and timely electronic surveillance information. Conduct threat research, simulation, and analysis of early warning radar characteristics. Develop multiple technical strategies and techniques for deceiving them in a network enabled operational environment. Develop advanced simulation capabilities to support network enabled jamming of adversary early warning and surveillance networks. Develop and evaluate integrated digital receiver/jammer architectures.			
(U) In FY 2009: Continue to provide hardware simulation and analysis support to multi-intelligence sensor needs for accurate and timely electronic surveillance information. Develop advanced radar jamming engineering models including technique generators, wide-band amplifier modules and apertures, needed to conduct network enabled research and evaluation of countermeasure techniques. Continue to develop advanced simulation capabilities to support network enabled jamming of adversary early warning and surveillance networks. Continue to develop and evaluate integrated digital receiver/jammer brassboard architectures that leverage real-time electronic surveillance signal processing to enhance electronic attack effectiveness.			
(U) CONGRESSIONAL ADD: Receiver and Processing Concepts Evaluation (RAPCEval).	0.996	0.000	0.000
(U) In FY 2007: Conducted Congressionally-directed effort for RAPCEval.			
(U) In FY 2008: Not Applicable.			
(U) In FY 2009: Not Applicable.			
(U) Total Cost	8.643	7.691	6.788

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to</u>	<u>Total Cost</u>
	<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Complete</u>	
(U) <u>C. Other Program Funding Summary (\$ in Millions)</u>									
(U) Related Activities:									
(U) PE 0602204F, Aerospace Sensors.									
(U) PE 0604270F, Electronic Warfare (EW) Development.									
(U) PE 0603500F, Multi-disciplinary Advanced Space Technology.									

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE

**0603270F Electronic Combat
Technology**

PROJECT NUMBER AND TITLE

**431G RF Warning &
Countermeasures Tech****(U) C. Other Program Funding Summary (\$ in Millions)****(U)** PE 0604270N, EW
Development.**(U)** This project has been
coordinated through the
Reliance 21 process to
harmonize efforts and eliminate
duplication.**(U) D. Acquisition Strategy**

Not Applicable.

Exhibit R-2a, RDT&E Project Justification

DATE
February 2008

BUDGET ACTIVITY 03 Advanced Technology Development (ATD)				PE NUMBER AND TITLE 0603270F Electronic Combat Technology			PROJECT NUMBER AND TITLE 691X EO/IR Warning & Countermeasures Tech			
Cost (\$ in Millions)		FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
691X	EO/IR Warning & Countermeasures Tech	12.770	12.021	8.390	5.887	7.420	10.122	9.527	Continuing	TBD
Quantity of RDT&E Articles		0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project develops and demonstrates the advanced warning and countermeasure technologies required to negate electro-optical, infrared, and laser threats to aerospace platforms. Off-board (decoys and expendables) and on-board countermeasure technologies developed for aircraft self-protection will provide robust, affordable solutions for protection against infrared missiles with autonomous seekers, multi-spectral threats, laser-guided weapons, and electro-optical and infrared tracking systems used to direct electro-optical, infrared, and radar-guided missiles.

(U) B. Accomplishments/Planned Program (\$ in Millions)

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) MAJOR THRUST: Analyze the vulnerabilities of current infrared missile systems and future imaging infrared sensors.	1.862	3.687	4.565
(U) In FY 2007: Continued conducting in-house analyses on infrared-guided missile and future imaging infrared sensor susceptibilities. Further evaluated countermeasure techniques for countering multiple types of missiles and imaging infrared sensors. Conducted digital simulations to assess the effectiveness of spatial decoy techniques against imaging infrared missiles under fly-out conditions. Assessed proposed advanced countermeasure techniques to defeat imaging infrared sensors.			
(U) In FY 2008: Conclude in-house analyses on infrared-guided missile and future imaging infrared sensor susceptibilities. Further evaluation of countermeasure techniques for countering multiple types of missiles and imaging infrared sensors. Identify optimal countermeasure techniques to defeat single color imaging infrared sensors.			
(U) In FY 2009: Perform laboratory analyses on future infrared guided missile capabilities. Assess effectiveness of current and planned techniques against new threat trends and direction of future countermeasure technique requirements. Conduct digital simulations to assess effectiveness of expendable and laser countermeasure techniques.			
(U) MAJOR THRUST: Develop aerospace laser warning sensor technologies for timely alert to advanced laser acquisition/tracking sensors, including detecting and locating both high power (dazzle/damage) and low power (laser-guided ordnance) signals.	1.629	0.862	0.942
(U) In FY 2007: Initiated development of advanced laser warning receiver for integration into tactical aircraft. Continued developing laser warning sensor technologies to address emerging laser threats. Initiated miniature laser			

UNCLASSIFIED

Exhibit R-2a, RDT&E Project Justification		DATE February 2008		
BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE		
03 Advanced Technology Development (ATD)	0603270F Electronic Combat Technology	691X EO/IR Warning & Countermeasures Tech		
(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u>		<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
warning for personnel protection.				
(U) In FY 2008: Continue developing laser warning sensors to address emerging laser threats. Initiate development of miniaturized laser warning sensors. Fabricate compact device for personnel protection. Demonstrate capability to geolocate laser threats for enhanced situational awareness.				
(U) In FY 2009: Continue developing laser warning sensors to address emerging laser threats. Continue development of miniaturized laser warning sensors. Fabricate sensor for sensor and eye protection cueing. Demonstrate capability to cue agile filters for optimized protection against advanced laser threats.				
(U) MAJOR THRUST: Develop a countermeasure technology to defeat passive electro-optical and infrared aircraft tracking sensors and ordnance guidance.		5.271	5.101	2.883
(U) In FY 2007: Continued field tests to locate and counter passive threats before threats can develop a fire control solution. Initiated development of a tower demonstration system. Demonstrated capability to scan wide field of regard and locate passive surveillance sensors in real time.				
(U) In FY 2008: Complete field tests to locate and counter passive threats before threats can develop fire control solution. Complete tower demonstration system development and conduct experiments over 2 km range. Evaluate effectiveness of countermeasure techniques against night vision devices and other passive surveillance sensors.				
(U) In FY 2009: Initiate development of affordable, lightweight infrared countermeasures capability combining passive surveillance and missile defeat techniques for tactical aircraft. Initiate design of a compact system to geolocate and identify threats.				
(U) MAJOR THRUST: Develop electro-optical/infrared missile warning technologies to alert aircrews and aircraft self-protection systems to the approach of advanced, low-signature threats. Note: This effort ends in FY 2008.		0.820	0.880	0.000
(U) In FY 2007: Completed tests and evaluation of the affordable visible missile warning system.				
(U) In FY 2008: Characterize sensor performance in varied background clutter. Identify maximum detection ranges for high priority threat missiles.				
(U) In FY 2009: Not Applicable.				
(U) CONGRESSIONAL ADD: Affordable Visible Missile Warning System.		1.893	0.000	0.000
(U) In FY 2007: Conducted Congressionally-directed effort for the Affordable Visible Missile Warning System.				
(U) In FY 2008: Not Applicable.				
(U) In FY 2009: Not Applicable.				

Exhibit R-2a, RDT&E Project Justification	DATE February 2008
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BUDGET ACTIVITY 03 Advanced Technology Development (ATD)	PE NUMBER AND TITLE 0603270F Electronic Combat Technology	PROJECT NUMBER AND TITLE 691X EO/IR Warning & Countermeasures Tech
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(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U)			
(U) CONGRESSIONAL ADD: Battlefield Laser Detection System (BLADES).	1.295	1.491	0.000
(U) In FY 2007: Conducted Congressionally-directed effort for BLADES.			
(U) In FY 2008: Conduct Congressionally-directed effort for BLADES.			
(U) In FY 2009: Not Applicable.			
(U)			
(U) Total Cost	12.770	12.021	8.390

(U) <u>C. Other Program Funding Summary (\$ in Millions)</u>									
	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to</u>	<u>Total Cost</u>
	<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Complete</u>	
(U) Related Activities:									
(U) PE 0602204F, Aerospace Sensors.									
(U) PE 0604270F, Electronic Warfare (EW) Development.									
(U) PE 0603500F, Multi-disciplinary Advanced Development Space Technology.									
(U) PE 0604270N, EW Development.									
(U) PE 0603203F, Advanced Aerospace Sensors.									
(U) This project has been coordinated through the Reliance 21 process to harmonize efforts and eliminate duplication.									
(U) <u>D. Acquisition Strategy</u>									
Not Applicable.									

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UNCLASSIFIED

PE NUMBER: 0603311F
 PE TITLE: Ballistic Missile Technology

Exhibit R-2, RDT&E Budget Item Justification	DATE February 2008
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BUDGET ACTIVITY 03 Advanced Technology Development (ATD)	PE NUMBER AND TITLE 0603311F Ballistic Missile Technology
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Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
Total Program Element (PE) Cost	9.128	0.000	0.000	0.000	0.000	0.000	0.000	0.000	47.294
4091 Missile Electronics	9.128	0.000	0.000	0.000	0.000	0.000	0.000	0.000	47.294

Note: In FY 1997, the Air Force eliminated this program. However, Congress has added funds for Congressionally-directed efforts from FY 1997-2007.

(U) A. Mission Description and Budget Item Justification

This program develops, integrates, and demonstrates advanced guidance, navigation, and control technologies for ballistic missiles, including upgrades for range safety instrumentation. 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) B. Program Change Summary (\$ in Millions)

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) Previous President's Budget	9.365	0.000	0.000
(U) Current PBR/President's Budget	9.128	0.000	0.000
(U) Total Adjustments	-0.237	0.000	
(U) Congressional Program Reductions			
Congressional Rescissions			
Congressional Increases			
Reprogrammings			
SBIR/STTR Transfer	-0.237		

(U) Significant Program Changes:

In FY 1997, the Air Force eliminated this program. However, Congress has added funds for Congressional-directed efforts since FY 1997.

C. Performance Metrics

(U) Under Development.

Exhibit R-2a, RDT&E Project Justification

DATE
February 2008

BUDGET ACTIVITY 03 Advanced Technology Development (ATD)				PE NUMBER AND TITLE 0603311F Ballistic Missile Technology			PROJECT NUMBER AND TITLE 4091 Missile Electronics		
Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
4091 Missile Electronics	9.128	0.000	0.000	0.000	0.000	0.000	0.000	0.000	47.294
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

- (U) **A. Mission Description and Budget Item Justification**
 This program develops, integrates, and demonstrates advanced guidance, navigation, and control technologies for ballistic missiles, including upgrades for range safety instrumentation. 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) <u>B. Accomplishments/Planned Program (\$ in Millions)</u> | <u>FY 2007</u> | <u>FY 2008</u> | <u>FY 2009</u> |
| (U) CONGRESSIONAL ADD: Ballistic Missile Technology/Minuteman III. | 3.884 | 0.000 | 0.000 |
| (U) In FY 2007: Conducted Congressionally-directed effort for Minuteman III. | | | |
| (U) In FY 2008: Not Applicable. | | | |
| (U) In FY 2009: Not Applicable. | | | |
| (U) | | | |
| (U) CONGRESSIONAL ADD: Pacific Ballistic Missile Technology Program. | 1.166 | 0.000 | 0.000 |
| (U) In FY 2007: Conducted Congressionally-directed effort for Pacific Ballistic Missile Technology Program. | | | |
| (U) In FY 2008: Not Applicable. | | | |
| (U) In FY 2009: Not Applicable. | | | |
| (U) | | | |
| (U) CONGRESSIONAL ADD: P-Net. | 2.330 | 0.000 | 0.000 |
| (U) In FY 2007: Conducted Congressionally-directed effort for P-Net. | | | |
| (U) In FY 2008: Not Applicable. | | | |
| (U) In FY 2009: Not Applicable. | | | |
| (U) | | | |
| (U) CONGRESSIONAL ADD: Forward Based Conventional Strike. | 1.748 | 0.000 | 0.000 |
| (U) In FY 2007: Conducted Congressionally-directed effort for Forward Based Conventional Strike. | | | |
| (U) In FY 2008: Not Applicable. | | | |
| (U) In FY 2009: Not Applicable. | | | |
| (U) Total Cost | 9.128 | 0.000 | 0.000 |

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE

**0603311F Ballistic Missile
Technology**

PROJECT NUMBER AND TITLE

4091 Missile Electronics

(U) **C. Other Program Funding Summary (\$ in Millions)**

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to</u>	<u>Total Cost</u>
	<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Complete</u>	

(U) Related Activities:

(U) PE 0602204F, Aerospace
Sensors.

(U) This project has been
coordinated through the
Reliance 21 process to
harmonize efforts and eliminate
duplication.

(U) **D. Acquisition Strategy**

Not Applicable.

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UNCLASSIFIED

PE NUMBER: 0603401F
 PE TITLE: Advanced Spacecraft Technology

Exhibit R-2, RDT&E Budget Item Justification	DATE February 2008
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BUDGET ACTIVITY 03 Advanced Technology Development (ATD)	PE NUMBER AND TITLE 0603401F Advanced Spacecraft Technology
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Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
Total Program Element (PE) Cost	105.422	100.600	80.958	84.853	89.247	92.093	90.001	Continuing	TBD
2181 Spacecraft Payloads	31.200	31.483	24.997	23.420	23.987	21.840	21.716	Continuing	TBD
3834 Integrated Space Technology Demonstrations	35.108	30.313	29.305	33.473	33.988	36.839	36.218	Continuing	TBD
4400 Space Systems Protection	3.440	4.923	7.866	9.472	11.633	10.294	9.246	Continuing	TBD
5021 Space Systems Survivability	4.452	4.831	5.175	5.229	5.431	5.380	5.342	Continuing	TBD
5083 Ballistic Missiles Technology	2.990	5.806	5.649	5.179	5.429	6.259	6.077	Continuing	TBD
682J Spacecraft Vehicles	28.232	23.244	7.966	8.080	8.779	11.481	11.402	Continuing	TBD

Note: Funds for the FY 2007 Congressionally-directed Massively Parallel Optical Interconnects in the amount of \$1.1 million were moved from this PE to PE 0603789F, C3I Advanced Development, Project 634216, for execution. Also, funds for the FY 2007 Congressionally-directed Advanced Satellite Thermal Control Program were moved from PE 0603211F, Aerospace Technology Development and Demonstration, Project 63486U, to this PE, for execution.

(U) A. Mission Description and Budget Item Justification

This program develops, integrates, and demonstrates space technologies in the areas of spacecraft payloads, spacecraft protection, spacecraft and launch vehicles, ballistic missiles, space systems survivability, and development of advanced laser communications technologies to support next generation satellite communication systems. The integrated space technologies are demonstrated by component or system level tests on the ground or in flight. Note: In FY 2008, Congress added \$1.8 million for Small Low Cost Reconnaissance Spacecraft; \$2.4 million for Micromachined Switches for Next Generation Modular Satellites; \$1.6 million for Microsatellite Serial Manufacturing; \$2.0 million for Satellite Coherent Optical Receiver (SCORE); \$1.2 million for Space Situational Awareness; \$2.4 million for Systematic Approach to Radiation Hardened Electronics (SHARE); \$1.6 million for Intelligent Free Space Optical Satellite Communications Node; \$1.6 million for Radially Segmented Launch Vehicle (RSLV) Risk Reduction Program; \$2.0 million for COTS Technology for Situational Awareness; \$4.3 million for Large Automated Production of Expendable Launch Structures (LAPELS); and \$3.2 million for Thin Film Amorphous Solar Arrays. This program is in Budget Activity 3, Advanced Technology Development, since it develops and demonstrates technologies for existing space system upgrades and/or new space system developments that have military utility and address warfighter needs.

Exhibit R-2, RDT&E Budget Item Justification

DATE

February 2008

BUDGET ACTIVITY

03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE

0603401F Advanced Spacecraft Technology

(U) **B. Program Change Summary (\$ in Millions)**

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) Previous President's Budget	101.115	78.704	85.838
(U) Current PBR/President's Budget	105.422	100.600	80.958
(U) Total Adjustments	4.307	21.896	
(U) Congressional Program Reductions		-1.543	
Congressional Rescissions		-0.661	
Congressional Increases		24.100	
Reprogrammings	6.182		
SBIR/STTR Transfer	-1.875		

(U) **Significant Program Changes:**

Changes to this PE since the previous President's Budget are due to higher Air Force priorities.

C. Performance Metrics

(U) Under Development.

Exhibit R-2a, RDT&E Project Justification

DATE
February 2008

BUDGET ACTIVITY 03 Advanced Technology Development (ATD)				PE NUMBER AND TITLE 0603401F Advanced Spacecraft Technology			PROJECT NUMBER AND TITLE 2181 Spacecraft Payloads		
Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
2181 Spacecraft Payloads	31.200	31.483	24.997	23.420	23.987	21.840	21.716	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

- (U) **A. Mission Description and Budget Item Justification**
 This project funds the development, demonstration, and evaluation of radiation-hardened space electronic hardware, satellite control hardware and software for advanced satellite surveillance operations, and development of advanced laser communications technologies to support next generation satellite communications systems. 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 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 Department of Defense 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) <u>B. Accomplishments/Planned Program (\$ in Millions)</u> | <u>FY 2007</u> | <u>FY 2008</u> | <u>FY 2009</u> |
| (U) MAJOR THRUST: Develop spacecraft microelectronic devices, including 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. | 12.481 | 11.564 | 12.470 |
| (U) In FY 2007: Completed engineering model of the high performance 500 million instruction per second general-purpose processor. Fabricated a high performance design hardened analog-to-digital converter (ADC) for use in space and designed a very low-power ADC using advanced design cells and design hardening. Fabricated the miniaturized military Global Positioning System (GPS) receiver for use on terrestrial, aero, and space platforms. Fabricated the building blocks for a very high performance ten million-gate design hardened field programmable gate array. | | | |
| (U) In FY 2008: Initiate capabilities to the current Satellite Design Automation software to evolve a logical sequence to form a "push-button toolflow" satellite builder. Initiate radiation-hardened space sensor interface modules allocating standardized data messages protocols from sensors for ease device control of sensors and actuators. | | | |
| (U) In FY 2009: Complete capabilities to the current Satellite Design Automation software to evolve a logical sequence to form a "push-button toolflow" satellite builder. Demonstrate radiation-hardened space sensor interface modules allocating standardized data messages protocols from sensors for ease device control of sensors and actuators. | | | |
| (U) MAJOR THRUST: Develop intelligent satellite system technologies for responsive spacecraft operations and for satellite control, precision navigation, formation flying, and proximity operations technologies for spacecraft | 2.097 | 2.675 | 2.192 |

Exhibit R-2a, RDT&E Project Justification	DATE February 2008
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BUDGET ACTIVITY 03 Advanced Technology Development (ATD)	PE NUMBER AND TITLE 0603401F Advanced Spacecraft Technology	PROJECT NUMBER AND TITLE 2181 Spacecraft Payloads
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	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u> constellations.			
(U) In FY 2007: Refined command, control, guidance, and navigational capabilities for counterspace to apply to space situational awareness and offensive/defensive operations. Integrated initial autonomous flight software technologies with command, control, guidance, and navigation technologies to support responsive space systems. Extended hardware-in-the-loop testbed, spacecraft command and telemetry simulations, and mission ops center to development and testing of responsive and tactical space systems. Integrated modules and complete distributed aperture sensor analysis tool for engineering level, mission/engagement and campaign level analyses.			
(U) In FY 2008: Further refine command, control, guidance, and navigational capabilities for space superiority. Continue to integrate autonomous flight software technologies with command, control, guidance, and navigation technologies. Continue to extend hardware-in-the-loop testbed, spacecraft command and telemetry simulations, and mission ops centers. Begin to model command, control, and communications systems, conduct engineering trades, and perform military utility analysis.			
(U) In FY 2009: Complete command, control, guidance, and navigational capabilities for space superiority. Complete integration of autonomous flight software technologies with command, control, guidance, and navigation technologies. Complete extension of hardware-in-the-loop testbed, spacecraft command and telemetry simulations, and mission ops centers. Continue to model command, control, and communications systems, conduct engineering trades, and perform military utility analysis.			
(U) MAJOR THRUST: Develop modeling, simulation, and analysis tools and data exploitation methodologies for space-based surveillance systems, space capability protection technologies, access/mobility technologies, and flight experiments.	1.239	0.711	0.730
(U) In FY 2007: Completed development of models of surveillance systems for military utility to include tactical surveillance and electro-optical technologies. Further developed models of responsive and reconfigurable technologies. Applied physics-to-engineering-to-engagement level models for systems engineering, tech trades, mission planning and operations, and utility analysis to flight experiments in tactical and responsive satellites.			
(U) In FY 2008: Begin development of space-based communications models for blue force situational awareness, communications on the move, and data exfiltration. Complete development of models of responsive or reconfigurable technologies. Continue to apply physics-to-engineering-to-engagement level models for systems engineering, tech trades, mission planning and operations, and utility analysis to flight experiments in tactical and responsive satellites.			
(U) In FY 2009: Continue to develop space-based communications models for blue force situational awareness,			

