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Exhibit R-2, RDT&E Budget Item Justification: PB 2017 Air Force **Date:** February 2016

Appropriation/Budget Activity 3600: <i>Research, Development, Test & Evaluation, Air Force I BA 3: Advanced Technology Development (ATD)</i>					R-1 Program Element (Number/Name) PE 0603112F <i>I Advanced Materials for Weapon Systems</i>							
COST (\$ in Millions)	Prior Years	FY 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
Total Program Element	-	38.262	46.665	35.137	0.000	35.137	36.664	36.519	37.778	38.535	Continuing	Continuing
632100: <i>Laser Hardened Materials</i>	-	16.816	15.629	15.472	0.000	15.472	15.343	15.617	15.926	16.245	Continuing	Continuing
633153: <i>Non-Destructive Inspection Development</i>	-	4.251	5.029	6.350	0.000	6.350	6.331	6.423	6.550	6.681	Continuing	Continuing
633946: <i>Materials Transition</i>	-	17.195	26.007	13.315	0.000	13.315	14.990	14.479	15.302	15.609	Continuing	Continuing

A. Mission Description and Budget Item Justification

This program develops and demonstrates materials technology for transition into Air Force systems. The program has three projects which develop: hardened materials technologies for the protection of aircrews and sensors; non-destructive inspection and evaluation (NDI/E) technologies; and materials transition technologies on structural and non-structural materials for aerospace applications. Efforts in the program have been coordinated through the Department of Defense (DoD) Science and Technology (S&T) Executive Committee process to harmonize efforts and eliminate duplication.

This program is in Budget Activity 3, Advanced Technology Development because this budget activity includes development of subsystems and components and efforts to integrate subsystems and components into system prototypes for field experiments and/or tests in a simulated environment.

<u>B. Program Change Summary (\$ in Millions)</u>	<u>FY 2015</u>	<u>FY 2016</u>	<u>FY 2017 Base</u>	<u>FY 2017 OCO</u>	<u>FY 2017 Total</u>
Previous President's Budget	40.177	37.665	36.284	0.000	36.284
Current President's Budget	38.262	46.665	35.137	0.000	35.137
Total Adjustments	-1.915	9.000	-1.147	0.000	-1.147
• Congressional General Reductions	0.000	0.000			
• Congressional Directed Reductions	0.000	0.000			
• Congressional Rescissions	0.000	0.000			
• Congressional Adds	0.000	9.000			
• Congressional Directed Transfers	0.000	0.000			
• Reprogrammings	-1.064	0.000			
• SBIR/STTR Transfer	-0.851	0.000			
• Other Adjustments	0.000	0.000	-1.147	0.000	-1.147

Congressional Add Details (\$ in Millions, and Includes General Reductions)

Project: 633946: *Materials Transition*

Congressional Add: *Metals Affordability Research*

FY 2015	FY 2016
8.000	9.000

UNCLASSIFIED

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Congressional Add Details (\$ in Millions, and Includes General Reductions)		FY 2015	FY 2016
Congressional Add Subtotals for Project: 633946		8.000	9.000
Congressional Add Totals for all Projects		8.000	9.000
<u>Change Summary Explanation</u>			
Decrease in FY 2015 reflects reprogramming to support Research and Development Projects, 10 U.S.C. Section 2358.			
Decrease in FY 2017 due to higher DoD priorities.			