Exhibit R-2a, RDT&E Project Justification		DATE February 2008		
BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE		
03 Advanced Technology Development (ATD)	0603401F Advanced Spacecraft Technology	2181 Spacecraft Payloads		
(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u>		<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
communications on the move, and data exfiltration. Apply additional physics-to-engineering-to-engagement level models for systems engineering, tech trades, mission planning and operations, and utility analysis to flight experiments in tactical and responsive satellites.				
(U) MAJOR THRUST: 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. Note: In FY 2008, Congress reduced this effort by \$1.5 million for program growth.		2.577	4.915	8.665
(U) In FY 2007: Studied detectors and readouts needed for laser-based surveillance. Investigated additional readouts fabricated on existing foundries and radiation hard design principles.				
(U) In FY 2008: Continue studies for detectors and readouts needed for exquisite imaging. Increase size/speed of Radiation Hardened by Design Readout Integrated Circuits (RHBD ROICs). Fold radiation hardness improvement of visible sensor with RHBD ROIC into full focal plane array.				
(U) In FY 2009: Begin full focal plane array for exquisite imaging. Develop visible sensor for potential transition.				
(U) MAJOR THRUST: Develop technologies for multi-access laser communications space terminals with reduced weight, power, and cost for transformational communications.		1.302	1.054	0.733
(U) In FY 2007: Finalized brassboard integration.				
(U) In FY 2008: Begin multi-access laser communications terminal form-fit-function development. Continue environmental testing of multi-access laser communications terminal components and subsystems in relevant environment.				
(U) In FY 2009: Complete multi-access laser communications terminal form-fit-function demonstration. Complete testing of multi-access laser communications terminal components and subsystems in relevant environment. Initiate multi-access laser communications terminal system level testing in relevant environment.				
(U) MAJOR THRUST: Develop spectral/polarimetric sensing and data exploitation demonstrations for military imaging and remote sensing applications.		0.358	0.198	0.207
(U) In FY 2007: Conducted field collection with polarimetric focal plane camera. Demonstrated feasibility of hardware design for transition to acquisition system.				
(U) In FY 2008: Collect laboratory data of satellites using spectral/polarimetric sensing and demonstrate applicability of techniques for space situational awareness.				
(U) In FY 2009: Compare measurements of satellites to predictive models and determine the feasibility of model based				

UNCLASSIFIED

Exhibit R-2a, RDT&E Project Justification		DATE February 2008		
BUDGET ACTIVITY 03 Advanced Technology Development (ATD)	PE NUMBER AND TITLE 0603401F Advanced Spacecraft Technology	PROJECT NUMBER AND TITLE 2181 Spacecraft Payloads		
(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u>		<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
exploitation for space situational awareness.				
(U)				
(U) CONGRESSIONAL ADD: Precision Integrated Navigation and Position-Intelligent Networking Technology.		2.835	0.000	0.000
(U) In FY 2007: Conducted Congressionally-directed effort for Precision Integrated Navigation and Position-Intelligent Networking Technology.				
(U) In FY 2008: Not Applicable.				
(U) In FY 2009: Not Applicable.				
(U)				
(U) CONGRESSIONAL ADD: Integrated Passive Microelectronic Components.		0.978	0.000	0.000
(U) In FY 2007: Conducted Congressionally-directed effort for Integrated Passive Microelectronic Components.				
(U) In FY 2008: Not Applicable.				
(U) In FY 2009: Not Applicable.				
(U)				
(U) CONGRESSIONAL ADD: Integrated Spacecraft Engineering Tool. Note: This Add has been previously executed in Project 633834.		1.271	0.000	0.000
(U) In FY 2007: Conducted Congressionally-directed effort for Integrated Spacecraft Engineering Tool.				
(U) In FY 2008: Not Applicable.				
(U) In FY 2009: Not Applicable.				
(U)				
(U) CONGRESSIONAL ADD: Micromachined Switches for Next-Generation Modular Satellites.		0.978	2.393	0.000
(U) In FY 2007: Conducted Congressionally-directed effort for Micromachined Switches for Next-Generation Modular Satellites.				
(U) In FY 2008: Conduct Congressionally-directed effort for Micromachined Switches for Next-Generation Modular Satellites.				
(U) In FY 2009: Not Applicable.				
(U)				
(U) CONGRESSIONAL ADD: Systemic Hierarchical Approach to Radiation Hardened Electronics.		2.738	2.392	0.000
(U) In FY 2007: Conducted Congressionally-directed effort for Systemic Hierarchical Approach to Radiation Hardened Electronics.				
(U) In FY 2008: Conduct Congressionally-directed effort for Systemic Hierarchical Approach to Radiation Hardened Electronics.				

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Exhibit R-2a, RDT&E Project Justification	DATE February 2008
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BUDGET ACTIVITY 03 Advanced Technology Development (ATD)	PE NUMBER AND TITLE 0603401F Advanced Spacecraft Technology	PROJECT NUMBER AND TITLE 2181 Spacecraft Payloads
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(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) In FY 2009: Not Applicable.			
(U) CONGRESSIONAL ADD: Intelligent Free Space Optical Satellite Communications Node.	1.369	1.595	0.000
(U) In FY 2007: Conducted Congressionally-directed effort for Intelligent Free Space Optical Satellite Communications Node.			
(U) In FY 2008: Conduct Congressionally-directed effort for Intelligent Free Space Optical Satellite Communications Node.			
(U) In FY 2009: Not Applicable.			
(U) CONGRESSIONAL ADD: COTS Technology for Situational Space Awareness.	0.977	1.993	0.000
(U) In FY 2007: Conducted Congressionally-directed effort for COTS Technology for Situational Space Awareness.			
(U) In FY 2008: Conduct Congressionally-directed effort for COTS Technology for Situational Space Awareness.			
(U) In FY 2009: Not Applicable.			
(U) CONGRESSIONAL ADD: Satellite Coherent Optical Receiver (SCORE).	0.000	1.993	0.000
(U) In FY 2007: Not Applicable.			
(U) In FY 2008: Conduct Congressionally-directed effort for Satellite Coherent Optical Receiver (SCORE).			
(U) In FY 2009: Not Applicable.			
(U) Total Cost	31.200	31.483	24.997

(U) <u>C. Other Program Funding Summary (\$ in Millions)</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to Complete</u>	<u>Total Cost</u>
	<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>		
(U) Related Activities:									
(U) PE 0303601F, MILSTAR Satellite Communications System.									
(U) PE 0305160F, Defense Meteorological Satellite Program (DMSP).									
(U) PE 0602601F, Spacecraft Technology.									

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE

**0603401F Advanced Spacecraft
Technology**

PROJECT NUMBER AND TITLE

2181 Spacecraft Payloads**(U) C. Other Program Funding Summary (\$ in Millions)**

- (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 21 process to harmonize efforts and eliminate duplication.
- (U) **D. Acquisition Strategy**
Not Applicable.

Exhibit R-2a, RDT&E Project Justification

DATE
February 2008

BUDGET ACTIVITY 03 Advanced Technology Development (ATD)				PE NUMBER AND TITLE 0603401F Advanced Spacecraft Technology			PROJECT NUMBER AND TITLE 3834 Integrated Space Technology Demonstrations		
Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
3834 Integrated Space Technology Demonstrations	35.108	30.313	29.305	33.473	33.988	36.839	36.218	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

- (U) **A. Mission Description and Budget Item Justification**
 This project is a series of advanced technology demonstrations designed to address mission needs by applying emerging technologies from the Air Force Research Laboratory, other U.S. Government laboratories, and industry. These technologies are integrated into system-level demonstrations that are used to test, evaluate, and validate the technologies in an relevant environment.
- (U) **B. Accomplishments/Planned Program (\$ in Millions)**
- | | | | |
|--|----------------|----------------|----------------|
| | <u>FY 2007</u> | <u>FY 2008</u> | <u>FY 2009</u> |
| (U) MAJOR THRUST: Develop microsatellite (10-100Kg) technologies for integrated, robust, flexible, microsatellite demonstrations building on previous work and leveraging investments by other organizations. Applications include space-based space situational awareness and/or tactical satellite concepts. | 34.130 | 28.718 | 29.305 |
| (U) In FY 2007: Completed payload and bus fabrication. Performed functional and environmental tests of payload and bus. Completed system level integration of payload and microsatellite and complete functional and environmental tests of integrated system. Integrated with launch vehicle. Integrated ground control system and satellite software simulations. Performed simulated mission operations for missions operations training. | | | |
| (U) In FY 2008: Complete system level integration of payload and microsatellite and complete functional and environmental tests of integrated system. Begin integration with launch vehicle. Integrate ground control system and satellite software simulations. Perform simulated mission operations for missions operations training. | | | |
| (U) In FY 2009: Complete flight demonstration. Perform de-orbit maneuver. Complete next in the series of satellite design(s) and procurement of initial bus and payload hardware. | | | |
| (U) CONGRESSIONAL ADD: Radially Segmented Launch Vehicle (RSLV) Risk Reduction. | 0.978 | 1.595 | 0.000 |
| (U) In FY 2007: Conducted Congressionally-directed effort for Radially Segmented Launch Vehicle (RSLV) Risk Reduction. | | | |
| (U) In FY 2008: Conduct Congressionally-directed effort for Radially Segmented Launch Vehicle (RSLV) Risk Reduction. | | | |
| (U) In FY 2009: Not Applicable. | | | |
| (U) Total Cost | 35.108 | 30.313 | 29.305 |

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY 03 Advanced Technology Development (ATD)	PE NUMBER AND TITLE 0603401F Advanced Spacecraft Technology	PROJECT NUMBER AND TITLE 3834 Integrated Space Technology Demonstrations
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(U) **C. Other Program Funding Summary (\$ in Millions)**

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to</u>	<u>Total Cost</u>
	<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Complete</u>	

(U) Related Activities:

(U) PE 0602601F, Spacecraft Technology.

(U) PE 0603605F, Advanced Weapons Technology.

(U) This project has been coordinated through the Reliance 21 process to harmonize efforts and eliminate duplication.

(U) **D. Acquisition Strategy**

Not Applicable.

Exhibit R-2a, RDT&E Project Justification

DATE
February 2008

BUDGET ACTIVITY 03 Advanced Technology Development (ATD)				PE NUMBER AND TITLE 0603401F Advanced Spacecraft Technology			PROJECT NUMBER AND TITLE 4400 Space Systems Protection		
Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
4400 Space Systems Protection	3.440	4.923	7.866	9.472	11.633	10.294	9.246	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

- (U) **A. Mission Description and Budget Item Justification**
 This project develops and demonstrates tools, instruments, and mitigation techniques required to assure operation of U.S. space assets in potentially hostile warfighting environments. The project performs assessments of critical components and subsystems, and evaluates susceptibility and vulnerability to radio frequency (RF) 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.
- (U) **B. Accomplishments/Planned Program (\$ in Millions)**
- | | | | |
|--|----------------|----------------|----------------|
| | <u>FY 2007</u> | <u>FY 2008</u> | <u>FY 2009</u> |
| (U) MAJOR THRUST: Use multi-threat assessment tools to assess space-based electro-optical, communication, and other responses to various candidate RF and laser countermeasures and directed energy threats. Note: In FY 2009, increase in funding due to increased emphasis on defensive counterspace technologies. | 0.825 | 1.182 | 1.889 |
| (U) In FY 2007: Verified mitigation models against test data and commence predictive analysis of technique effectiveness. | | | |
| (U) In FY 2008: Conduct laboratory testing of candidate RF and laser countermeasures and validate multi-threat assessment tool. | | | |
| (U) In FY 2009: Conduct demonstrations illustrating effects and meditation analysis. Identify technology transfer opportunities and report findings to major commands. | | | |
| (U) MAJOR THRUST: Develop passive satellite countermeasures and mitigation techniques for current and future threats to satellites. Note: In FY 2009, increase in funding due to increased emphasis on defensive counterspace technologies. | 1.824 | 2.609 | 4.168 |
| (U) In FY 2007: Conducted defensive technology space demonstration and post flight analysis. Identified technology transfer opportunities. | | | |
| (U) In FY 2008: Select the most promising detection and defensive technology and begin integration. Conduct demonstrations of systems integration and performance. | | | |
| (U) In FY 2009: Conduct mitigation technology space demonstration and post flight analysis. | | | |
| (U) MAJOR THRUST: Develop visible and near-infrared laser protection technologies. Note: In FY 2009, increase in funding due to increased emphasis on defensive counterspace technologies. | 0.791 | 1.132 | 1.809 |
| (U) In FY 2007: Coordinated space demonstration of protective technology. Identified technology transfer opportunities | | | |

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY 03 Advanced Technology Development (ATD)	PE NUMBER AND TITLE 0603401F Advanced Spacecraft Technology	PROJECT NUMBER AND TITLE 4400 Space Systems Protection
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(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
and reported findings to major commands.			
(U) In FY 2008: Develop selected protection techniques and coordinate space simulation testing of prospective protection technology. Qualify technology for application on space experiment for orbital demonstration.			
(U) In FY 2009: Nominate "space qualified" technology and provide test unit to experimental satellite for integration.			
(U) Total Cost	3.440	4.923	7.866

(U) <u>C. Other Program Funding Summary (\$ in Millions)</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to</u>	<u>Total Cost</u>
	<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Complete</u>	
(U) Related Activities:									
(U) PE 0602102F, Materials.									
(U) PE 0602601F, Spacecraft Technology.									
(U) PE 0603605F, Advanced Weapons Technology.									
(U) This project has been coordinated through the Reliance 21 process to harmonize efforts and eliminate duplication.									
(U) <u>D. Acquisition Strategy</u>									
Not Applicable.									

Exhibit R-2a, RDT&E Project Justification

DATE
February 2008

BUDGET ACTIVITY 03 Advanced Technology Development (ATD)				PE NUMBER AND TITLE 0603401F Advanced Spacecraft Technology			PROJECT NUMBER AND TITLE 5021 Space Systems Survivability			
Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total	
5021 Space Systems Survivability	4.452	4.831	5.175	5.229	5.431	5.380	5.342	Continuing	TBD	
Quantity of RDT&E Articles	0	0	0	0	0	0	0			

- (U) **A. Mission Description and Budget Item Justification**
 This project develops and demonstrates technologies to improve space system survivability and reliability of current and future Department of Defense space systems that must continue operation despite natural space hazards. It develops and demonstrates cost-effective solutions to mitigate hazardous space environmental interactions including electrical charge buildup and electronics failures due to both single radiation events and long-term radiation doses.
- (U) **B. Accomplishments/Planned Program (\$ in Millions)**
- | | | | |
|---|----------------|----------------|----------------|
| | <u>FY 2007</u> | <u>FY 2008</u> | <u>FY 2009</u> |
| (U) MAJOR THRUST: Develop sensors to specify and forecast conditions in the space environment that degrade the operation of satellite, communication, navigation, and surveillance systems. Support integration, launch, validation, and operation of instrumentation to provide improved space radiation and ionospheric hazard specification and forecasting. | 3.444 | 3.657 | 3.953 |
| (U) In FY 2007: Identified space test opportunity and constructed preliminary joint agency coronagraph and heliospheric imager for solar hazard detection. Completed concept design of next-generation miniaturized space weather sensors and developed initial engineering models. | | | |
| (U) In FY 2008: Continue construction of joint agency coronagraph and heliospheric imager for solar hazard detection. Continue development of miniaturized space weather sensor engineering models. Initiate program to test and evaluate empirical flare prediction models based on synoptic data from Air Force and national observatory assets. | | | |
| (U) In FY 2009: Continue construction of joint agency coronagraph and heliospheric imager for solar hazard detection. Complete development of miniaturized space weather sensor engineering models. Identify space test opportunity for miniaturized solar hazard sensors. Continue program to test and evaluate empirical flare prediction models based on synoptic data from Air Force and national observatory assets. | | | |
| (U) MAJOR THRUST: Conduct collaborative space and laboratory experiments and develop hardware and software tools to improve the survivability of spacecraft power, communications, navigation, and surveillance systems. | 0.328 | 0.379 | 0.398 |
| (U) In FY 2007: Constructed space plasma control experiment payload and established joint-agency collaboration for spaceflight. Expanded spacecraft environment effect tool suite to include dynamic space particle climatologies and forecast models. Completed radiation belt remediation payload and commenced calibration and integration onto Air Force test satellite. | | | |
| (U) In FY 2008: Complete space plasma control experiment payload and begin calibration and integration onto Air Force test satellite. Complete spacecraft environment effect tool suite to include dynamic space particle | | | |

Exhibit R-2a, RDT&E Project Justification	DATE February 2008
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BUDGET ACTIVITY 03 Advanced Technology Development (ATD)	PE NUMBER AND TITLE 0603401F Advanced Spacecraft Technology	PROJECT NUMBER AND TITLE 5021 Space Systems Survivability
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	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u>			
climatologies and forecast models. Release tool suite to DoD community. Complete radiation belt remediation payload calibration and complete integration onto Air Force test satellite.			
(U) In FY 2009: Launch space plasma control experiment payload on Air Force test satellite into orbit. Begin on-orbit checkout and in-flight calibration. Begin development of new medium earth orbit radiation belt model. Launch radiation belt remediation payload on Air Force test satellite into orbit. Begin on-orbit checkout and in-flight calibration.			
(U) MAJOR THRUST: Develop technology to warn of spacecraft radiation, charging, and kinetic impact hazards and to provide space environment situational awareness and anomaly resolution capability for Department of Defense space systems.	0.680	0.795	0.824
(U) In FY 2007: Employed full energy spectra algorithms to convert entire compact environment anomaly sensor data bases into dynamic climatological model for anomaly resolution and space system design. Constructed initial hardware for space demonstration of the distributed anomaly resolution sensor. Calibrated and integrated compact environment anomaly sensor for diagnosing severe radiation environment on Air Force test satellite.			
(U) In FY 2008: Analyze data from compact environment anomaly sensor data bases and continue anomaly resolution for space system design. Continue construction of hardware for space demonstration of the distributed anomaly resolution sensor. Integrate compact environment anomaly sensor for diagnosing severe radiation environment on Air Force test satellite.			
(U) In FY 2009: Continue construction of hardware for space demonstration of the distributed anomaly resolution sensor. Perform verification and validation of compact environment anomaly sensor for diagnosing- severe radiation environment.			
(U) Total Cost	4.452	4.831	5.175

		<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to</u>	<u>Total Cost</u>
		<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Complete</u>	
(U) PE 0602601F, Spacecraft Technology.										
(U) This project has been coordinated through the Reliance 21 process to harmonize efforts and eliminate										

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE

0603401F Advanced Spacecraft
Technology

PROJECT NUMBER AND TITLE

5021 Space Systems Survivability

(U) C. Other Program Funding Summary (\$ in Millions)

duplication.

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification

DATE
February 2008

BUDGET ACTIVITY 03 Advanced Technology Development (ATD)				PE NUMBER AND TITLE 0603401F Advanced Spacecraft Technology			PROJECT NUMBER AND TITLE 5083 Ballistic Missiles Technology			
Cost (\$ in Millions)		FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
5083	Ballistic Missiles Technology	2.990	5.806	5.649	5.179	5.429	6.259	6.077	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0		

- (U) **A. Mission Description and Budget Item Justification**
 This project develops, integrates, and demonstrates advanced technologies for sustainment and modernization of strategic ballistic missiles. The project focuses on developing robust, low maintenance inertial navigation instruments to sustain current ballistic missile systems, as well as provide new, small, low-powered, high precision instrumentation for next generation missile systems.
- (U) **B. Accomplishments/Planned Program (\$ in Millions)**
- | | | | |
|--|----------------|----------------|----------------|
| | <u>FY 2007</u> | <u>FY 2008</u> | <u>FY 2009</u> |
| (U) MAJOR THRUST: Develop, integrate, and demonstrate advanced navigation instrumentation applied to emerging vehicle designs and other technologies that sustain current strategic missile systems. Provide critical missile technology concepts to support future space force application and strategic systems. | 1.495 | 2.903 | 2.825 |
- (U) In FY 2007: Developed and integrated engineering design next generation missile navigation systems and ground tested in environments relevant to subsequent flight test conditions. Evaluated system performance and provided improvements to meet established performance goals. Planned flight test demonstration.
- (U) In FY 2008: Continue next generation missile navigation system engineering development, design, and ground test in relevant strategic environments, and evaluate design improvements against established performance goals. Continue flight test demonstration planning. Initiate engineering system design verification and testing.
- (U) In FY 2009: Continue engineering system development design verification and testing to incorporate performance improvements. Conduct flight qualification testing and evaluation of candidate demonstration flight units. Initiate system integration of flight demonstration units with emerging vehicle designs.
- | | | | |
|---|-------|-------|-------|
| (U) MAJOR THRUST: Develop, integrate, and demonstrate advanced navigation technologies with new vehicle designs to provide robust, flexible, lower cost solutions for sustaining current strategic missile systems. | 1.495 | 2.903 | 2.824 |
|---|-------|-------|-------|
- (U) In FY 2007: Performed additional long-term planning and developed initial long-lead hardware acquisition and coordination with test facilities in preparation for sled testing of high-gravitational force tolerant navigation instrumentation and range safety devices. Measured performance of navigation instrumentation and range safety devices with associated platform hardware, power sources, support software, and communication interfaces in 100 times the gravitational force flight-like vibration environments. Interfaced system level design with experimental test bed.
- (U) In FY 2008: Complete test planning, integration, and conduct sled testing of high-gravitational force tolerant navigational instrumentation and range safety devices in preparation for future flight test demonstrations. Continue

Exhibit R-2a, RDT&E Project Justification

DATE
February 2008

BUDGET ACTIVITY 03 Advanced Technology Development (ATD)	PE NUMBER AND TITLE 0603401F Advanced Spacecraft Technology	PROJECT NUMBER AND TITLE 5083 Ballistic Missiles Technology
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(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
performance evaluation of navigation instrumentation and range safety devices with associated hardware and software interfaces in relevant dynamic and hostile environments. Validate system design refinements and initiate long-term plan for flight testing advanced navigational instrumentation and range safety devices with new vehicle designs.			
(U) In FY 2009: Measure and evaluate performance of advanced navigation instrumentation and range safety devices from experimental test bed and sled testing. Continue long-term planning and initiate long-lead hardware acquisition for flight testing advanced navigational instrumentation and range safety devices with new vehicle design interfaces. Initiate qualification testing of designs against validated system level interfaces.			
(U) Total Cost	2.990	5.806	5.649

(U) <u>C. Other Program Funding Summary (\$ in Millions)</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to</u>	<u>Total Cost</u>
	<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Complete</u>	
(U) PE 0601102F, Defense Research Sciences.									
(U) PE 0602601F, Space Technology.									
(U) PE 0603311F, Ballistic Missile Technology.									
(U) PE 0603601F, Conventional Weapons Technology.									
(U) PE 0603851F, Intercontinental Ballistic Missile-Dem/Val.									
(U) PE 0604851F, Intercontinental Ballistic Missile-EMD.									
(U) PE 0605860F, Rocket System Launch Program-Space.									
(U) This project has been coordinated through the Reliance 21 process to harmonize efforts and eliminate duplication.									

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE

0603401F Advanced Spacecraft
Technology

PROJECT NUMBER AND TITLE

5083 Ballistic Missiles Technology

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification

DATE
February 2008

BUDGET ACTIVITY 03 Advanced Technology Development (ATD)				PE NUMBER AND TITLE 0603401F Advanced Spacecraft Technology			PROJECT NUMBER AND TITLE 682J Spacecraft Vehicles		
Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
682J Spacecraft Vehicles	28.232	23.244	7.966	8.080	8.779	11.481	11.402	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

Note: Funds for the FY 2007 Congressionally-directed Massively Parallel Optical Interconnects in the amount of \$1.1 million were moved from this Project to PE 0603789F, C3I Advanced Development, Project 634216, for execution. Also, funds for the FY 2007 Congressionally-directed Advanced Satellite Thermal Control Program were moved from PE 0603211F, Aerospace Technology Development and Demonstration, Project 63486U, to this PE, for execution.

(U) A. Mission Description and Budget Item Justification

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 space systems.

(U) B. Accomplishments/Planned Program (\$ in Millions)

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) MAJOR THRUST: 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.	1.566	2.330	1.660
(U) In FY 2007: Performed radiation testing of five to six junction solar cells. Constructed flight hardware for thin-film solar array. Demonstrated roll-to-roll production of thin-film solar cells on polymer substrates.			
(U) In FY 2008: Complete fabrication of flight hardware for Thin-Film Radiation Exposure flight experiment. Complete ground portion of on-orbit prediction model for thin-film solar cells. Develop interconnect technologies for advanced multijunction solar cell structures.			
(U) In FY 2009: Demonstrate greater than 14% efficient thin-film solar cells. Begin performance optimization of greater than 40% efficient solar cell concepts.			
(U) MAJOR THRUST: Develop technologies for long life, efficient, low-vibration, lightweight mechanical cryocoolers and integration components for space applications.	1.005	1.316	1.169
(U) In FY 2007: Assessed various advanced technologies such as micro-electro-mechanical, optical cooling, and other concepts to further reduce cryocooler mass and improve performance for space based situational awareness applications. Developed initial advanced concept program to support multi-temperature and large focal plane cooling requirements for space-based space surveillance and other mission applications.			
(U) In FY 2008: Complete design and begin development of a non moving parts compressor using proton biased membrane technology. Complete design and begin development of a low vibration conductance, cross gimbal 35 K			

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE

0603401F Advanced Spacecraft
Technology

PROJECT NUMBER AND TITLE

682J Spacecraft Vehicles

(U) B. Accomplishments/Planned Program (\$ in Millions)	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
cooling loop interface to support space tracking missions. Complete design and begin development of an improved thermal interface material doubling conductive transfer capacity in space cooling applications. Complete comprehensive study and begin technology development of satellite cryogenic interface requirements and improved technologies to support space tracking applications.			
(U) In FY 2009: Continue development of a non moving parts compressor using proton biased membrane technology. Continue development of a low vibration conductance, cross gimbal 35 K cooling loop interface to support space tracking missions. Continue development of an improved thermal interface material doubling conductive transfer capacity in space cooling applications. Continue technology development of satellite cryogenic interface requirements and improved technologies to support space tracking applications			
(U)			
(U) MAJOR THRUST: Develop composites for launch vehicle and spacecraft structures and space applications, such as launch vehicle shrouds, thermal protection structures, and space antennas. Note: In FY 2008, increase in funding is due to acceleration of the thermal management testbed program.	2.958	5.172	2.884
(U) In FY 2007: Demonstrated space qualification-level performance for large diameter launch vehicle fairing. Transitioned multi-functional structures technology to unmanned aerial vehicle and launch vehicle community. Demonstrated space qualification-level performance for 25-meters long ultralightweight deployable structures.			
(U) In FY 2008: Develop symbiotic structural technologies for large deployable structural sensors and improved thermal management sensors. Perform flight-qualification tests of novel deployable structure architectures, cryogenic tanks, and launch vehicle structural components. Develop thermal management testbed.			
(U) In FY 2009: Fly elastically-deployed, stored strain energy, deployable structural architectures including shape memory alloy reinforced hinges. Develop and test thermal management hardware.			
(U)			
(U) MAJOR THRUST: 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.	2.074	2.363	2.253
(U) In FY 2007: Ground demonstrated full multi-axis flywheel attitude control system with integrated energy storage. Demonstrated space qualification-level performance for passive vibro-acoustic damping devices to mitigate launch vehicle acoustic loads. Flight demonstrated on-orbit docking and fluid transfer mechanisms.			
(U) In FY 2008: Implement estimation algorithm for improved local situational awareness using on existing on-orbit asset.			
(U) In FY 2009: Begin implementation of advanced estimation algorithms for improved local situational awareness onto			

UNCLASSIFIED

Exhibit R-2a, RDT&E Project Justification		DATE February 2008		
BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE		
03 Advanced Technology Development (ATD)	0603401F Advanced Spacecraft Technology	682J Spacecraft Vehicles		
(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u>		<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
flight hardware prototype under development.				
(U) CONGRESSIONAL ADD: Information Sciences Institute Microsatellite Serial Manufacturing Demonstration Program.		0.977	0.000	0.000
(U) In FY 2007: Conducted Congressionally-directed effort for Information Sciences Institute Microsatellite Serial Manufacturing Demonstration Program.				
(U) In FY 2008: Not Applicable.				
(U) In FY 2009: Not Applicable.				
(U) CONGRESSIONAL ADD: Photovoltaic Module Development for Lighter than Air Vehicles.		0.978	0.000	0.000
(U) In FY 2007: Conducted Congressionally-directed effort for Photovoltaic Module Development for Lighter than Air Vehicles.				
(U) In FY 2008: Not Applicable.				
(U) In FY 2009: Not Applicable.				
(U) CONGRESSIONAL ADD: Space Situational Awareness/Star Tracking System.		1.564	0.000	0.000
(U) In FY 2007: Conducted Congressionally-directed effort for Space Situational Awareness/Star Tracking System.				
(U) In FY 2008: Not Applicable.				
(U) In FY 2009: Not Applicable.				
(U) CONGRESSIONAL ADD: Advanced Satellite Thermal Control Program.		1.369	0.000	0.000
(U) In FY 2007: Conducted Congressionally-directed effort for Advanced Satellite Thermal Control Program.				
(U) In FY 2008: Not Applicable.				
(U) In FY 2009: Not Applicable.				
(U) CONGRESSIONAL ADD: Thin Film Amorphous Solar Arrays.		10.168	3.190	0.000
(U) In FY 2007: Conducted Congressionally-directed effort for Thin Film Amorphous Solar Arrays.				
(U) In FY 2008: Not Applicable.				
(U) In FY 2009: Not Applicable.				
(U) CONGRESSIONAL ADD: Large Automated Production of Expendable Launch Structure (LAPELS).		2.542	4.287	0.000

UNCLASSIFIED

Exhibit R-2a, RDT&E Project Justification	DATE February 2008
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BUDGET ACTIVITY 03 Advanced Technology Development (ATD)	PE NUMBER AND TITLE 0603401F Advanced Spacecraft Technology	PROJECT NUMBER AND TITLE 682J Spacecraft Vehicles
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(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) In FY 2007: Conducted Congressionally-directed effort for LAPELS.			
(U) In FY 2008: Not Applicable.			
(U) In FY 2009: Not Applicable.			
(U) CONGRESSIONAL ADD: Microsatellite Serial Manufacturing.	1.955	1.595	0.000
(U) In FY 2007: Conducted Congressionally-directed effort for Microsatellite Serial Manufacturing.			
(U) In FY 2008: Not Applicable.			
(U) In FY 2009: Not Applicable.			
(U) CONGRESSIONAL ADD: Small Low-Cost Reconnaissance Spacecraft.	1.076	1.795	0.000
(U) In FY 2007: Conducted Congressionally-directed effort for Small Low-Cost Reconnaissance Spacecraft.			
(U) In FY 2008: Not Applicable.			
(U) In FY 2009: Not Applicable.			
(U) CONGRESSIONAL ADD: Space Situational Awareness.	0.000	1.196	0.000
(U) In FY 2007: Not Applicable.			
(U) In FY 2008: Conduct Congressionally-directed effort for Space Situational Awareness.			
(U) In FY 2009: Not Applicable.			
(U) Total Cost	28.232	23.244	7.966

(U) <u>C. Other Program Funding Summary (\$ in Millions)</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to Complete</u>	<u>Total Cost</u>
	<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>		
(U) Related Activities:									
(U) PE 0602203F, Aerospace Propulsion.									
(U) PE 0602601F, Spacecraft Technology.									
(U) PE 0603218C, Research and Support.									
(U) PE 0603226E, Experimental Evaluation of Major Innovative									

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE

**0603401F Advanced Spacecraft
Technology**

PROJECT NUMBER AND TITLE

682J Spacecraft Vehicles**(U) C. Other Program Funding Summary (\$ in Millions)**

Technologies.

(U) PE 0603500F,
Multi-Disciplinary Advanced
Development Space Technology.**(U)** This project has been
coordinated through the
Reliance 21 process to
harmonize efforts and eliminate
duplication.**(U) D. Acquisition Strategy**

Not Applicable.

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UNCLASSIFIED

PE NUMBER: 0603444F
 PE TITLE: MAUI SPACE SURVEILLANCE SYSTEM

Exhibit R-2, RDT&E Budget Item Justification	DATE February 2008
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BUDGET ACTIVITY 03 Advanced Technology Development (ATD)	PE NUMBER AND TITLE 0603444F MAUI SPACE SURVEILLANCE SYSTEM
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Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
Total Program Element (PE) Cost	49.502	42.160	4.838	5.902	6.029	5.704	5.683	Continuing	TBD
4868 Maui Space Surveillance System	49.502	42.160	4.838	5.902	6.029	5.704	5.683	Continuing	TBD

(U) A. Mission Description and Budget Item Justification

This program funds space situational awareness technology development and demonstration at the Maui Space Surveillance System (MSSS) in Hawaii, as well as the operation and upgrade of the facility. Note: In FY 2008, Congress added \$5.2 million for the High Accuracy Network Determination System (HANDS), \$23.0 million for MSSS Operations and Research, and \$9.0 million for the Panoramic Survey Telescope and Rapid Response System (PanSTARRS). This program is in Budget Activity 3, Advanced Technology Development, since it enables and demonstrates technologies for existing system upgrades and/or new system developments that have military utility and address warfighter needs.

(U) B. Program Change Summary (\$ in Millions)

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) Previous President's Budget	50.383	5.237	5.338
(U) Current PBR/President's Budget	49.502	42.160	4.838
(U) Total Adjustments	-0.881	36.923	
(U) Congressional Program Reductions			
Congressional Rescissions		-0.277	
Congressional Increases		37.200	
Reprogrammings	0.053		
SBIR/STTR Transfer	-0.934		

(U) Significant Program Changes:

Not Applicable.

C. Performance Metrics

Under Development.

Exhibit R-2a, RDT&E Project Justification

DATE
February 2008

BUDGET ACTIVITY 03 Advanced Technology Development (ATD)				PE NUMBER AND TITLE 0603444F MAUI SPACE SURVEILLANCE SYSTEM			PROJECT NUMBER AND TITLE 4868 Maui Space Surveillance System		
Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
4868 Maui Space Surveillance System	49.502	42.160	4.838	5.902	6.029	5.704	5.683	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

- (U) **A. Mission Description and Budget Item Justification**
 This program funds space situational awareness technology development and demonstration at the Maui Space Surveillance System (MSSS) in Hawaii, as well as the operation and upgrade of the facility. Note: In FY 2008, Congress added \$5.2 million for the High Accuracy Network Determination System (HANDS), \$23.0 million for MSSS Operations and Research, and \$9.0 million for the Panoramic Survey Telescope and Rapid Response System (PanSTARRS). This program is in Budget Activity 3, Advanced Technology Development, since it enables and demonstrates technologies for existing system upgrades and/or new system developments that have military utility and address warfighter needs.
- (U) **B. Accomplishments/Planned Program (\$ in Millions)**
- | | | | |
|---|----------------|----------------|----------------|
| | <u>FY 2007</u> | <u>FY 2008</u> | <u>FY 2009</u> |
| (U) MAJOR THRUST/CONGRESSIONAL ADD: Develop, demonstrate, and integrate space situational awareness technology at the Maui Space Surveillance System (MSSS) in Hawaii, as well as operate and upgrade the facility. Note: This effort includes Congressional Adds of \$25.0 million in FY 2007 and \$23.0 million in FY 2008. | 30.436 | 28.052 | 4.838 |
- (U) In FY 2007: Continued MSSS infrastructure contributions for research, development, and operations that supported customers and experimenters. Upgraded and modernized facilities, telescopes, and sensors. Maintained site safety and security. Continued development and implementation of self-sufficiency plan. Developed concepts to provide operational support for space situational awareness (SSA), space system characterization, and active tracking. Assessed military utility, enhanced mission effectiveness, and transitioned technology to user commands. Initiated development of advanced adaptive optics system for improved imaging performance, reliability, and characterization of dim objects. Provided health/status, identification, and anomaly resolution for selected satellites using ultra-precise astrodynamics techniques and electro-optic characterization.
- (U) In FY 2008: Continue MSSS research, development, and operational contributions supporting various customers and experimenters. Continue refurbishing and upgrading MSSS and maintaining site safety and security in accordance with Air Force regulations. Continue development and implementation of self-sufficiency plan. Develop concepts for SSA, space system characterization, and active tracking. Continue development of a state-of-the-art, high-performance sodium beacon adaptive optics system. Provide health/status, identification, and anomaly resolution for selected satellites using ultra-precise astrodynamics techniques and electro-optic characterization.
- (U) In FY 2009: Continue MSSS infrastructure contributions in research, development, and operations that support various customers and experimenters. Continue refurbishing and upgrading MSSS to accommodate those missions and maintaining requirements for safety and security in accordance with Air Force regulations. Continue development and implementation of self-sufficiency plan.

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY 03 Advanced Technology Development (ATD)	PE NUMBER AND TITLE 0603444F MAUI SPACE SURVEILLANCE SYSTEM	PROJECT NUMBER AND TITLE 4868 Maui Space Surveillance System
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(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u>	FY 2007	FY 2008	FY 2009
(U) CONGRESSIONAL ADD: Panoramic Survey Telescope And Rapid Response System (Pan-STARRS). In FY 2007: Completed Maui single telescope Pan-STARRS including system integration and testing. Initial demonstration completed. Began military utility demonstration. Provided information on Mauna Kea site strategic planning to support installation of Pan-STARRS four-telescope system. In FY 2008: Maui telescope will transition into routine use for sky surveys. Complete utility demonstration. Initiate four-telescope system design and development based on lessons learned from Maui installation/operations. In FY 2009: Not Applicable.	11.244	8.941	0.000
(U) CONGRESSIONAL ADD: High Accuracy Network Determination System (HANDS). In FY 2007: Developed small autonomous operating telescopes linked into a network to provide a testbed in support of space situational awareness. Supported precision satellite metrics, photometry, and hand-off. Initiated foreign operating rights request to deploy telescope to Australia. In FY 2008: Support research activities and data collection to improve persistent space situational awareness capabilities. Complete foreign operating rights process and deploy a small telescope to Australia. Develop improved small autonomous telescope with increased data collection capabilities. In FY 2008: Not Applicable.	7.822	5.167	0.000
(U) Total Cost	49.502	42.160	4.838

(U) <u>C. Other Program Funding Summary (\$ in Millions)</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to Complete</u>	<u>Total Cost</u>
	<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>		
(U) Related Activities:									
(U) PE 0602605F, Directed Energy Technology.									
(U) PE 0603605F, Advanced Weapons Technology.									
(U) PE 0601108F, High Energy Laser Research Initiatives.									
(U) PE 0602890F, High Energy Laser Research.									
(U) PE 0603924F, High Energy									

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE

0603444F MAUI SPACE
SURVEILLANCE SYSTEM

PROJECT NUMBER AND TITLE

4868 Maui Space Surveillance System

(U) **C. Other Program Funding Summary (\$ in Millions)**Laser Advanced Technology
Program.(U) PE 0603883C, Ballistic Missile
Defense Boost Phase Segment.(U) This project has been
coordinated through the
Reliance process to harmonize
efforts and eliminate duplication.(U) **D. Acquisition Strategy**

Not Applicable.