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Exhibit R-2A, RDT&E Project Justification: PB 2017 Air Force										Date: February 2016		
Appropriation/Budget Activity 3600 / 3					R-1 Program Element (Number/Name) PE 0603112F / <i>Advanced Materials for Weapon Systems</i>				Project (Number/Name) 632100 / <i>Laser Hardened Materials</i>			
COST (\$ in Millions)	Prior Years	FY 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
632100: <i>Laser Hardened Materials</i>	-	16.816	15.629	15.472	0.000	15.472	15.343	15.617	15.926	16.245	Continuing	Continuing
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 sensors and systems to ensure safety, survivability, and operability in threat environments.												
B. Accomplishments/Planned Programs (\$ in Millions)									FY 2015	FY 2016	FY 2017	
Title: Aerospace Systems Protection									7.904	7.379	7.306	
Description: Develop and demonstrate materials technologies that enhance hardening for sensors, avionics, and components to increase survivability and mission effectiveness of aerospace systems.												
FY 2015 Accomplishments: Continued to advance development of protection materials for visual/near-infrared (NIR) Intelligence, Surveillance, and Reconnaissance (ISR) Sensors. Validated and demonstrated the use of protection technologies for future ISR sensor designs and strategies to mitigate directed energy damage for visual/NIR, short wave infrared (SWIR), and mid wave infrared (MWIR) detectors. Continued to develop survivable electro-optic sensors that provide full spectrum protection for missile warning. Continued evaluating the performance impact of damage-limiting semiconductor materials designed to harden electro-optic imaging sensors. Continued to develop laser countermeasures for survivability of dynamic electro-optic and infrared (EO/IR) imagers. Validated and continued to employ computational materials science to model materials characteristics to increase accuracy and shorten design cycle time of coatings for use in sensor hardening. Initiated air systems airframe and anti-access munitions hardening assessment.												
FY 2016 Plans: Continue development of protection materials for visual/NIR ISR sensors. Demonstrate use of protection technologies for future ISR sensor designs and strategies to mitigate directed energy damage for visual/NIR, SWIR, and MWIR detectors. Develop survivable electro-optic sensors that provide full spectrum protection for missile warning. Continue evaluating the performance impact of damage-limiting semiconductor materials designed to harden electro-optic imaging sensors. Develop laser countermeasures for survivability of dynamic EO/IR imagers. Continue to employ computational materials science to model materials characteristics to increase accuracy and shorten design cycle time of coatings for use in sensor hardening. Continue air systems airframe and anti-access munitions hardening assessment.												
FY 2017 Plans:												

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Appropriation/Budget Activity 3600 / 3	R-1 Program Element (Number/Name) PE 0603112F / <i>Advanced Materials for Weapon Systems</i>	Project (Number/Name) 632100 / <i>Laser Hardened Materials</i>	
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2015	FY 2016
Continue to analyze and develop protection materials for visual/NIR ISR sensors. Continue to demonstrate use of protection technologies for future ISR sensor designs and strategies to mitigate directed energy damage for visual/NIR, SWIR, and MWIR detectors. Continue to develop survivable electro-optic sensors that provide full spectrum protection for missile warning. Continue analyzing the performance impact of damage-limiting semiconductor materials designed to harden electro-optic imaging sensors. Continue to develop laser countermeasures for survivability of dynamic EO/IR imagers. Continue to employ computational materials science to model materials characteristics to increase accuracy and shorten design cycle time of coatings for use in sensor hardening. Continue to develop air systems airframe and anti-access munitions hardening assessments.			
Title: Aircrew Protection Description: Develop and demonstrate materials technologies that enhance protection for Air Force aircrews to ensure safety and to enable aircrews to perform required missions in a threat environment. FY 2015 Accomplishments: Developed and demonstrated laser protection materials and technologies for personnel protection e.g., laser eye protection. Continued development of helmet mounted sensor hardening materials. Continued development of visor based aircrew protection materials. Characterized eye protection technologies using computational materials science tools. Continued to improve functionality and performance of personnel protection technologies in expected operational conditions. FY 2016 Plans: Continue to develop and demonstrate laser protection materials and technologies for personnel protection. Validate and continue development of helmet mounted sensor hardening materials. Continue to advance development of visor based aircrew protection materials. Characterize and demonstrate eye protection technologies using computational materials science tools. Demonstrate and continue to improve functionality and performance of personnel protection technologies in expected operational conditions. FY 2017 Plans: Continue to develop and demonstrate laser protection materials and technologies for personnel protection. Validate and continue development of helmet mounted sensor hardening materials focusing on next generation nighttime sensors. Continue to advance development of visor based aircrew protection materials with agile protection. Characterize and demonstrate eye protection technologies using computational materials science tools. Demonstrate and continue to improve functionality and performance of personnel protection technologies in expected operational conditions.		8.912	8.250
		8.166	
Accomplishments/Planned Programs Subtotals		16.816	15.472
C. Other Program Funding Summary (\$ in Millions)			
N/A			

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Appropriation/Budget Activity 3600 / 3	R-1 Program Element (Number/Name) PE 0603112F / <i>Advanced Materials for Weapon Systems</i>	Project (Number/Name) 632100 / <i>Laser Hardened Materials</i>
C. Other Program Funding Summary (\$ in Millions)		
Remarks		
D. Acquisition Strategy N/A		
E. Performance Metrics Please refer to the Performance Base Budget Overview Book for information on how Air Force resources are applied and how those resources are contributing to Air Force performance goals and most importantly, how they contribute to our mission.		

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Exhibit R-2A, RDT&E Project Justification: PB 2017 Air Force										Date: February 2016		
Appropriation/Budget Activity 3600 / 3					R-1 Program Element (Number/Name) PE 0603112F / Advanced Materials for Weapon Systems				Project (Number/Name) 633153 / Non-Destructive Inspection Development			
COST (\$ in Millions)	Prior Years	FY 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
633153: Non-Destructive Inspection Development	-	4.251	5.029	6.350	0.000	6.350	6.331	6.423	6.550	6.681	Continuing	Continuing
A. Mission Description and Budget Item Justification												
This project develops and demonstrates advanced 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.												
B. Accomplishments/Planned Programs (\$ in Millions)									FY 2015	FY 2016	FY 2017	
Title: Advanced Engine Inspection Technologies									1.063	1.237	1.964	
Description: Develop and demonstrate advanced technologies to improve capabilities to inspect for cracks and other damage to extend the total safe life of turbine engines.												
FY 2015 Accomplishments: Continued development of NDI/E approaches to nondestructively assess material and damage state of critical turbine engine components for the purpose of extending the useful life without increasing risk of in-flight failure of fracture critical to gas turbine engine components. Added sonic IR inspection system to the NDE toolkit.												
FY 2016 Plans: Demonstrate NDI/E approaches to nondestructively assess material and damage state of critical turbine engine components for the purpose of extending the useful life without increasing risk of in-flight failure of fracture critical to gas turbine engine components.												
FY 2017 Plans: Continue to demonstrate NDI/E approaches to nondestructively assess material and damage state of critical turbine engine components for the purpose of extending the useful life without increasing risk of in-flight failure of fracture critical to gas turbine engine components. Validate robotic nondestructive inspection methods to minimize disassembly and reduced maintenance burden to perform inspections of aircraft structures. Continue to develop novel approaches to collect, analyze, transport, archive, and use digital nondestructive inspection data and information.												
Title: Low-Observable Inspection Technologies									0.808	0.939	1.585	
Description: Develop and demonstrate advanced inspection technologies supporting low-observable (LO) systems to enhance affordability and ensure full performance and survivability.												

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Appropriation/Budget Activity 3600 / 3		R-1 Program Element (Number/Name) PE 0603112F / <i>Advanced Materials for Weapon Systems</i>		Project (Number/Name) 633153 / <i>Non-Destructive Inspection Development</i>	
B. Accomplishments/Planned Programs (\$ in Millions)			FY 2015	FY 2016	FY 2017
FY 2015 Accomplishments: Continued development of improved methods to acquire and analyze data to facilitate improved characterization, registration, and tracking of degradation and damage of LO materials that enables/ensures more affordable signature assessment. Completed and transitioned a hand-held imaging tool. FY 2016 Plans: Initiate new and continue development of improved methods to acquire and analyze data to facilitate improved characterization, registration, and tracking of degradation and damage of LO materials that enables/ensures more affordable signature assessment. FY 2017 Plans: Demonstrate improved methods to acquire and analyze data to facilitate improved characterization, registration, and tracking of degradation and damage of LO materials that enables/ensures more affordable signature assessment. Develop tools to improve characterization of specialty multilayer coatings.					
Title: Advanced System Monitoring Technologies Description: 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. FY 2015 Accomplishments: Validated improved field and depot-level nondestructive inspection/evaluation technologies and methodologies for assessing the structural integrity of airframes. Added a sonic IR NDE inspection system to the tool box. Developed analytical methods to assess the location of damage in multi-layered structure based on nondestructive inspection data and results. Continued development of robotic nondestructive inspection methods to minimize disassembly and reduced maintenance burden to perform inspections of aircraft structures. Validated the integration of computational materials science tools with life prediction methods to enable risk-based life management. Validated technologies to analyze materials state awareness and prevent corrosion. FY 2016 Plans: Transition improved field and depot-level nondestructive inspection/evaluation technologies and methodologies for assessing the structural integrity of airframes. Continue development of analytical methods to assess the location of damage in multi-layered structure base on nondestructive inspection data and results. Continue development of robotic nondestructive inspection methods to minimize disassembly and reduced maintenance burden to perform inspections of aircraft structures. Initiate development of novel approaches to collect, analyze, transport, archive, and use digital nondestructive inspection data and information. Continue enhanced methods for collecting and analyzing digital nondestructive inspection/evaluation data necessary for improved damage			2.380	2.853	2.801