UNCLASSIFIED

PE NUMBER: 0603601F
 PE TITLE: Conventional Weapons Technology

Exhibit R-2, RDT&E Budget Item Justification	DATE February 2008
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BUDGET ACTIVITY 03 Advanced Technology Development (ATD)	PE NUMBER AND TITLE 0603601F Conventional Weapons Technology
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Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
Total Program Element (PE) Cost	38.602	18.379	11.813	17.942	18.167	21.910	18.902	Continuing	TBD
670A Conventional Weapons Development	38.602	18.379	11.813	17.942	18.167	21.910	18.902	Continuing	TBD

(U) A. Mission Description and Budget Item Justification

This program develops, demonstrates, and integrates ordnance and advanced guidance technologies for air-launched conventional weapons. The program includes development of conventional ordnance technologies including warheads, fuzes, and explosives; and development of advanced guidance technologies including seekers, navigation and control, and guidance. Note: In FY 2008, Congress added \$1.6 million for Moving Target Strike. This program is in the 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) B. Program Change Summary (\$ in Millions)

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) Previous President's Budget	38.530	16.904	13.794
(U) Current PBR/President's Budget	38.602	18.379	11.813
(U) Total Adjustments	0.072	1.475	
(U) Congressional Program Reductions		-0.004	
Congressional Rescissions		-0.121	
Congressional Increases		1.600	
Reprogrammings	0.949		
SBIR/STTR Transfer	-0.877		

(U) Significant Program Changes:

Not Applicable.

C. Performance Metrics

(U) Under Development.

Exhibit R-2a, RDT&E Project Justification

DATE
February 2008

BUDGET ACTIVITY 03 Advanced Technology Development (ATD)				PE NUMBER AND TITLE 0603601F Conventional Weapons Technology			PROJECT NUMBER AND TITLE 670A Conventional Weapons Development		
Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
670A Conventional Weapons Development	38.602	18.379	11.813	17.942	18.167	21.910	18.902	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

- (U) **A. Mission Description and Budget Item Justification**
 This program develops, demonstrates, and integrates ordnance and advanced guidance technologies for air-launched conventional weapons. The program includes development of conventional ordnance technologies including warheads, fuzes, and explosives; and development of advanced guidance technologies including seekers, navigation and control, and guidance. Note: In FY 2008, Congress added \$1.6 million for Moving Target Strike. This program is in the 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) <u>B. Accomplishments/Planned Program (\$ in Millions)</u> | <u>FY 2007</u> | <u>FY 2008</u> | <u>FY 2009</u> |
| (U) MAJOR THRUST: Develop and demonstrate advanced air-delivered munitions fuze and mass-focusing warhead technologies to improve munition effectiveness, allowing for smaller warheads and munition airframes, thereby improving sortie effectiveness and increasing strike aircraft load-outs. Develop a fuzing capability that will transmit function data from penetrating weapons through various hard target mediums. | 3.768 | 3.399 | 2.758 |
| (U) In FY 2007: Further designed a hard target influence fuze capable of denying hard and deeply buried facilities access. Completed developing fuzes that can transmit bomb damage information to an aircraft platform. | | | |
| (U) In FY 2008: Complete initial phase of hard target influence fuze development and testing. Begin developing an active imaging target device that can provide warhead aimpoint selection for mass focused warheads. | | | |
| (U) In FY 2009: Continue developing an active imaging target device that can provide warhead aimpoint selection for mass focused warheads. | | | |
| (U) MAJOR THRUST: Develop and demonstrate conventional munition subsystem and platform integration technologies to include innovative air-delivered munition carriage and release equipment, miniature weapon release concepts, and reduced airframe size providing the capability to safely carry, launch, and communicate with the aerospace vehicle and other multiple miniature weapons. These integration technologies will increase weapon load-outs and improve sortie effectiveness for current and future strike aircraft, while reducing munition airlift requirements. | 0.259 | 0.312 | 0.267 |
| (U) In FY 2007: Completed a miniaturized datalink flight demonstration. Enhanced plans and begin design of a low-cost miniature cruise missile. Matured plans and began design of a miniature persistent munition that will provide area dominance with a multiple-shot capability. Note: Datalink flight test conducted in the navigation and control technologies activity in this project. | | | |

UNCLASSIFIED

Exhibit R-2a, RDT&E Project Justification		DATE February 2008		
BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE		
03 Advanced Technology Development (ATD)	0603601F Conventional Weapons Technology	670A Conventional Weapons Development		
		<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) B. Accomplishments/Planned Program (\$ in Millions)				
(U) In FY 2008: Begin development of a small powered short-range precision-guided submunition capable of attacking multiple moving targets.				
(U) In FY 2009: Begin developing a missile with the capability to defeat a broad range of small and highly agile air targets as well as high value ground targets, such as enemy air defenses.				
(U) MAJOR THRUST: Develop and demonstrate advanced conventional armament warhead technologies, including heavy metal liners, dense metal cases, and insensitive explosives with increased energy release performance attributes. The goal of these efforts is to destroy hardened targets by more effectively penetrating protective surfaces and by enhancing kill mechanisms against softer surface targets.		6.823	6.949	3.269
(U) In FY 2007: Completed insensitive explosive warhead fills that significantly reduce fill volume requirements. Further developed an ordnance package that will significantly improve counter air lethality against cruise missiles and manned aircraft. Developed and tested systems needed for an ordnance package with low collateral damage and minimum far-field lethality. Further developed a multi-mode warhead package designed for precision-guided submunitions. Further developed a weapon system capable of dispensing payloads within a target for counterforce applications.				
(U) In FY 2008: Extend development of an ordnance package with improved counter-air lethality to address cruise missile and urban targets, as well as attacking a subset of ground targets to include enemy air defenses. Continue developing a multi-mode warhead package designed for precision guided submunitions.				
(U) In FY 2009: Demonstrate an ordnance package with improved counter-air lethality to address cruise missile and counter-air targets, as well as attacking a subset of ground targets to include enemy air defenses. Demonstrate a multi-mode warhead package designed for precision guided submunitions.				
(U) MAJOR THRUST: Develop and demonstrate advanced conventional armament seeker technologies for miniature munitions applications. These seeker technologies will autonomously detect, acquire, and guide to targets of interest in adverse weather and battlefield conditions. Also, the seeker technologies will increase the probability of kill and minimize collateral damage, while providing increased weapons load-out and improved sortie effectiveness. In FY 2007, the Miniature Navigator Demonstration (in another thrust in this project) will be completed allowing seekers for two different munition concepts to be initiated.		7.629	6.130	5.519
(U) In FY 2007: Designed, fabricated, and commenced ground and flight testing of a low-cost laser detection and ranging seeker that reduces moving parts compared to earlier generation seekers. Matured plans and began designing a small multiple-mode radar for an air to surface weapon demonstration. Developed ordnance package designed for				

UNCLASSIFIED

Exhibit R-2a, RDT&E Project Justification		DATE February 2008		
BUDGET ACTIVITY 03 Advanced Technology Development (ATD)	PE NUMBER AND TITLE 0603601F Conventional Weapons Technology	PROJECT NUMBER AND TITLE 670A Conventional Weapons Development		
(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u>		<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) low collateral damage and minimum far-field lethality.				
(U) In FY 2008: Continue design and demonstration of low cost laser detection and ranging seeker to increase data rates and reduce moving parts compared to earlier generation laser seeker technologies. Develop a multi-mode radar seeker capable of engaging both moving and stationary targets in adverse weather.				
(U) In FY 2009: Continue design and demonstration of a low cost laser detection ordnance seeker to increase data rates and LADAR moving parts compared to earlier generation LADAR seeker technologies. Flight test a multi-mode radar seeker capable of engaging both moving and stationary targets in adverse weather.				
(U)				
(U) MAJOR THRUST: Develop and demonstrate advanced conventional armament navigation and control technologies to increase armament navigation accuracy, improve stand off range, and enhance weapons control and operation in electronic jamming environments. In FY 2007, the Miniature Navigator Demonstration will be completed allowing seekers for two different munition concepts to be initiated (in another thrust in this project).		1.626	0.000	0.000
(U) In FY 2007: Completed design and fabrication of a weapon datalink and integrated datalink into a guided munition for commencement of flight testing.				
(U) In FY 2008: Not Applicable.				
(U) In FY 2009: Not Applicable.				
(U)				
(U) CONGRESSIONAL ADD: Air Force Special Ops Innovative Miniature Infrared Camera.		1.363	0.000	0.000
(U) In FY 2007: Conducted Congressionally-directed effort for Air Force Special Ops Innovative Miniature Infrared Camera.				
(U) In FY 2008: Not Applicable.				
(U) In FY 2009: Not Applicable.				
(U)				
(U) CONGRESSIONAL ADD: Clandestine Electric Reconnaissance Vehicle (CERV) for Air Force Special Operations Command (AFSOC).		3.116	0.000	0.000
(U) In FY 2007: Conducted Congressionally-directed effort for CERV for AFSOC.				
(U) In FY 2008: Not Applicable.				
(U) In FY 2009: Not Applicable.				
(U)				
(U) CONGRESSIONAL ADD: Micro-Sized Air-Launched Atmospheric Visibility Sensor.		1.363	0.000	0.000
(U) In FY 2007: Conducted Congressionally-directed effort for Micro-Sized Air-Launched Atmospheric Visibility				

UNCLASSIFIED

Exhibit R-2a, RDT&E Project Justification		DATE February 2008		
BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE		
03 Advanced Technology Development (ATD)	0603601F Conventional Weapons Technology	670A Conventional Weapons Development		
(U) B. Accomplishments/Planned Program (\$ in Millions)		<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
Sensor.				
(U) In FY 2008: Not Applicable.				
(U) In FY 2009: Not Applicable.				
(U)				
(U) CONGRESSIONAL ADD: Falcon Eye Seeker		1.947	0.000	0.000
(U) In FY 2007: Conducted Congressionally-directed effort for Falcon Eye Seeker.				
(U) In FY 2008: Not Applicable.				
(U) In FY 2009: Not Applicable.				
(U)				
(U) CONGRESSIONAL ADD: Ground Mobile Gateway System.		1.363	0.000	0.000
(U) In FY 2007: Conducted Congressionally-directed effort for Ground Mobile Gateway System.				
(U) In FY 2008: Not Applicable.				
(U) In FY 2009: Not Applicable.				
(U)				
(U) CONGRESSIONAL ADD: Under Vehicle Mobile Inspection.		3.503	0.000	0.000
(U) In FY 2007: Conducted Congressionally-directed effort for Under Vehicle Mobile inspection System.				
(U) In FY 2008: Not Applicable.				
(U) In FY 2009: Not Applicable.				
(U)				
(U) CONGRESSIONAL ADD: Next Generation Fixed Wing S-3B Heavy Aerial Firefighting Tanker.		3.116	0.000	0.000
(U) In FY 2007: Conducted Congressionally-directed effort for Next Generation Fixed Wing S-3B Heavy Aerial Firefighting Tanker.				
(U) In FY 2008: Not Applicable.				
(U) In FY 2009: Not Applicable.				
(U)				
(U) CONGRESSIONAL ADD: Unmanned Air Vehicle (UAV) Sensor Interface and Payloads for Targeting.		1.363	0.000	0.000
(U) In FY 2007: Conducted Congressionally-directed effort for UAV Sensor Interface and Payloads for Targeting.				
(U) In FY 2008: Not Applicable.				
(U) In FY 2009: Not Applicable.				
(U)				
(U) CONGRESSIONAL ADD: Weapons Data Link.		1.363	0.000	0.000

Exhibit R-2a, RDT&E Project Justification	DATE February 2008
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BUDGET ACTIVITY 03 Advanced Technology Development (ATD)	PE NUMBER AND TITLE 0603601F Conventional Weapons Technology	PROJECT NUMBER AND TITLE 670A Conventional Weapons Development
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(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) In FY 2007: Conducted Congressionally-directed effort for Weapons Data Link.			
(U) In FY 2008: Not Applicable.			
(U) In FY 2009: Not Applicable.			
(U) CONGRESSIONAL ADD: Moving Target Strike.	0.000	1.589	0.000
(U) In FY 2007: Not Applicable.			
(U) In FY 2008: Conduct Congressionally-direct effort for Moving Target Strike.			
(U) In FY 2009: Not Applicable.			
(U) Total Cost	38.602	18.379	11.813

(U) <u>C. Other Program Funding Summary (\$ in Millions)</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to Complete</u>	<u>Total Cost</u>
	<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>		
(U) Related Activities:									
(U) PE 0602602F, Conventional Munitions.									
(U) This project has been coordinated through the Reliance 21 process to harmonize efforts and eliminate duplication.									
(U) <u>D. Acquisition Strategy</u> Not Applicable.									

UNCLASSIFIED

PE NUMBER: 0603605F
 PE TITLE: Advanced Weapons Technology

Exhibit R-2, RDT&E Budget Item Justification	DATE February 2008
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BUDGET ACTIVITY 03 Advanced Technology Development (ATD)	PE NUMBER AND TITLE 0603605F Advanced Weapons Technology
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Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
Total Program Element (PE) Cost	74.683	74.383	44.507	48.530	43.000	48.961	56.415	Continuing	TBD
11SP Advanced Optics and Laser Space Tech	20.598	38.243	16.586	17.053	16.591	16.641	16.684	Continuing	TBD
3150 Advanced Optics Technology	11.690	11.524	0.000	0.000	0.000	0.000	0.000	Continuing	TBD
3151 High Power Solid State Laser Technology	26.206	14.186	19.623	15.003	10.681	19.264	26.954	Continuing	TBD
3152 High Power Microwave Technology	12.551	10.430	8.298	16.474	15.728	13.056	12.777	Continuing	TBD
3647 High Energy Laser Technology	3.638	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	TBD

Note: In FY 2007, Project 11SP, Advanced Optics and Laser Space Technology, efforts transferred from PE 0603500F, Multidisciplinary Advanced Development Space Technology, Project 5031, Advanced Optics and Laser Space Technology, in order to more effectively manage and provide oversight of the efforts.

(U) A. Mission Description and Budget Item Justification

This program provides for the development and demonstration of advanced directed energy and optical concepts. In solid state lasers, compact, reliable, relatively high power, cost-effective single electric laser devices and arrays of electric laser devices are demonstrated. Technologies such as high power chemical lasers and beam control components/techniques are also demonstrated. In high power microwaves, technologies such as narrowband and wideband devices and antennas are demonstrated. Note: In FY 2008, Congress added \$1.9 million for All Electric Laser, \$8.4 million for Applications of LIDAR to Vehicles with Analysis (ALVA), \$1.6 million for Real-time Optical Surveillance Applications, \$2.4 million for the Satellite Active Imaging National Testbed Program, \$15.0 million for Space Situational Awareness Research, and \$1.6 million for Compound Zoom for Airborne Reconnaissance (CZAR). 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.

Exhibit R-2, RDT&E Budget Item Justification

DATE

February 2008

BUDGET ACTIVITY

03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE

0603605F Advanced Weapons Technology

(U) **B. Program Change Summary (\$ in Millions)**

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) Previous President's Budget	76.733	43.999	38.877
(U) Current PBR/President's Budget	74.683	74.383	44.507
(U) Total Adjustments	-2.050	30.384	
(U) Congressional Program Reductions		-0.026	
Congressional Rescissions		-0.490	
Congressional Increases		30.900	
Reprogrammings	-0.347		
SBIR/STTR Transfer	-1.703		

(U) **Significant Program Changes:**

Funding was increased in FY 2009 for additional demonstrations leading to an earlier transition of tactical directed energy weapon technologies.

C. Performance Metrics

Under Development.

Exhibit R-2a, RDT&E Project Justification

DATE
February 2008

BUDGET ACTIVITY 03 Advanced Technology Development (ATD)				PE NUMBER AND TITLE 0603605F Advanced Weapons Technology			PROJECT NUMBER AND TITLE 11SP Advanced Optics and Laser Space Tech		
Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
11SP Advanced Optics and Laser Space Tech	20.598	38.243	16.586	17.053	16.591	16.641	16.684	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

Note: In FY 2007, efforts transferred from PE 0603500F, Multidisciplinary Advanced Development Space Technology, Project 5031, Advanced Optics and Laser Space Technology, in order to more effectively manage and provide oversight of the efforts.

(U) A. Mission Description and Budget Item Justification

This project provides for the demonstration and detailed assessment of space unique technologies needed for advanced optical and laser systems.

(U) B. Accomplishments/Planned Program (\$ in Millions)

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) MAJOR THRUST: Develop and demonstrate advanced, long-range optical technologies such as advanced beam control; beam acquisition, tracking, and pointing; adaptive optics; dual line-of-sight pointing; large lightweight optics; and optical coatings.	1.186	1.060	0.937
(U) In FY 2007: Performed cost trade studies and commenced design of integrated testbed. Developed laboratory setup to test performance of a deformable mirror system.			
(U) In FY 2008: Begin integration of advanced optical technologies in an optical testbed and design sub-systems such as power, advanced thermal management, signal processing, sensors, and optical mounting and vibration control.			
(U) In FY 2009: Continue integration of testbed and begin testing of sub-systems.			
(U) MAJOR THRUST: Perform atmospheric compensation/beam control experiments for space situational awareness applications using large aperture telescopes, including high-resolution satellite imaging, detection and characterization of small/dim space objects, and high accuracy space object tracking.	5.453	4.317	3.322
(U) In FY 2007: Demonstrated detection and discrimination of small, non-resolved space objects. Demonstrated visible and near-infrared imaging of satellites too small or dim for present systems. Began detailed design, simulation, and component specification of high efficiency adaptive optics system for compensated visible imaging and detection of very dim space objects. Demonstrated phased array imaging for large aperture high resolution telescopes.			
(U) In FY 2008: Continue design and begin subsystem integration of high efficiency adaptive optics system for compensated imaging and detection of very dim space objects at visible and near infrared wavelengths. Perform laboratory tests to validate the performance of lightweight mirrors.			
(U) In FY 2009: Integrate high efficiency adaptive optics system on large aperture high resolution telescope. Perform system tests and prepare for demonstrations of high resolution compensated imaging and detection of very dim space objects at visible and infrared wavelengths. Conclude phased array imaging experiments.			

UNCLASSIFIED

Exhibit R-2a, RDT&E Project Justification		DATE February 2008		
BUDGET ACTIVITY 03 Advanced Technology Development (ATD)	PE NUMBER AND TITLE 0603605F Advanced Weapons Technology	PROJECT NUMBER AND TITLE 11SP Advanced Optics and Laser Space Tech		
(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u>		<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) MAJOR THRUST: Develop and demonstrate advanced optical beam control technologies for laser propagation through severe and/or extended atmospheric turbulence.		13.959	15.580	12.327
(U) In FY 2007: Began integration of advanced ground diagnostic system for characterization of laser propagation through atmospheric turbulence. Demonstrated and characterized operation of advanced adaptive optics and tracking technologies in stressing atmospheric conditions.				
(U) In FY 2008: Continue integration of advanced ground diagnostic system for characterization of laser propagation through stressing atmospheric turbulence. Perform laboratory characterization on components for sensing and wavefront control technologies.				
(U) In FY 2009: Complete design and begin to build advanced ground diagnostic system performance of laser propagation through atmospheric turbulence in a variety of atmospheric conditions. Conduct brassboard integration of advanced sensing and wavefront control technologies.				
(U) CONGRESSIONAL ADD: Space Situational Awareness.		0.000	14.902	0.000
(U) In FY 2007: Not Applicable.				
(U) In FY 2008: Develop, integrate, and test component and system level technologies to advance space situational awareness. Improve the performance of current collection, analysis, fusion, and dissemination capabilities. Develop technologies for satellite modeling and assessment. Develop tools for analysis, modeling, and simulation. Develop and demonstrate resolved and non-resolved satellite imaging concepts. Develop and demonstrate passive and active imaging concepts. Develop and demonstrate space-object identification techniques. Develop image processing algorithms.				
(U) In FY 2009: Not Applicable.				
(U) CONGRESSIONAL ADD: Satellite Active Imaging National Testbed (formerly GEO Light Imaging National Testbed (GLINT)).		0.000	2.384	0.000
(U) In FY 2007: Not Applicable.				
(U) In FY 2008: Develop active imaging technologies for meeting space active awareness spatial resolution goals from user community.				
(U) In FY 2009: Not Applicable.				
(U) Total Cost		20.598	38.243	16.586

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE

0603605F Advanced Weapons Technology

PROJECT NUMBER AND TITLE

11SP Advanced Optics and Laser Space Tech

(U) C. Other Program Funding Summary (\$ in Millions)

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to</u>	<u>Total Cost</u>
	<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Complete</u>	
(U) PE 0602605F, Directed Energy Technology									
(U) PE 0603444F, Maui Space Surveillance System									
(U) PE 0601108F, High Energy Laser Research Initiatives.									
(U) PE 0602890F, High Energy Laser Research.									
(U) PE 0603924F, High Energy Laser Advanced Technology Program.									
(U) PE 0602120A, Sensors and Electronic Survivability.									
(U) PE 0602307A, Advanced Weapons Technology.									
(U) PE 0602624A, Weapons and Munitions Technology.									
(U) PE 0603004A, Weapons and Munitions Advanced Technology.									
(U) PE 0602114N, Power Projection Applied Research.									
(U) PE 0602702E, Tactical Technology.									
(U) PE 0603175C, Ballistic Missile Defense Technology.									
(U) PE 0603883C, Ballistic Missile Defense Boost Phase Segment									
(U) PE 0602651M, Joint Non-Lethal									

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE

**0603605F Advanced Weapons
Technology**

PROJECT NUMBER AND TITLE

**11SP Advanced Optics and Laser
Space Tech****(U) C. Other Program Funding Summary (\$ in Millions)**

Weapons Applied Research.

(U) PE 0603651M, Joint Non-LethalWeapons Technology
Development.**(U) This project has been
coordinated through the
Reliance 21 process to
harmonize efforts and eliminate
duplication.****(U) D. Acquisition Strategy**

Not Applicable.

UNCLASSIFIED

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY 03 Advanced Technology Development (ATD)				PE NUMBER AND TITLE 0603605F Advanced Weapons Technology			PROJECT NUMBER AND TITLE 3150 Advanced Optics Technology		
Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
3150 Advanced Optics Technology	11.690	11.524	0.000	0.000	0.000	0.000	0.000	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project develops advanced optical technologies for various strategic and tactical beam control applications.

(U) B. Accomplishments/Planned Program (\$ in Millions)

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) CONGRESSIONAL ADD: Near Earth Space Surveillance Initiative (NESSI).	1.559	0.000	0.000
(U) In FY 2007: Continued development of the wide field corrector, the prime focus instrument package, and the tracker system.			
(U) In FY 2008: Not Applicable.			
(U) In FY 2009: Not Applicable.			
(U) CONGRESSIONAL ADD: Mobile Active Targeting Resource for Integrated Experiments.	0.974	0.000	0.000
(U) In FY 2007: Successfully completed missile detection and tracking at Tonopah Test Range. Designed, fabricated and integrated system upgrades to improve performance against man portable air defense systems (MANPADS). Demonstrated performance improvements.			
(U) In FY 2008: Not Applicable.			
(U) In FY 2009: Not Applicable.			
(U) CONGRESSIONAL ADD: Hyper/multispectral Data Reduction and Archiving (HyDRA) Project.	0.974	0.000	0.000
(U) In FY 2007: Developed advanced change and anomaly detection algorithms to significantly enhance targeting capability of tactical laser weapons. Developed system requirements and plans for integration to legacy systems. Demonstrated ability to automatically extracted target signatures from background clutter.			
(U) In FY 2008: Not Applicable.			
(U) In FY 2009: Not Applicable.			
(U) CONGRESSIONAL ADD: Applications of LIDAR to Vehicles with Analysis (ALVA).	6.624	8.346	0.000
(U) In FY 2007: ALVA consists of two efforts: Standoff Intelligence Designator (SID) and Hi-Class. SID: Developed airborne night-time imaging to support missions such as counter-improvised explosive device detection. Demonstrated military utility of lasers for night-time video including flight testing, integrating state-of-the-art sensors into real-world air frames. Conducted proof of concept demonstrations for communications networks and			

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE

0603605F Advanced Weapons
Technology

PROJECT NUMBER AND TITLE

3150 Advanced Optics Technology

(U) B. Accomplishments/Planned Program (\$ in Millions)	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
evaluation studies. Hi-Class: Conducted initial testing of the three-dimensional sensor in a two-dimensional mode for imaging/detection of small/dim space objects for space situational awareness and missile tracking applications. Altered the Hi-Class laser setup to ensure better reliability, maintainability, and support to customers.			
(U) In FY 2008: SID: Complete testing of active nighttime imagers and prepare to transition technology to customers. Develop smaller, lighter laser imagers for new customers. Evaluate potential for using continuous-wave laser sensors for different applications. Hi-Class: Continue integration and undertake testing of the three-dimensional capability for imaging/detection of small/dim space objects. Integrate a hyperspectral imager into the Hi-Class system.			
(U) In FY 2009: Not Applicable.			
(U)			
(U) CONGRESSIONAL ADD: Real-time Optical Surveillance Applications (ROSA).	1.559	1.589	0.000
(U) In FY 2007: Developed detailed simulations involving physics-based model for time-resolved photon counter sensor to study the benefits and limitations of the sensor in potential space situational awareness applications. Developed advanced observatory control architecture for maximum reliability yet flexible enough to accommodate diverse missions and compliant with security requirements.			
(U) In FY 2008: Leverage previously developed models to exploit unique capabilities of time-resolved photon counter for detection of extremely small or faint objects. Conduct modeling and simulation studies to push current capabilities in change detection with optical sensors. Pursue artificial intelligence paradigm in automation of telescope networks for space situational awareness mission.			
(U) In FY 2009: Not Applicable.			
(U)			
(U) CONGRESSIONAL ADD: Compound Zoom for Airborne Reconnaissance (CZAR).	0.000	1.589	0.000
(U) In FY 2007: Not Applicable.			
(U) In FY 2008: Develop requirements and provide designs for all hardware and software modifications to adapt and demonstrate a commercial high quality compact compound zoom lens for application on an Air Force gunship. Conduct a study to evaluate multiple sensors (cameras). Use modeling and simulation to develop robust stabilization control.			
(U) In FY 2009: Not Applicable.			
(U) Total Cost	11.690	11.524	0.000

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE

0603605F Advanced Weapons Technology

PROJECT NUMBER AND TITLE

3150 Advanced Optics Technology

(U) **C. Other Program Funding Summary (\$ in Millions)**

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to</u>	<u>Total Cost</u>
	<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Complete</u>	

(U) Related Activities:

(U) PE 0603444F, Maui Space Surveillance Systems.

(U) PE 0602605F, Directed Energy Technology.

(U) This project has been coordinated through the Reliance 21 process to harmonize efforts and eliminate duplication.

(U) **D. Acquisition Strategy**

Not Applicable.

Exhibit R-2a, RDT&E Project Justification

DATE
February 2008

BUDGET ACTIVITY 03 Advanced Technology Development (ATD)				PE NUMBER AND TITLE 0603605F Advanced Weapons Technology			PROJECT NUMBER AND TITLE 3151 High Power Solid State Laser Technology		
Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
3151 High Power Solid State Laser Technology	26.206	14.186	19.623	15.003	10.681	19.264	26.954	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project provides for the development, integration, demonstration, and detailed assessment of low to high power laser and beam control technologies needed for aircraft protection, force protection, force application, precision engagement, and Global War on Terrorism missions. Critical technologies developed and demonstrated include: (1) compact, reliable, and affordable laser devices with good beam quality and scalability to high power; (2) advanced optics and laser beam control components to effectively compensate and propagate laser radiation through the atmosphere to a target. Emphasis will be on demonstrating the ability to meet key system concept performance parameters, reliability, affordability, and packaging requirements unique to potential applications. Perform laser system concept assessments to include vulnerability assessments and target effect testing. Identify critical design data for laser system concepts. Develop high energy laser system concepts and identify issues relating to system concept architectures, technology readiness, technology tradeoffs, mission effectiveness, and military utility.

(U) B. Accomplishments/Planned Program (\$ in Millions)

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) MAJOR THRUST: Develop, integrate, and demonstrate solid state, chemical, gas, and hybrid laser technologies for scalable, high energy laser devices for insertion into airborne tactical and strategic applications and ground-based laser system concepts.	3.789	1.022	2.315
(U) In FY 2007: Scaled solid state lasers with a goal of reaching weapons-class parameters including power, beam quality, and run time. Investigated integrating the laser technology with tactical platform sub-systems such as power, advanced thermal management systems, avionics, sensors, and fire control to increase the potential for successful transition. Investigated tactical laser applications. Demonstrated tactical laser utility through field experiments and customer interaction.			
(U) In FY 2008: Develop solid state lasers for a wide set of applications including tactical weapons, self-defense, and space situational awareness (e.g. active tracking and imaging) with a goal of exceeding the thresholds for weapons-class power, beam quality, and run time capabilities. Develop technologies to support solid state laser technology insertion in airborne systems. These technologies will reduce laser size and weight, as well as increase efficiency, affordability, reliability, maintainability, supportability, operational environmental acceptability, and ruggedness. Investigate integrating laser device technology with tactical platform sub-systems such as power, advanced thermal management systems, avionics, sensors, and fire control to increase the potential for successful transition.			
(U) In FY 2009: Continue to simulate, build, and evaluate solid state lasers for a variety of applications such as airborne tactical weapons and space situational awareness applications (i.e. active track, active imaging, illumination).			

UNCLASSIFIED

Exhibit R-2a, RDT&E Project Justification		DATE February 2008		
BUDGET ACTIVITY 03 Advanced Technology Development (ATD)	PE NUMBER AND TITLE 0603605F Advanced Weapons Technology	PROJECT NUMBER AND TITLE 3151 High Power Solid State Laser Technology		
(U) B. Accomplishments/Planned Program (\$ in Millions)	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	
(U) Continue to focus on reducing size and weight, as well as increasing efficiency, affordability, reliability, maintainability, supportability, operational environmental acceptability, and ruggedness. Continue to investigate integration of laser technology with tactical platform sub-systems such as power, advanced thermal management systems, avionics, sensors, and fire control to increase the potential for successful transition. Prepare for integration of appropriate laser technologies for a large aircraft demonstration of solid state laser-based precision engagements.				
(U) MAJOR THRUST: Develop, integrate, and demonstrate advanced optical and imaging technologies for advanced systems concepts. Develop and demonstrate integrated tactical laser and beam control technologies. Technologies include optical components, optical coatings, advanced beam control, atmospheric compensation, and pointing and tracking. Analyze system concepts and perform critical experiments with integrated laser and beam control technologies. Funding was increased in FY 2009 for additional integrated demonstrations leading to an earlier transition of tactical airborne laser and beam control technologies.	11.020	11.276	17.308	
(U) In FY 2007: Acquired a solid state laser for an integrated high energy laser testbed that can use various beam control systems. Began integration experiments to focus on architectures favorable in terms of size, weight, efficiency, affordability, reliability, maintainability, supportability, operational environmental acceptability, and ruggedness for tactical weapon applications. Began facility and support equipment modifications for integrated high energy laser testbed.				
(U) In FY 2008: Upgrade existing facility, integrate solid state laser device into facility, and conduct initial testbed checkout. Demonstrate advanced tactical beam control hardware components in the laboratory. Analyze advanced beam control concepts in integrated simulations. Begin development of the second-generation tactical relay mirror demonstrator including the telescopes, the optics, the associated gimbals, the lightweight optics bench, and electronics.				
(U) In FY 2009: Begin upgrade of the integrated high energy laser testbed and perform testing to evaluate testbed performance objectives. Demonstrate integrated tactical laser and beam control technologies. Continue integrated tactical beam control field tests to optimize advanced active tracking algorithms and advanced jitter reduction in breadth of environments for airborne tactical laser engagements. Complete the development of the second-generation relay mirror demonstrator. Demonstrate the use of the second-generation relay mirror with the solid state laser testbed in the laboratory.				
(U) CONGRESSIONAL ADD: Mid-Infrared Semiconductor Laser Technology.	1.656	0.000	0.000	
(U) In FY 2007: Provided environmental hardening for a low-cost, multi-band, compact, robust, lightweight				

UNCLASSIFIED

Exhibit R-2a, RDT&E Project Justification		DATE February 2008		
BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE		
03 Advanced Technology Development (ATD)	0603605F Advanced Weapons Technology	3151 High Power Solid State Laser Technology		
(U) B. Accomplishments/Planned Program (\$ in Millions)		<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
semiconductor laser demonstration system capable of jamming infrared missiles with both open and closed loop capability. Incorporated and fiber-coupled the advanced high-brightness infra-red semiconductor lasers for a pod-mounted infra-red countermeasure.				
(U) In FY 2008: Not Applicable.				
(U) In FY 2009: Not Applicable.				
(U)				
(U) CONGRESSIONAL ADD: High Energy Laser- Directed Energy Weapon Scaling Optimization.		2.338	0.000	0.000
(U) In FY 2007: Performed trade studies to enhance the scalability of the ceramic solid state ThinZag laser.				
(U) In FY 2008: Not Applicable.				
(U) In FY 2009: Not Applicable.				
(U)				
(U) CONGRESSIONAL ADD: Advanced Weapons and Laser Diode Development.		2.533	0.000	0.000
(U) In FY 2007: Continued to refine fiber-coupling and improved manufacturing and packaging concepts of laser diodes.				
(U) In FY 2008: Not Applicable.				
(U) In FY 2009: Not Applicable.				
(U)				
(U) CONGRESSIONAL ADD: Lightweight Multi-purpose Laser.		4.870	0.000	0.000
(U) In FY 2007: Improved epitaxial growth and processing to improve yield and cut costs. Improved device layout and packaging to improve reliability. Extended high efficiency designs into additional wavelength ranges.				
(U) In FY 2008: Not Applicable.				
(U) In FY 2009: Not Applicable.				
(U)				
(U) CONGRESSIONAL ADD: All Electric Laser.		0.000	1.888	0.000
(U) In FY 2007: Not Applicable.				
(U) In FY 2008: Develop electric laser technologies for airborne applications.				
(U) In FY 2009: Not Applicable.				
(U)				
(U) Total Cost		26.206	14.186	19.623

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE

0603605F Advanced Weapons Technology

PROJECT NUMBER AND TITLE

3151 High Power Solid State Laser Technology

(U) C. Other Program Funding Summary (\$ in Millions)

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to</u>	<u>Total Cost</u>
	<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Complete</u>	
(U) Related Activities:									
(U) PE 0602102F, Materials.									
(U) PE 0603270F, Electronic Combat Technology.									
(U) PE 0602605F, Directed Energy Technology.									
(U) PE 0601108F, High Energy Laser Research Initiatives.									
(U) PE 0602890F, High Energy Laser Research.									
(U) PE 0603924F, High Energy Laser Advanced Technology Program.									
(U) PE 0602120A, Sensors and Electronic Survivability.									
(U) PE 0602307A, Advanced Weapons Technology.									
(U) PE 0602624A, Weapons and Munitions Technology.									
(U) PE 0603004A, Weapons and Munitions Advanced Technology.									
(U) PE 0602114N, Power Projection Applied Research.									
(U) PE 0603175C, Ballistic Missile Defense Technology									
(U) PE 0603883C, Ballistic Missile Defense Boost Phase Segment.									
(U) PE 0602651M, Joint Non-Lethal									

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE

**0603605F Advanced Weapons
Technology**

PROJECT NUMBER AND TITLE

**3151 High Power Solid State Laser
Technology****(U) C. Other Program Funding Summary (\$ in Millions)**

Weapons Applied Research.

(U) PE 0602651M, Joint Non-Lethal
Weapons Applied Research.**(U)** This project has been
coordinated through the
Reliance 21 process to
harmonize efforts and eliminate
duplication.**(U)** The technology efforts in this PE
that are supporting future
enhancements to airborne lasers
have been coordinated with the
Airborne Laser program office.**(U) D. Acquisition Strategy**

Not Applicable.

Exhibit R-2a, RDT&E Project Justification

DATE
February 2008

BUDGET ACTIVITY 03 Advanced Technology Development (ATD)				PE NUMBER AND TITLE 0603605F Advanced Weapons Technology			PROJECT NUMBER AND TITLE 3152 High Power Microwave Technology			
Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total	
3152 High Power Microwave Technology	12.551	10.430	8.298	16.474	15.728	13.056	12.777	Continuing	TBD	
Quantity of RDT&E Articles	0	0	0	0	0	0	0			

(U) A. Mission Description and Budget Item Justification

This project develops and demonstrates high power microwave (HPM) generation and transmission technologies that support a wide range of Air Force missions such as the potential disruption, degradation, damage, or destruction of an adversary's electronic infrastructure and military capability. These targeted capabilities include local computer and communication systems, as well as large and small air defense and command and control systems. In many cases, this effect can be covert with no collateral structural or human damage. In addition, millimeter wave force protection technologies are developed and demonstrated. It also develops a susceptibility, vulnerability, and lethality data base to identify potential vulnerabilities of U.S. systems to HPM threats and to provide a basis for future offensive and defensive weapon system decisions. Representative U.S. and foreign assets are tested to understand real system susceptibilities. Both wideband (wide frequency range) and narrowband (very small frequency range) technologies are being developed.

(U) B. Accomplishments/Planned Program (\$ in Millions)

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) MAJOR THRUST: Conduct effects experimentation to expand and refine data library and support susceptibility predictions. Investigate and develop technologies for HPM airfield defense. Note: Due to higher Air Force priorities this thrust is being temporarily terminated in FY 2009.	0.948	0.594	0.000
(U) In FY 2007: Conducted high power microwave effects tests to improve HPM system design and lethality. Modeled real targets and predicted probability of kill for various HPM scenarios, including HPM/radio frequency airfield defense against small surface-to-air missile attack. Identified and developed techniques to mitigate vulnerabilities of U.S. infrastructure to HPM attack. Investigated electromagnetic interference/electromagnetic compatibility sub-system and system interface issues.			
(U) In FY 2008: Refine airfield defense technologies. Evaluate components as appropriate.			
(U) In FY 2009: Not Applicable.			
(U) MAJOR THRUST: Develop and evaluate millimeter-wave Active Denial technologies for non-lethal, anti-personnel weapon applications such as ground force protection from a stand-off aircraft.	5.747	3.768	4.429
(U) In FY 2007: Developed and evaluated technologies for non-lethal weapons applications. Continued to develop high power millimeter-wave source for airborne applications. Evaluated first phase conventional source approach. Identified deficiencies and evaluated need to rebuild. Completed critical design review for coaxial source design. Commenced hardware development for full power source test stand including award of test stand contract. Provided technical expertise and background to external organizations tailoring Active Denial concepts and capabilities to their needs and gleaned data relevant to airborne applications.			

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Exhibit R-2a, RDT&E Project Justification		DATE February 2008		
BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE		
03 Advanced Technology Development (ATD)	0603605F Advanced Weapons Technology	3152 High Power Microwave Technology		
(U) B. Accomplishments/Planned Program (\$ in Millions)		<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) In FY 2008: Continue to develop and evaluate technologies for non-lethal weapons applications. Continue the development of high power millimeter-wave source for airborne applications. Finish rebuild and manufacturer testing of the second version of the conventional gyrotron approach. Begin build of the first coaxial design gyrotron. Continue with hardware development, procurement, fabrication, and testing for the full power source test stand. Provide technical expertise and background to external organizations tailoring Active Denial concepts and capabilities to their needs and glean data relevant to airborne applications.				
(U) In FY 2009: Continue to develop and evaluate technologies for non-lethal weapons applications. Downselect from conventional or coaxial approaches arriving at best high power millimeter-wave source hardware. Complete the development of millimeter-wave source for airborne applications in ground-based demonstration form. Continue hardware development, procurement, fabrication, and testing for the full power source test stand. Provide technical expertise and background to external organizations tailoring Active Denial concepts and capabilities to their needs and glean data relevant to airborne applications.				
(U) MAJOR THRUST: Develop the technology to integrate HPM devices on various platforms, to include aerial, and investigate specific target sets of interest. Develop and demonstrate HPM technologies to disrupt, degrade, damage, or destroy an adversary's electronic systems.		5.856	6.068	3.869
(U) In FY 2007: Continued miniaturization, integration, and ruggedization of HPM testbed for field experimentation. Examined the interactions of the HPM source, antenna, and pulse power to increase functionality. Investigated enhanced configuration for permanent magnets in relativistic magnetron and fabricated source. Continued integration and began evaluating the HPM testbed to determine efficiency and potential electromagnetic interference/coupling issues. Improved HPM testbed command and control sub-systems. Demonstrated performance of the integrated gigawatt-class HPM source and antenna. Investigated HPM system interaction with airborne platforms. Performed system diagnostics on integrated experiment to ensure proper source operation.				
(U) In FY 2008: Integrate and ruggedize the HPM testbed for field experimentation. Perform HPM system testing and diagnostics on hardware developed and integrated in FY 2007. Improve HPM testbed command and control systems for pulsed operation greater than threshold levels.				
(U) In FY 2009: Conduct laboratory demonstration of the miniaturized and ruggedized HPM testbed. Enhance the system performance and address all electromagnetic interference issues. Implement the improved HPM testbed command and control systems for expanded pulsed operation. Implement subcomponent improvements as determined by FY 2007 risk reduction exercise.				
(U) Total Cost		12.551	10.430	8.298

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE

0603605F Advanced Weapons Technology

PROJECT NUMBER AND TITLE

3152 High Power Microwave Technology

(U) **C. Other Program Funding Summary (\$ in Millions)**

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to</u>	<u>Total Cost</u>
	<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Complete</u>	

(U) Related Activities:

(U) PE 0602202F, Human Systems Technology.

(U) PE 0602605F, Directed Energy Technology.

(U) PE 0602120A, Sensors and Electronic Survivability.

(U) PE 0602624A, Weapons and Munitions Technology.

(U) PE 0602114N, Power Projection.

(U) PE 0602651M, Joint Non-Lethal Weapons Applied Research.

(U) PE 0603851M, Nonlethal Weapons.

(U) This project has been coordinated through the Reliance 21 process to harmonize efforts and eliminate duplication.

(U) **D. Acquisition Strategy**

Not Applicable.

Exhibit R-2a, RDT&E Project Justification

DATE
February 2008

BUDGET ACTIVITY 03 Advanced Technology Development (ATD)				PE NUMBER AND TITLE 0603605F Advanced Weapons Technology			PROJECT NUMBER AND TITLE 3647 High Energy Laser Technology		
Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
3647 High Energy Laser Technology	3.638	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

Note: In FY 2008, this effort moved into Project 3151 in this program element to consolidate the laser device development efforts.

(U) A. Mission Description and Budget Item Justification

This project provides for the development, demonstration, and detailed assessment of non-space unique technologies needed for high energy laser weapons. Near-term focus is on airborne high energy laser missions, although the technology developed for this project is directly applicable to most high energy laser applications. Critical technologies developed and demonstrated include advanced high energy laser devices and laser beam control to efficiently compensate and propagate laser radiation through the atmosphere to a target. Correcting the laser beam for distortions induced by propagation through the turbulent atmosphere is the key technology in most long-range high energy laser applications. Detailed computational models to establish high energy laser weapon effectiveness and target vulnerability are developed.

(U) B. Accomplishments/Planned Program (\$ in Millions)

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) MAJOR THRUST: Develop and demonstrate the technology for scalable, high energy laser devices with improved efficiency for insertion in tactical airborne lasers and other potential weapon applications.	1.690	0.000	0.000
(U) In FY 2007: Tested overall device-level performance and issues based on the integration of the ejector nozzle concepts and increased mass flow from singlet-oxygen generators into a laser device. Tested advanced fuels and determined performance increases. Investigated systems performance of airborne chemical oxygen iodine laser systems.			
(U) In FY 2008: Not Applicable.			
(U) In FY 2009: Not Applicable.			
(U) CONGRESSIONAL ADD: Laser Spark Countermeasure Program.	1.948	0.000	0.000
(U) In FY 2007: Performed laboratory effects tests and modeling to resolve measured differences in the damage threshold of different focal plane arrays. Performed and documented a countermeasure effectiveness study for selected operational scenarios.			
(U) In FY 2008: Not Applicable.			
(U) In FY 2009: Not Applicable.			
(U) Total Cost	3.638	0.000	0.000

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE

0603605F Advanced Weapons Technology

PROJECT NUMBER AND TITLE

3647 High Energy Laser Technology

(U) **C. Other Program Funding Summary (\$ in Millions)**

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to</u>	<u>Total Cost</u>
	<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Complete</u>	

(U) Related Activities:

(U) PE 0602605F, Directed Energy Technology.

(U) PE 0603883C, Ballistic Missile Defense Boost Phase Segment.

(U) This project has been coordinated through the Reliance 21 process to harmonize efforts and eliminate duplication.

(U) The technology efforts in this PE that are supporting future enhancements to airborne lasers have been coordinated with the Airborne Laser program office.

(U) **D. Acquisition Strategy**

Not Applicable.

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PE NUMBER: 0603680F
 PE TITLE: Manufacturing Technologies

Exhibit R-2, RDT&E Budget Item Justification	DATE February 2008
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BUDGET ACTIVITY 03 Advanced Technology Development (ATD)	PE NUMBER AND TITLE 0603680F Manufacturing Technologies
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Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
Total Program Element (PE) Cost	0.000	0.000	39.729	40.480	40.865	41.653	42.493	0.000	0.000
5280 Manufacturing Technologies	0.000	0.000	35.756	36.432	36.779	37.488	38.244	0.000	0.000
5281 Manufacturing Readiness	0.000	0.000	3.973	4.048	4.086	4.165	4.249	0.000	0.000

Note: In FY 2009 the AF Manufacturing Technology program will transfer to PE 0603680F, Manufacturing Technologies, from PE 0708011F, Industrial Preparedness, to focus on long-term manufacturing and processes.

(U) A. Mission Description and Budget Item Justification

The ManTech program is mandated by Section 2521, Title 10, United States Code, to create an affordable, world-class industrial base manufacturing capability responsive to the warfighter's needs. The Air Force ManTech major program tenets are: development and improvement of technologies and processes; collaboration with government program offices, industry, and academia; investments in generic technologies that can be applied to different applications, technologies beyond reasonable risk level for industry alone; cost-sharing; multiple system/customer applications; potential for significant return on investment; and customer commitment to implement. To this end, ManTech develops, demonstrates, assesses and transitions advanced manufacturing processes and technologies to reduce costs, improve quality/capability, and shorten cycle times of weapon systems during design, development, production, and sustainment. Where mature processes are not available, laboratory-developed and demonstrated process capabilities are made available for transition into weapon system programs. ManTech objectives are conducted through partnerships with all industry levels, from large prime contractors to small material and parts vendors. Manufacturing Technologies is in Budget Activity 3, Advanced Technology Development, since it develops and demonstrates manufacturing technologies for existing upgrades and/or new system developments that have military utility and address warfighter needs.

(U) B. Program Change Summary (\$ in Millions)

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) Previous President's Budget			
(U) Current PBR/President's Budget	0.000	0.000	39.729
(U) Total Adjustments	0.000		
(U) Congressional Program Reductions			
Congressional Rescissions			
Congressional Increases			
Reprogrammings			
SBIR/STTR Transfer			
(U) <u>Significant Program Changes:</u>			

Exhibit R-2a, RDT&E Project Justification

DATE
February 2008

BUDGET ACTIVITY 03 Advanced Technology Development (ATD)				PE NUMBER AND TITLE 0603680F Manufacturing Technologies			PROJECT NUMBER AND TITLE 5280 Manufacturing Technologies		
Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
5280 Manufacturing Technologies	0.000	0.000	35.756	36.432	36.779	37.488	38.244	0.000	0.000
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

Note: In FY 2009 the AF Manufacturing Technologies program will transfer to PE 0603680F, Manufacturing Technologies, from PE 0708011F, Industrial Preparedness, to focus on long-term manufacturing technologies and processes.

(U) A. Mission Description and Budget Item Justification

The ManTech program is mandated by Section 2521, Title 10, United States Code, to create an affordable, world-class industrial base manufacturing capability responsive to the warfighter's needs. The Air Force ManTech major program tenets are: development and improvement of manufacturing technologies and processes; collaboration with government program offices, industry, and academia; investments in generic technologies that can be applied to different applications, cost-sharing; multiple system/customer applications; potential for significant return on investment; and customer commitment to implement. To this end, ManTech develops, demonstrates, and transitions advanced manufacturing processes and technologies to reduce costs, improve quality/capability, and shorten cycle times of weapon systems during design, development, production, and sustainment. Where mature processes are not available, laboratory-developed and demonstrated initial process capabilities are made available for transition into weapon system programs. ManTech objectives are conducted through partnerships with all industry levels, from large prime contractors to small material and parts vendors.

(U) B. Accomplishments/Planned Program (\$ in Millions)

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) MAJOR THRUST: Pursue cost-effective maintenance, repair, and manufacturing technologies for sustainment of Air Force weapon systems.	0.000	0.000	6.675
(U) In FY 2007: Not Applicable.			
(U) In FY 2008: Not Applicable.			
(U) In FY 2009: Continue cost-effective repair and manufacturing technologies for affordable sustainment of aircraft and turbine engine components. Continue Engine Rotor Life Extension (ERLE) spiral II technical effort to extend the life of critical, high value rotating engine components, which have been in service and scheduled for retirement. Continue assessments and manufacturing technology development to reduce costs and lead times for high value supply chain commodities. Continue rapid response productivity improvement efforts with selected high value programs.			
(U) MAJOR THRUST: Address generic and critical and pervasive affordability and producibility issues for various weapon systems and processes, to include manned and unmanned aircraft, advanced tactical missiles, directed energy systems, Command and Control Intelligence, Surveillance and Reconnaissance (C2ISR) platforms, space, structures, propulsion, stealth, and avionics/electronics.	0.000	0.000	29.081
(U) In FY 2007: Not Applicable.			

Exhibit R-2a, RDT&E Project Justification	DATE February 2008
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BUDGET ACTIVITY 03 Advanced Technology Development (ATD)	PE NUMBER AND TITLE 0603680F Manufacturing Technologies	PROJECT NUMBER AND TITLE 5280 Manufacturing Technologies
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(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) In FY 2008: Not Applicable.			
(U) In FY 2009: Continue high value efforts to verify advantages of flexible manufacturing, commercial/military integration, quality processing, and supplier improvements. Continue development of manufacturing capabilities for more affordable low-observable structures. Develop manufacturing capabilities for advanced propulsion technologies. Continue rapid response productivity improvement efforts for selected high value programs. Continue efforts to address critical electronics manufacturing technologies for various C2ISR and space systems in order to improve affordability and producibility. Continue efforts on Active Electronically Scanned Arrays (AESA) radar to enable improved manufacturing processes for reduced costs and cycle times and greater production capacity. Continue efforts on affordable datalink components to enable improved manufacturing processes for reduced costs and cycle times and increased production throughput. Conduct assessments on critical technologies in lab and acquisition programs to ensure affordable, producible technology transition.			
(U) Total Cost	0.000	0.000	35.756

(U) <u>C. Other Program Funding Summary (\$ in Millions)</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to</u>	<u>Total Cost</u>
	<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Complete</u>	
(U) PE 0708011F, Industrial Preparedness									
(U) This project has been coordinated through the Reliance 21 process to harmonize efforts and eliminate duplication.									
(U) <u>D. Acquisition Strategy</u>									
All major contracts in this Program Element were awarded after full and open competition.									

Exhibit R-2a, RDT&E Project Justification

DATE
February 2008

BUDGET ACTIVITY 03 Advanced Technology Development (ATD)				PE NUMBER AND TITLE 0603680F Manufacturing Technologies			PROJECT NUMBER AND TITLE 5281 Manufacturing Readiness		
Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
5281 Manufacturing Readiness	0.000	0.000	3.973	4.048	4.086	4.165	4.249	0.000	0.000
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

Note: In FY 2009 the AF Manufacturing Technologies program will transfer to PE 0603680F, Manufacturing Technologies, from PE 0708011F, Industrial Preparedness, to focus on long-term manufacturing and processes.

(U) A. Mission Description and Budget Item Justification

Manufacturing readiness of technologies is a key concern when identifying and mitigating risk to successfully transition these technologies and systems into production. Within each product sector (aeronautical, space, munitions/directed energy, and C2ISR), manufacturing readiness assessments (MRAs) will be applied and manufacturing readiness levels (MRLs) utilized to gauge and manage manufacturing related issues. Advanced Technology Demonstrations (ATDs) will be used when appropriate to aid in efficient transition. Selected acquisition programs will also be assessed to determine readiness for milestone decisions and/or to reduce manufacturing risk. Pervasive, generic and system-specific manufacturing maturation plans will be developed and implemented based on the assessments to reduce overall program risk and to provide an increased awareness of manufacturing issues throughout major weapon system life cycles. Generic and pervasive manufacturing issues will be identified and considered as potential ManTech programs to transition advanced manufacturing technologies into multiple sectors.

(U) B. Accomplishments/Planned Program (\$ in Millions)

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) MAJOR THRUST: Through application of MRAs, develop and implement manufacturing maturation plans to mitigate transition risk from development to production.	0.000	0.000	3.973
(U) In FY 2007: Not Applicable.			
(U) In FY 2008: Not Applicable.			
(U) In FY 2009: Develop Manufacturing Maturation Plans (MMPs) for all Category I ATDs and selected high-visibility program based on MRA. Selected MMPs will be executed to increase the MRL and improve technology transition to production. MRAs will also be conducted on selected Air Force acquisition programs to aid in Milestone Decision Reviews and/or to mitigate cost, schedule, or rate issues. Manufacturing risk will be documented based on the assessments and delivered to the appropriate program offices. Pervasive manufacturing issues discovered during the assessments will be vetted through the ManTech requirements process.			
(U) Total Cost	0.000	0.000	3.973

(U) C. Other Program Funding Summary (\$ in Millions)

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to</u>	<u>Total Cost</u>
	<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Complete</u>	
(U) Related Activities									
(U) PE, 0708011F, Industrial									

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE

**0603680F Manufacturing
Technologies**

PROJECT NUMBER AND TITLE

5281 Manufacturing Readiness**(U) C. Other Program Funding Summary (\$ in Millions)**

Preparedness

- (U) This project has been coordinated through the Reliance 21 process to harmonize efforts and eliminate duplication.

(U) D. Acquisition Strategy

All major contracts in this Program Element were awarded after full and open competition.

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PE NUMBER: 0603789F
 PE TITLE: C3I Advanced Development

Exhibit R-2, RDT&E Budget Item Justification	DATE February 2008
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BUDGET ACTIVITY 03 Advanced Technology Development (ATD)	PE NUMBER AND TITLE 0603789F C3I Advanced Development
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Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
Total Program Element (PE) Cost	47.352	32.821	30.103	42.165	38.996	42.300	49.509	Continuing	TBD
4072 Dominant Battlespace Awareness	18.350	5.994	7.970	9.802	8.922	9.623	10.737	Continuing	TBD
4216 Battlespace Information Exchange	12.119	11.828	11.104	17.079	15.734	18.654	22.614	Continuing	TBD
4872 Aerospace Information Dominance	16.883	14.999	11.029	15.284	14.340	14.023	16.158	Continuing	TBD

(U) A. Mission Description and Budget Item Justification

This program develops and demonstrates Air Force Command, Control, Communications, and Intelligence (C3I) technologies for the warfighter. The technologies address the ability to support the global information exchange of correlated and fused information to ensure the Air Force can plan and execute missions in a dynamic, complex environment. The Dominant Battlespace Awareness project will provide affordable operational data capabilities for personnel to understand militarily relevant situations, on a consistent basis, with the precision and timeliness needed to accomplish the mission. The Battlespace Information Exchange project will develop reliable, secure, jam-resistant, inter-operable worldwide global information enterprise capabilities, providing the Air Force assured communications and reach-back capability in a distributed operational environment. It will also demonstrate offensive cyber operations technologies allowing attack and exploitation of adversary information systems by the Air Force. The Aerospace Information Dominance project provides the technology and demonstrations needed to allow the warfighter to plan, assess, execute, monitor, and re-plan on the compressed time scales required for tomorrow's conflicts, whether in combat or peacekeeping missions. Note: In FY 2008, Congress added \$1.0 million for Collaboration Gateway, \$0.8 million for Interoperability Network to Fuse and Exchange Real-Time Information, and \$3.9 million for Massively Parallel Optical Interconnects for Battlespace Information Exchange. This program is in Budget Activity 3, Advanced Technology Development, since it develops and demonstrates technologies for existing upgrades and/or new system developments that have military utility and address warfighter needs

(U) B. Program Change Summary (\$ in Millions)

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) Previous President's Budget	48.195	27.357	32.050
(U) Current PBR/President's Budget	47.352	32.821	30.103
(U) Total Adjustments	-0.843	5.464	
(U) Congressional Program Reductions		-0.020	
Congressional Rescissions		-0.216	
Congressional Increases		5.700	
Reprogrammings	0.200		
SBIR/STTR Transfer	-1.043		
(U) <u>Significant Program Changes:</u> Not Applicable.			

Exhibit R-2, RDT&E Budget Item Justification

DATE

February 2008

BUDGET ACTIVITY

03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE

0603789F C3I Advanced Development

C. Performance Metrics
(U) Under Development.

Exhibit R-2a, RDT&E Project Justification

DATE
February 2008

BUDGET ACTIVITY 03 Advanced Technology Development (ATD)				PE NUMBER AND TITLE 0603789F C3I Advanced Development			PROJECT NUMBER AND TITLE 4072 Dominant Battlespace Awareness		
Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
4072 Dominant Battlespace Awareness	18.350	5.994	7.970	9.802	8.922	9.623	10.737	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) **A. Mission Description and Budget Item Justification**
 This project develops, integrates, and demonstrates advanced technologies to achieve Dominant Battlespace Awareness (DBA) and Predictive Battlespace Awareness (PBA) using information from all sources. DBA is the information required to support dynamic planning and execution with the accuracy, fidelity, and timeliness needed to dominate the battlespace. Technology development includes: tasking information collectors (intelligence, surveillance, and reconnaissance platforms, national intelligence sources, etc.); correlating and geo-registering the collected data; exploiting the data to extract information of military significance; fusing information from multiple sources to create a digital n-dimensional representation of the battlespace; assessing the situation; predicting adversary courses of action (COA); and archiving the results for ready use by decision makers. This is a dynamic, complex process that involves technologies for information access, extraction, fusion, processing, storage, and retrieval, as well as technologies for machine reasoning, pattern recognition, and timeline analysis.

(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) MAJOR THRUST: Develop and demonstrate advanced signal and data exploitation technologies for detection, tracking, identification, and targeting of time-critical targets, and information extraction technologies for situational awareness.	2.654	1.974	2.152
(U) In FY 2007: Demonstrated a baseline capability to perform advanced text exploitation of human intelligence reports and correlate and fuse the information with information from other sources. Demonstrated a prototype that is able to extract information from voluminous textual data. Initiated development of a real-time Signal Processing and Geolocation capability for emerging commercial communications used by military and asymmetrical threats. Initiated development of airborne-cued, ground-based signal processing.			
(U) In FY 2008: Continue development of a real-time Signal Processing and Geolocation capability for emerging commercial communications used by military and asymmetrical threats. Continue development of airborne-cued, ground-based signal processing.			
(U) In FY 2009: Demonstrate a real-time signal processing and geolocation capability for emerging commercial communications used by military and asymmetrical threats. Demonstrate airborne-cued ground-based signal processing. Develop multi-sensor exploitation tools to enable characterization and assessment of adversary satellites. Integrate intelligence data and analysis products to produce anticipatory ground to space awareness picture.			
(U) MAJOR THRUST/CONGRESSIONAL ADD: Develop and demonstrate advanced data handling, event visualization technologies, and distributed data fusion to enable a more effective utilization of the vast amounts of	9.529	4.020	5.818

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE

0603789F C3I Advanced Development

PROJECT NUMBER AND TITLE

4072 Dominant Battlespace Awareness

(U) **B. Accomplishments/Planned Program (\$ in Millions)**FY 2007FY 2008FY 2009

data available to intelligence analysts to provide optimized situation awareness, as well as to support all phases of combat operations. Note: This effort includes \$5.8 million in FY 2007 Congressional Add funding.

- (U) In FY 2007: Enhanced the evaluation environment for assessing the state-of-the-art and maturity of algorithms for transition to the warfighter. Demonstrated an automated process to visualize the overlaying of disparate information domains on a single screen and provide an optimal means of fusing all source intelligence data. Completed demonstration of feature-aided tracking to monitor, assess, and predict possible courses of action. Completed development and demonstrated operator-focused dynamic resource allocation algorithms and techniques for optimization and collaboration of information products. Initiated software and algorithmic development for determination of adversarial behavior within persistent surveillance data, contextual tracking, target-feature-aided tracking, multiple intelligence sources (multi-INT) association and cross-cueing and geospatial reasoning and cued exploitation. Investigated methods for combining post-event processing of intelligence data with real-time streaming intelligence data for indications and warning functions. Conducted Congressionally-directed effort for Advanced Fusion in Urban Operations for Forensic Anticipation of Insurgent Activity. Conducted Congressionally-directed effort for National Center for Multi-Source Information.
- (U) In FY 2008: Continue software and algorithmic design and development efforts for determination of adversarial behavior within persistent surveillance data, contextual tracking, target-feature-aided tracking, multi-INT association and cross-cueing and geospatial reasoning and cued exploitation. Continue to develop methods for combining post-event processing of intelligence data with real-time streaming intelligence data for indications and warning functions. Initiate the design and development of a synthetic assessment environment for the evaluation of the full range of fusion technologies to include basic correlation algorithms to higher levels of fusion algorithms tested in conjunction with command and control systems. Initiate investigation of Fusion of Cyber Intelligence (CYBINT) with traditional INTs.
- (U) In FY 2009: Demonstrate software and algorithmic design and development efforts for determination of adversarial behavior within persistent surveillance data, contextual tracking, target-feature-aided tracking, multi-INT association and cross-cueing and geospatial reasoning and cued exploitation. Demonstrate methods for combining post-event processing of Intel data with real time streaming Intel data for indications and warning functions. Continue design and development of a synthetic assessment environment for the evaluation of the full range of fusion technologies to include basic correlation algorithms to higher levels of fusion algorithms tested in conjunction with C2 systems. Continue investigation of Fusion of CYBINT with traditional INTs. Develop the capability to extract events of interest from unstructured text in order to enable automated visualization of events on timelines and maps.

(U)

UNCLASSIFIED

Exhibit R-2a, RDT&E Project Justification	DATE February 2008
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BUDGET ACTIVITY 03 Advanced Technology Development (ATD)	PE NUMBER AND TITLE 0603789F C3I Advanced Development	PROJECT NUMBER AND TITLE 4072 Dominant Battlespace Awareness
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(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) MAJOR THRUST/CONGRESSIONAL ADD: Develop and demonstrate advanced data and information fusion capabilities to support multi-source capabilities, new sensor types, cognitive models, and automated fusion process management. Note: This effort contains \$1.0 million in FY 2007 Congressional Add funding. In FY 2008, efforts in this thrust move to Project 4216 in this PE.	4.416	0.000	0.000
(U) In FY 2007: Developed interoperable exploitation and data link technologies for real-time ISR management, which incorporates non-traditional ISR into the management algorithms for find, fix, track, target, engage, and access. Performed a multi-platform tracking demonstration utilizing airborne assets against a variety of advanced military and asymmetric threat scenarios. Demonstrated the capability to dynamically task sensors and assure timely, prioritized transport of information for purpose of tracking high value ground targets for long durations and potentially engaging them. Conducted Congressionally-directed effort for Non-Traditional Intelligence, Surveillance, and Reconnaissance.			
(U) In FY 2008: Not Applicable.			
(U) In FY 2009: Not Applicable.			
(U) CONGRESSIONAL ADD: Semantic Service Oriented Architectures for Dynamic Intelligence Fusion.	1.751	0.000	0.000
(U) In FY 2007: Developed and demonstrated a capability to collaboratively interact and manage sensor context sensitive knowledge across multiple platforms using Semantic Service Oriented Architectures, in conjunction with Intelligent Agent architectures, Ontological Knowledge, and Man-on-the-Look technology.			
(U) In FY 2008: Not Applicable.			
(U) In FY 2009: Not Applicable.			
(U) Total Cost	18.350	5.994	7.970

(U) <u>C. Other Program Funding Summary (\$ in Millions)</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to</u>	<u>Total Cost</u>
	<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Complete</u>	
(U) Related Activities:									
(U) PE 0602702F, Command, Control, and Communications.									
(U) PE 0603203F, Advanced Aerospace Sensors.									
(U) PE 0603742F, Combat Identification Technology.									

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE

0603789F C3I Advanced Development

PROJECT NUMBER AND TITLE

4072 Dominant Battlespace
Awareness(U) **C. Other Program Funding Summary (\$ in Millions)**

(U) This project has been coordinated through the Reliance 21 process to harmonize efforts and eliminate duplication.

(U) **D. Acquisition Strategy**

Not Applicable.

Exhibit R-2a, RDT&E Project Justification

DATE
February 2008

BUDGET ACTIVITY 03 Advanced Technology Development (ATD)				PE NUMBER AND TITLE 0603789F C3I Advanced Development			PROJECT NUMBER AND TITLE 4216 Battlespace Information Exchange		
Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
4216 Battlespace Information Exchange	12.119	11.828	11.104	17.079	15.734	18.654	22.614	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project develops and demonstrates advanced communications technologies for the Air Force that implement a secure environment for worldwide information exchange of near-real-time multimedia (i.e., voice, data, video, and imagery) information. This secure environment will be rapidly deployable, mobile, interoperable, and seamless between Air and Space Operations Centers (AOC) and aircraft, either en-route or in theater. It will: a) provide interoperability across echelons, services, coalition, and multi-national force boundaries; b) support mobile information superiority, sensor-to-shooter operations, and the battle management decision process; and c) provide in-transit visibility of en route aircraft, cargo, mission status, and reachback capabilities for aircraft to operations centers in the Continental United States (e.g., updating information and mission changes to en route aircraft). Technology developments include an information assurance decision support system, advanced information management, multi-level/secure communications, secure survivable networks, mission and content-based routing, quality-of-service mechanisms, communications transmission systems, cyber situational awareness, and offensive cyber operations capabilities to attack and exploit adversary information and information systems.

(U) B. Accomplishments/Planned Program (\$ in Millions)

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) MAJOR THRUST: Develop and demonstrate secure wideband assured networking between weapon platforms (e.g. munitions, uninhabited air systems, and aircraft), ground facilities and Special Operations Forces personnel.	3.757	0.944	1.134
(U) In FY 2007: Developed or adapted networked communications to support Special Operations Forces ground elements by connecting them into the airborne network weapon platforms and reachback to globally located command centers. Developed phase one of a small form-factor prototype information networking capability for information sharing and collaboration with other networking assets (aircraft, uninhabited air systems, ground facilities).			
(U) In FY 2008: Complete development of a small form-factor prototype information networking capability for information sharing and collaboration with other networking assets (aircraft, uninhabited air systems, ground facilities).			
(U) In FY 2009: Develop small form-factor networking and reachback capability. Begin certification of the capability in preparation for transition to the Special Operations Forces.			
(U) MAJOR THRUST: Proactively defend cyberspace through cyber situational awareness, detecting and defeating cyber threats, and surviving through adaptation and self-regeneration. Note: This effort transitions in FY 2008 from Applied Research PE 0602702F, Project 4519, into this PE.	0.000	0.772	2.710
(U) In FY 2007: Not Applicable.			

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY 03 Advanced Technology Development (ATD)	PE NUMBER AND TITLE 0603789F C3I Advanced Development	PROJECT NUMBER AND TITLE 4216 Battlespace Information Exchange
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(U) B. Accomplishments/Planned Program (\$ in Millions)	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) In FY 2008: Develop technology demonstration plans for a fleet of cooperative agents trusted to defend mission critical Air Force assets by gathering cyber situational awareness information for defensive decision making. Develop secure data sharing to prevent the disclosure of sensitive information to untrustworthy users.			
(U) In FY 2009: Develop technology demonstration plans for active ISR defense on wired networks. Continue cyber situational awareness demonstration. Continue development of secure data sharing to prevent the disclosure of sensitive information to untrustworthy users.			
(U) MAJOR THRUST: Design, develop, demonstrate, test, and validate an integrated tool suite for Modeling and Simulating the Air Force's extension of the Global Information Grid, the evolving Airborne Network. This thrust will provide the Air Force with the ability to accomplish both mission and technical analyses, at the appropriate levels of fidelity, to enable the effective migration of legacy systems for the development and evolution of the Airborne Network. Note: This effort transitions in FY 2008 from Applied Research PE 0602702F, Project 4519, into this PE.	0.000	0.664	1.374
(U) In FY 2007: Not Applicable.			
(U) In FY 2008: Test and validate the modeling and simulation capability using real world scenarios to determine the accuracy and real-time nature of the capability. Establish enhancements to the current modeling capability and to assess processing requirements.			
(U) In FY 2009: Continue the validation of the enhanced modeling and simulation capability and support tool suite and make it usable by an operational person instead of programmers. Exercise the limitations of the modeling capability and apply the model to proposed future DoD networking environments.			
(U) MAJOR THRUST: Design, develop, and demonstrate the enterprise management capability to accept on-paper policy (e.g., word documents, or other Air Tasking Orders, etc.) and translate that format into network policy language to provide this "policy meta-data" to a network enterprise system in executable form in order to re-configure, re-constitute, and strengthen Air Force networks in response to strategic, tactical, and network events (e.g., changes in information condition (INFOCON), threat condition (THREATCON), defense condition (DEFCON), malicious threat, outages, etc.). Note: This effort transitions in FY 2008 from Applied Research PE 0602702F, Project 4519, into this PE.	0.000	0.776	1.023
(U) In FY 2007: Not Applicable.			
(U) In FY 2008: Design and develop an enterprise management system with the capability to translate narrative policy into machine-readable code in order to reconfigure the network in response to strategic, tactical, and network threats.			

Exhibit R-2a, RDT&E Project Justification		DATE February 2008		
BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE		
03 Advanced Technology Development (ATD)	0603789F C3I Advanced Development	4216 Battlespace Information Exchange		
(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u>		<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) In FY 2009: Develop and demonstrate reconfiguration of network based-policy in response to strategic, tactical, and network events (e.g., changes in information condition (INFOCON), threat condition (THREATCON), defense condition (DEFCON), malicious threat, outages, etc.).				
(U) MAJOR THRUST: Develop and demonstrate offensive cyber operations capabilities in a series of experimental cyber craft technology demonstrations. These demonstrations will integrate capabilities developed from ongoing offensive cyber programs in the areas of gaining access to systems, performing operations in a stealthy manner, gathering intelligence from the compromised systems, and launching cyber "effects" against the systems. Note: This effort transitions in FY 2008 from Applied Research PE 0602702F, Project 4519, into this PE.		0.000	1.379	2.130
(U) In FY 2007: Not Applicable.				
(U) In FY 2008: Initiate development of offensive cyber capabilities to access, remain stealthy, gather intelligence, and affect adversary information and information systems. Develop technology demonstration plans for cyber operations.				
(U) In FY 2009: Analyze development of selected offensive cyber operations capabilities, integrated kinetic and cyber operations planning and execution capabilities, and cyber command and control (Cyber C2) operations functions.				
(U) MAJOR THRUST: Develop and demonstrate advanced expert system decision algorithms to prioritize and control resources for global reach.		0.524	0.000	0.000
(U) In FY 2007: Completed the transition of the combined Intelligent Information Manager, Integrated Network Controller, and the Global Media Access Controller.				
(U) In FY 2008: Not Applicable.				
(U) In FY 2009: Not Applicable.				
(U) MAJOR THRUST/CONGRESSIONAL ADD: Develop and demonstrate intelligent networking transport and management technology to provide assured, seamless, battlespace connectivity to the Air Force with a greatly reduced footprint. Note: This effort includes \$2.0 million in FY 2007 Congressional Add funding, and \$3.9 million in FY 2008 Congressional Add funding.		5.894	7.293	2.733
(U) In FY 2007: Demonstrated improved battle management command, control, and communications networked collaboration capabilities by making improvements in routing, mobile ad-hoc networks, and adaptive protocols to show the effectiveness for ISR platforms. Developed and demonstrated a survivable, mobile, deployable extension of the global information enterprise to support rapid, decisive and sustainable air power, command and control				

Exhibit R-2a, RDT&E Project Justification		DATE February 2008		
BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE		
03 Advanced Technology Development (ATD)	0603789F C3I Advanced Development	4216 Battlespace Information Exchange		
(U) B. Accomplishments/Planned Program (\$ in Millions)		<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
weapons data links, and ISR assets. Conducted Congressionally-directed effort for Massively Parallel Optical Interconnects to Battlespace Information Exchange.				
(U) In FY 2008: Continue improvements in the battle management command, control and communications networked collaborative capability by demonstrating Air Force airborne networking, in a coalition and multi-service environment, enabling aircraft to access each other's ISR airborne and ground information environments. Initiate the development of advanced, automated, network and bandwidth management technologies to move, manage, and process information in real-time to provide dynamic Quality of Assurance/Quality of Service for the warfighter. Initiate investigation to provide assured access (anti-jam) covert high capacity spectrum dominance for global networking, while denying the adversary the same. Conduct Congressionally-directed effort for Massively Parallel Optical Interconnects for Battle Information Exchange to expand the number of wavelengths by utilizing FY 2007 developments in flip-chip mounting of different lasers to a common dielectric silicon optical bench (SiOB). This represents a significant breakthrough in optoelectronic device technology.				
(U) In FY 2009: Complete improvements in the battle management command, control, and communications networked collaborative capability by demonstrating Air Force airborne networking, in a coalition and multi-service environment, enabling aircraft to access each other's intelligence, surveillance, and reconnaissance airborne and ground information environments. Continue investigation to provide assured access (anti-jam) covert high capacity spectrum dominance for global networking, while denying the adversary the same.				
(U)				
(U) CONGRESSIONAL ADD: Hybrid Radio Frequency - Optical Communications Terminal.		0.975	0.000	0.000
(U) In FY 2007: Conducted Congressionally directed effort for Hybrid Radio Frequency - Optical Communications Terminal. Developed parts and subsystems that can be used in either optical or RF communications systems, and be used simultaneously for RF and optical communications. Integrated RF and Optical hardware into a common subsystem. Developed the signaling protocols combining optical and RF characteristics. Developed packaging concepts for the combined RF and optical techniques.				
(U) In FY 2008: Not Applicable.				
(U) In FY 2009: Not Applicable.				
(U)				
(U) CONGRESSIONAL ADD: Cyber Security - Advanced Course in Engineering.		0.969	0.000	0.000
(U) In FY 2007: Developed training program in cyber security through the completion of research topics covering the areas of security policy, computer security, cryptography, steganography, digital forensics, network security, network defense, network attack, wireless security, and next generation security.				

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY 03 Advanced Technology Development (ATD)	PE NUMBER AND TITLE 0603789F C3I Advanced Development	PROJECT NUMBER AND TITLE 4216 Battlespace Information Exchange
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(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) In FY 2008: Not Applicable.			
(U) In FY 2009: Not Applicable.			
(U)			
(U) Total Cost	12.119	11.828	11.104

(U) <u>C. Other Program Funding Summary (\$ in Millions)</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to</u>	<u>Total Cost</u>
	<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Complete</u>	

(U) Related Activities:
 (U) PE 0602702F, Command, Control, and Communications.
 (U) This project has been coordinated through the Reliance 21 process to harmonize efforts and eliminate duplication.

(U) **D. Acquisition Strategy**
 Not Applicable.

Exhibit R-2a, RDT&E Project Justification

DATE
February 2008

BUDGET ACTIVITY 03 Advanced Technology Development (ATD)				PE NUMBER AND TITLE 0603789F C3I Advanced Development			PROJECT NUMBER AND TITLE 4872 Aerospace Information Dominance		
Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
4872 Aerospace Information Dominance	16.883	14.999	11.029	15.284	14.340	14.023	16.158	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

In order to achieve information dominance, the Air Force must be able to plan, assess, monitor, and replan missions rapidly across the full spectrum of operations (air, space and cyberspace) at all levels of war (strategic, operational, and tactical) and during all phases of conflict (pre-conflict, conflict and stability operations). This project develops and demonstrates technologies necessary for dynamic decision making. It provides the technology and demonstrations needed to enable the warfighter to monitor, assess, plan, and execute (MAPE) on the complex and compressed time scales required for tomorrow's conflicts, whether they are combat or operations other than war. It will develop and demonstrate a new generation of planning and assessment technologies that enable a new paradigm of network enabled operations, allowing decision makers to determine the desired operational effects and prosecute the mission accordingly. This project will develop innovative capabilities that will realize a strategy-to-task approach to warfare, exploiting anticipatory environments and agile command and control concepts. It will develop and demonstrate distributed information technologies that provide the decision maker and staff with seamless access to tailored multi-media, multi-spectral data, within a mobile, dynamic, scalable, globally distributed Air and Space Operations Center (AOC). This project will also develop knowledge-based intelligent information technologies to support robust, real-time, large-scale Air Force command and control systems.

(U) B. Accomplishments/Planned Program (\$ in Millions)

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) MAJOR THRUST: Develop and demonstrate distributed information technologies that are scalable and reconfigurable and provide seamless access to tailored multi-media, multi-spectral data for decision makers and staff in mobile, dynamic, scalable, globally distributed command and control centers.	5.493	4.134	1.526
(U) In FY 2007: Investigated a core set of functionality and supporting infrastructure, including multi-level security repositories for next generation operation centers, enabling the ability to plan, direct, coordinate, and control air forces and operations across security boundaries in a coalition environment. Developed execution of the air space planning and re-planning options to enable dynamic deconfliction capabilities; avoiding hazardous conditions. Demonstrated highly efficient business processes and tools to support information exchange between operations centers and other command and control centers. Prototyped and demonstrated intelligent agents that use physics-based modeling to provide accurate, detailed advice necessary to make informed decisions. Developed command and control decision-support capabilities. Initiated investigation of the processes and procedures to normalize the use of information operations with precision munitions to achieve desired effects against our adversaries within the air, space, and cyberspace domains. Developed peer-to-peer and publish/subscribe information distribution systems and adaptive embedded computing techniques operating within a persistent surveillance system for very high resolution, wide-area, and global positioning system-coded surveillance images. Initiated development of polymorphic computing technology for persistent surveillance systems using faster			

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE

0603789F C3I Advanced Development

PROJECT NUMBER AND TITLE

4872 Aerospace Information
Dominance(U) **B. Accomplishments/Planned Program (\$ in Millions)**FY 2007FY 2008FY 2009

processing and greatly reduced size, weight, and power.

- (U) In FY 2008: Complete development of capabilities that allow a networked enabled operations center to plan, direct, coordinate Air Force assets across security boundaries in a coalition environment. Develop and demonstrate the capability to accomplish dynamic air space management and de-confliction of manned and unmanned aircraft focused on air control measure parsing, timely conflict identification, advanced visualization and seamless collaboration. Develop a campaign of experimentation to quantitatively measure transformational command and control concepts enabled by net centric warfare capabilities. Demonstrate command and control decision-support capabilities. Continue to develop the capability to normalize the use of information operations with precision munitions to achieve desired effects against our adversaries within the air, space and cyberspace domains. Complete development of peer-to-peer and publish/subscribe/query information distribution systems and adaptive embedded computing techniques operating within a persistent surveillance system for very high resolution, wide-area, and global positioning system-coded surveillance images. Continue the development of polymorphic (adaptable) computing technology for persistent surveillance systems using faster processing and greatly reduced size, weight, and power requirements for processing hardware. Continue the development and application of Multi-Level Security/Multiple Single Levels of Security (MLS/MSLS) middleware technologies for persistent surveillance systems to support user access/denial of information at multiple security levels.

- (U) In FY 2009: Initiate the development of capabilities to allow seamless information sharing for enhanced situational awareness and understanding by the decision maker. Continue the development of an initial capability to plan and measure effectiveness of information operations in conjunction with precision munitions to determine successful achievement of command intent in time and location to achieve "self-synchronization." Continue campaign of experimentation to quantitatively measure transformational command and control concepts enabled by net centric warfare capabilities. Complete the development of polymorphic (adaptable) computing technology for persistent surveillance systems using faster processing and greatly reduced size, weight, and power requirements for processing hardware. Continue the development and application of MLS/MSLS middleware technologies for persistent surveillance systems to support user access/denial of information at multiple security levels.

(U)

- (U) MAJOR THRUST: Develop and demonstrate the integration of planning tools and information-based intelligent agents for adaptive preplanning and decision support tools for Air Force command and control systems.

3.998

1.235

0.690

- (U) In FY 2007: Demonstrated tools and technologies to revolutionize air mobility information superiority to respond swiftly and effectively to global demands across all spectrums of operations from humanitarian relief to a major conflict. Demonstrated advanced reasoning techniques for mobility courses-of-action development. Demonstrated

Exhibit R-2a, RDT&E Project Justification		DATE February 2008
BUDGET ACTIVITY 03 Advanced Technology Development (ATD)	PE NUMBER AND TITLE 0603789F C3I Advanced Development	PROJECT NUMBER AND TITLE 4872 Aerospace Information Dominance

(U) B. Accomplishments/Planned Program (\$ in Millions)	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
<p>the use of common mobility ontology to improve automation of decision support tools for increased situational awareness, planning, and execution management. Developed technologies to enable a Combat Air Force (CAF), Mobility Air Force (MAF), civilian shared situational awareness/synchronization to achieve desired "effects," and ensure mission success in a global environment. Demonstrated improved synchronization among Global Strike and Global Mobility Force participants within multiple theaters and global Civil air traffic management (ATM). Demonstrated the capability to support collaborative command and control, including dynamic and intermittent participation of players. Developed additional automated machine-to-machine exchange capabilities between CAF aircraft, MAF aircraft, their respective command and control elements, and civil ATM agencies, and demonstrated improved information sharing and interoperability between CAF and MAF mission planning and execution systems for improved velocity, efficiency, safety, and mission success. Developed appropriate virtual staff members to maintain a vision of command and control processes during human absences providing a 24/7 coverage.</p> <p>(U) In FY 2008: Complete development of improved synchronization among Global Strike and Global Mobility Force participants within multiple theaters and global Civil ATM. Complete automated machine-to-machine exchange of selected information capabilities between CAF aircraft, MAF aircraft, and their respective command and control elements. Complete multi-mission optimization capability by exploiting information discovery and delivery, advanced, multi-constraint and distributed optimization techniques, and evaluation models to support mobility operations with special emphasis on increased efficiency and decreased routine workload across functional and supervisory positions. Demonstrate capability for cross-functional collaboration that will increase situation awareness and understanding during mission planning and execution to allow the planning and execution teams to self-synchronize, ensuring a highly coordinated effort. Complete development of next generation tools and technologies to revolutionize air mobility information dominance to respond swiftly to global demands across all spectrums of operations from humanitarian relief to a major conflict.</p> <p>(U) In FY 2009: Initiate development of capabilities to be more agile within a net centric enabled environment. Develop timely option generation selection and coordination capabilities that account for uncertainty and missing and erroneous information, and supports intuitive decision making process between man and machine collaborating on complex, dynamic problems exploiting the respective strengths of machines (process lots of data) and human (analytical reasoning). Develop dynamic workflow and workload management capabilities to manage the command and control constellation of resources.</p> <p>(U) MAJOR THRUST: Develop and demonstrate an effects-based approach for the next generation of planning and assessment techniques that enable decision makers to determine the desired operational effects (nth-order) at the</p>			
	4.483	3.570	3.300

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE

0603789F C3I Advanced Development

PROJECT NUMBER AND TITLE

4872 Aerospace Information
Dominance(U) **B. Accomplishments/Planned Program (\$ in Millions)**FY 2007FY 2008FY 2009

right place at the right time, anywhere, anytime.

- (U) In FY 2007: Developed improved technologies to support effects-based planning, execution, and assessment by enabling the generation, tasking, and assessment of effects-based dynamic air execution orders. Developed improvements to support operations center personnel in assessing course of action options, based upon commander's intent, predictive battlespace awareness tools, and the ability to reason over models of the "enemy as a system." Developed technologies to capture, assess, and integrate cause-and-effect (first, second, and third order) relationships endemic to this "enemy as a system." Developed advanced information technologies to shorten the current execution timelines, while also allowing significant reductions in the number of personnel required in an operations center. Developed a streaming Air Tasking Order (ATO) prototype capability. Developed real-time operational assessment demonstration in a streaming ATO environment that will enable an effects-based approach to operational assessment, which will allow greater visibility into whether or not desired effects are being achieved.
- (U) In FY 2008: Demonstrate concepts and technologies supporting effects-based planning, execution, and assessment by enabling the generation, tasking, and assessment of effects-based tasking. Demonstrate technologies to allow operations center personnel to assess, in near-real-time, various courses of action options based upon command intent. Develop technologies to capture and assess integrated cause-and-effect (first, second, and third order) relationships endemic to this "enemy as a system." Complete the operational concept and architecture for effects based assessment to drive software development and experimentation to determine the ability of developed capabilities to assist warfighters in conducting accurate and timely assessments. Complete the development of techniques to continually assess status of planned actions against adversary systems to determine whether predicted effects are actually achieved. Initiate an analysis of cascading effects in real-time for diverse courses of action. Initiate research to forecast actionable futures to support a decision maker's ability to appraise and plan the "best" blue course of action for Rapid, Decide, Act, and Adapt (RDAA). Initiate investigation of ability to forecast potential adversaries and events-based on indications of known evidence and projected known and/or anticipated threat(s).
- (U) In FY 2009: Demonstrate technology to meet the needs for effects-based assessment in an operational environment. Design, develop, and demonstrate the capabilities for continuous effects-based assessment in a dynamic tasking environment. Demonstrate techniques to accomplish up-to-date awareness on whether the execution of the battle plan is meeting the desired effects. Investigate the methods to enable a decision support environment that enables the decision maker to anticipate and shape all aspects of the future battlespace. Initiate development of predictive battlespace awareness tools with the ability to reason over models of the "enemy as a system." Continue analysis of cascading effects in real-time for diverse courses of action. Continue research to forecast actionable futures to

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE

0603789F C3I Advanced Development

PROJECT NUMBER AND TITLE

4872 Aerospace Information
Dominance(U) **B. Accomplishments/Planned Program (\$ in Millions)**FY 2007FY 2008FY 2009

support a decision maker's ability to appraise and plan the "best" blue course of action for RDAA. Continue investigation of ability to forecast potential adversaries and events based on indications of known evidence and projected known and/or anticipated threat(s). Initiate assured end-to-end Quality of Service and Quality of Assurance integration to the information system enterprise during malicious and non-malicious faults.

(U)

(U) MAJOR THRUST: Develop and demonstrate high performance computing for size, weight, and power-limited applications, and emulate older computing components. Note: This effort transitions in FY 2008 from Applied Research PE 0602702F, Project 4594, into this PE.

0.000

1.343

1.081

(U) In FY 2007: Not Applicable.

(U) In FY 2008: Develop high performance computing for size, weight, and power-limited applications. Transition power efficient processors to DoD users by addressing power, programmability, and radiation issues. Develop and demonstrate emulation of older computing components and boards, allowing re-use of existing software while gaining the advantages of modern semiconductor processing technology.

(U) In FY 2009: Complete development of high performance computing for size, weight, and power-limited applications. Support the resulting hardware and software transition to the users. Initiate development of reliably autonomic small platforms for unmanned operations. Initiate analysis of hardware and system/support software that enables complex software to be readily composed.

(U)

(U) MAJOR THRUST: Demonstrate how a publish, subscribe, and query information management paradigm can enable vertical and horizontal integration of Air Force command, control, communication, computers, intelligence, surveillance, and reconnaissance information systems. Develop advanced prototypes of a Community of Interest (COI) infosphere that support information management requirements of various Air Force net-centric COI's. Demonstrate how such an infosphere can interact with and enhance the current net-centric operations infrastructure.

2.909

2.917

4.432

(U) In FY 2007: Ramped down information engineering efforts that allow existing and new Air Force systems to utilize COI infosphere prototypes. Developed next generation COI infospheres to provide real-time performance, security to Air Force standards, and high levels of scalability. Initiated study of tactical information management to enable information exchange across the enterprise to the tactical edge. Initiated the development of information management infrastructure to federate information among COI infospheres and across distinct information based communities.

(U) In FY 2008: Develop tactical and federated COI infospheres to manage information objects from diverse sources and data environments within and across the tactical edge. Apply adaptor technology to allow existing Air Force

Exhibit R-2a, RDT&E Project Justification	DATE February 2008
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BUDGET ACTIVITY 03 Advanced Technology Development (ATD)	PE NUMBER AND TITLE 0603789F C3I Advanced Development	PROJECT NUMBER AND TITLE 4872 Aerospace Information Dominance
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	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
<p>(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u></p> <p>systems to rapidly integrate with and utilize COI information sources, with a special emphasis on distributed and decentralized information brokering technology to enhance systems integration of information sources across the global information enterprise adapting to infrastructure and topology constraints. Complete information engineering efforts focusing on Unit Command and Control (Unit C2) and the Installation Control Center goals of providing unit decision makers with an integrated, standardized enterprise capability to control and manage resources to execute assigned missions; providing the ability to collaborate and synchronize unit enterprise activities with the warfighting headquarters; and sharing information real time in the accomplishment of normal day-to-day operations or in generating aircraft to support the wartime Air Tasking Order. Initiate the development of technologies that enable a generic methodology for the dissemination of information across multiple security level boundaries. Develop capability integrating tactical and edge user information management requirements. Initiate development of information transformation services and adaptive information management services that learn, self-configure, self-manage, and self-heal. Initiate a study on collaboration services on demand that will exploit dynamic information services matching end user devices (laptops, cell phones, etc.) with appropriate information formats. Continue to support development of COI Infospheres in the areas of context aware collaborative user interfaces and semantic interoperability.</p>			
<p>(U) In FY 2009: Develop and demonstrate technologies that enable pub/sub/query information dissemination across multiple security level boundaries. Initiate the study of discovery and filter technology to assess, evaluate, and convert unstructured information into structured information feeds. Demonstrate capability integrating tactical and edge user information management requirements. Continue development of information transformation services and adaptive information management services that learn, self-configure, self-manage, and are self-healing. Continue study on collaboration services on demand that will exploit dynamic information services matching end user devices (laptops, cell phones, etc.) with appropriate information formats. Continue to support context aware collaborative user interfaces and semantic interoperability.</p>			
<p>(U) CONGRESSIONAL ADD: Collaboration Gateway.</p>	0.000	1.000	0.000
<p>(U) In FY 2007: Not Applicable.</p>			
<p>(U) In FY 2008: Conduct Congressionally-directed effort for Collaboration Gateway to develop the capabilities of the Collaboration Gateway Architecture to support cross-domain audio conferencing, white-boarding, interoperability of commercial collaboration tools, and enhanced federated information search & retrieval capabilities.</p>			
<p>(U) In FY 2009: Not Applicable.</p>			
<p>(U)</p>			

Exhibit R-2a, RDT&E Project Justification	DATE February 2008
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BUDGET ACTIVITY 03 Advanced Technology Development (ATD)	PE NUMBER AND TITLE 0603789F C3I Advanced Development	PROJECT NUMBER AND TITLE 4872 Aerospace Information Dominance
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(U) <u>B. Accomplishments/Planned Program (\$ in Millions)</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) CONGRESSIONAL ADD: Interoperability Network to Fuse and Exchange Real-Time Information.	0.000	0.800	0.000
(U) In FY 2007: Not Applicable.			
(U) In FY 2008: Conduct Congressionally-directed effort for Interoperability Network to Fuse and Exchange Real-Time Information to demonstrate a threat agent network capable of providing chemical detection, intrusion detection, physical security, surveillance, command and control, wireless connectivity between the screening and environmental monitoring sites and to the command center and other existing technology at Liberty Island National Monument using the Integrated Information Management System (IIMS).			
(U) In FY 2009: Not Applicable.			
(U) Total Cost	16.883	14.999	11.029

(U) <u>C. Other Program Funding Summary (\$ in Millions)</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to</u>	<u>Total Cost</u>
	<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Complete</u>	
(U) Related Activities:									
(U) PE 0602702F, Command, Control, and Communications.									
(U) This project has been coordinated through the Reliance 21 process to harmonize efforts and eliminate duplication.									
(U) <u>D. Acquisition Strategy</u> Not Applicable.									

UNCLASSIFIED

PE NUMBER: 0603924F

PE TITLE: High Energy Laser Advanced Technology Program

Exhibit R-2, RDT&E Budget Item Justification	DATE February 2008
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BUDGET ACTIVITY 03 Advanced Technology Development (ATD)	PE NUMBER AND TITLE 0603924F High Energy Laser Advanced Technology Program
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Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
Total Program Element (PE) Cost	3.596	3.790	4.013	3.890	4.026	4.364	4.329	Continuing	TBD
5095 High Energy Laser Advanced Technology Program	3.596	3.790	4.013	3.890	4.026	4.364	4.329	Continuing	TBD

(U) A. Mission Description and Budget Item Justification

This program funds high energy laser (HEL) advanced technology development through the HEL Joint Technology Office (JTO). HEL weapons have many potential advantages, including speed-of-light delivery, precision target engagement, significant magazine depth, low-cost per kill, and reduced logistics requirements. HEL weapons have the potential to perform a wide variety of military missions including interception of ballistic missiles in boost phase, defeat of high-speed, maneuvering anti-ship and anti-aircraft missiles, and the ultra-precision negation of targets in urban environments with little/no collateral damage. This program is part of an overall Department of Defense (DoD) HEL Science and Technology program. This program is in Budget Activity 3, Advanced Technology Development, since it enables and demonstrates technologies for existing system upgrades and/or new system developments that have military utility and address warfighter needs.

(U) B. Program Change Summary (\$ in Millions)

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
(U) Previous President's Budget	3.699	3.815	4.152
(U) Current PBR/President's Budget	3.596	3.790	4.013
(U) Total Adjustments	-0.103	-0.025	
(U) Congressional Program Reductions			
Congressional Rescissions		-0.025	
Congressional Increases			
Reprogrammings			
SBIR/STTR Transfer	-0.103		
(U) <u>Significant Program Changes:</u>			
Not Applicable.			

C. Performance Metrics
Under Development.

Exhibit R-2a, RDT&E Project Justification

DATE
February 2008

BUDGET ACTIVITY 03 Advanced Technology Development (ATD)				PE NUMBER AND TITLE 0603924F High Energy Laser Advanced Technology Program			PROJECT NUMBER AND TITLE 5095 High Energy Laser Advanced Technology Program		
Cost (\$ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
5095 High Energy Laser Advanced Technology Program	3.596	3.790	4.013	3.890	4.026	4.364	4.329	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

- (U) **A. Mission Description and Budget Item Justification**
 This program funds high energy laser (HEL) advanced technology development through the HEL Joint Technology Office (JTO). HEL weapons have many potential advantages, including speed-of-light delivery, precision target engagement, significant magazine depth, low-cost per kill, and reduced logistics requirements. HEL weapons have the potential to perform a wide variety of military missions including interception of ballistic missiles in boost phase, defeat of high-speed, maneuvering anti-ship and anti-aircraft missiles, and the ultra-precision negation of targets in urban environments with little/no collateral damage. This program is part of an overall Department of Defense (DoD) HEL Science and Technology program. This program is in Budget Activity 3, Advanced Technology Development, since it enables and demonstrates technologies for existing system upgrades and/or new system developments that have military utility and address warfighter needs.
- (U) **B. Accomplishments/Planned Program (\$ in Millions)**
- | | | | |
|--|----------------|----------------|----------------|
| | <u>FY 2007</u> | <u>FY 2008</u> | <u>FY 2009</u> |
| (U) MAJOR THRUST: Advance solid state laser development, to include advanced technology demonstrations up to a Technology Readiness Level 6. Develop free electron laser technologies that scale to high power. Develop beam-control technologies for surface and air mission areas. | 3.596 | 3.790 | 4.013 |
| (U) In FY 2007: Participated in the 100 kilowatt Joint High Power Solid State Laser (JHPSSL) effort. Determined the requirements for other high-value experiments to follow the 100 kilowatt JHPSSL effort. Investigated advanced beam control architectures and algorithms. Developed technologies leading to a 100 kilowatt class free electron laser (FEL) demonstration. | | | |
| (U) In FY 2008: Continue the development of the 100 kilowatt JHPSSL devices. Provide for independent government-sponsored measurements of the 100 kilowatt lasers. Initiate systems level studies for integration onto airborne platforms. Evaluate advanced tactical laser technologies. | | | |
| (U) In FY 2009: Demonstrate the two 100 kilowatt solid state JHPSSL devices in laboratory environment. Participate in a joint effort to develop a high-power beam director suitable for mating with a JHPSSL device. Evaluate advanced tactical laser technologies. | | | |
| (U) Total Cost | 3.596 | 3.790 | 4.013 |

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY 03 Advanced Technology Development (ATD)	PE NUMBER AND TITLE 0603924F High Energy Laser Advanced Technology Program	PROJECT NUMBER AND TITLE 5095 High Energy Laser Advanced Technology Program
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(U) **C. Other Program Funding Summary (\$ in Millions)**

	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>	<u>FY 2013</u>	<u>Cost to</u>	<u>Total Cost</u>
	<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Complete</u>	
(U) PE 0602890F, High Energy Laser Research.									
(U) PE 0603444F, Maui Space Surveillance System.									
(U) PE 0603605F, Advanced Weapons Technology.									
(U) PE 0601108F, High Energy Laser Research Initiatives.									
(U) PE 0603883C, Ballistic Missile Defense Boost Phase Segment.									
(U) PE 0602605F, Directed Energy Technology.									
(U) PE 0602307A, Advanced Weapons Technology.									
(U) PE 0602114N, Power Projection Applied Research.									
(U) PE 0602120A, Sensors and Electronic Survivability.									
(U) PE 0603004A, Weapons and Munitions Advanced Technology.									
(U) PE 0602702E, Tactical Technology.									
(U) PE 0603175C, Ballistic Missile Defense Technology.									
(U) PE 0602651M, Joint Non-Lethal Weapons Applied Research.									
(U) PE 0603651M, Joint Non-Lethal Weapons Technology.									

Exhibit R-2a, RDT&E Project Justification

DATE

February 2008

BUDGET ACTIVITY

03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE

**0603924F High Energy Laser
Advanced Technology Program**

PROJECT NUMBER AND TITLE

**5095 High Energy Laser Advanced
Technology Program****(U) C. Other Program Funding Summary (\$ in Millions)**

Development.

- (U) This project has been coordinated through the Reliance 21 process to harmonize efforts and eliminate duplication.

(U) D. Acquisition Strategy

Not Applicable.