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B. Accomplishments/Planned Programs (\$ in Millions)		FY 2015	FY 2016
detection and characterization. Demonstrate the integration of computational materials science tools with life prediction methods to enable risk-based life management.			
FY 2017 Plans: Continue development of analytical methods to assess the location of damage in multi-layered structure base on nondestructive inspection data and results. Validate robotic nondestructive inspection methods to minimize disassembly and reduced maintenance burden to perform inspections of aircraft structures. Continue development of novel approaches to collect, analyze, transport, archive, and use digital nondestructive inspection data and information. Continue enhanced methods for collecting and analyzing digital nondestructive inspection/evaluation data necessary for improved damage detection and characterization. Continue the integration of computational materials science tools with life prediction methods to enable risk-based life management.			
Accomplishments/Planned Programs Subtotals		4.251	5.029
C. Other Program Funding Summary (\$ in Millions) N/A			
Remarks			
D. Acquisition Strategy N/A			
E. Performance Metrics Please refer to the Performance Base Budget Overview Book for information on how Air Force resources are applied and how those resources are contributing to Air Force performance goals and most importantly, how they contribute to our mission.			

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COST (\$ in Millions)	Prior Years	FY 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
633946: <i>Materials Transition</i>	-	17.195	26.007	13.315	0.000	13.315	14.990	14.479	15.302	15.609	Continuing	Continuing

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. This design and scale-up data improves the overall affordability of promising materials and processing technologies, providing needed initial incentives for their industrial development.

B. Accomplishments/Planned Programs (\$ in Millions)

	FY 2015	FY 2016	FY 2017
Title: Air Vehicle Materials Technologies Description: Develop and demonstrate materials and processes technologies for air vehicle and subsystems to enhance lift, propulsion, Low-observable performance, power generation management, and affordability of air vehicles. FY 2015 Accomplishments: Validated processing methods and lifing tools for ceramic matrix composites and graded microstructure turbine engine disk concepts. Demonstrated repeatability of magnetoresistive sensing technologies. Continued integration of damage with risk-based life management strategies for turbine engines. Continued development of materials and processes to increase Low-observable materials affordability. FY 2016 Plans: Demonstrate processing methods and lifing tools for ceramic matrix composites and graded microstructure turbine engine disk concepts. Continue developing the repeatability of magnetoresistive sensing technologies. Integrate damage with risk-based life management strategies for turbine engines. Continue development of materials and processes to increase Low-observable materials and metals affordability. FY 2017 Plans: Demonstrate in field the repeatability of magnetoresistive sensing. Transition materials and processes to increase LO materials affordability. Initiate development of methods to perform damage characterization of turbine engines. Continue to develop affordable metals and computational technologies for advanced aero structure and engine components.	7.816	14.524	10.672
Title: High Temperature Material Technologies Description: Develop and demonstrate affordable, novel high temperature materials/structures and thermal management concepts to enable future defense capabilities for prompt global strike concepts.	1.379	2.483	2.643

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B. Accomplishments/Planned Programs (\$ in Millions)		FY 2015	FY 2016
<i>FY 2015 Accomplishments:</i> Initiated validation of repeatability of multimaterial structures to optimally address operational temperature zones for hot structure and expendable thermal protection systems made out of advanced ceramics, ceramic matrix composites, hybrids, advanced metals, and intermetallics. Continued to develop 2700 degrees Fahrenheit ceramic matrix composites for turbine hot section components. Completed risk reduction enhancements to ensure out year goals are met. <i>FY 2016 Plans:</i> Validate repeatability of multimaterial structures to optimally address operational temperature zones for hot structure and expendable thermal protection systems made out of advanced ceramics, ceramic matrix composites, hybrids, advanced metals, and intermetallics. Demonstrate 2700F ceramic matrix composites for turbine hot section components. Initiate development of high temperature materials for next generation turbine engine disks. <i>FY 2017 Plans:</i> Continue to validate repeatability of multimaterial structures to optimally address operational temperature zones for hot structure and expendable thermal protection systems made out of advanced ceramics, ceramic matrix composites, hybrids, advanced metals, and intermetallics. Continue to demonstrate and model 2700F ceramic matrix composites for turbine hot section components. Continue to develop high temperature materials for next generation turbine engine disks.			
Accomplishments/Planned Programs Subtotals		9.195	17.007
		FY 2015	FY 2016
<i>Congressional Add:</i> Metals Affordability Research		8.000	9.000
<i>FY 2015 Accomplishments:</i> Conduct Congressionally directed effort.			
<i>FY 2016 Plans:</i> Conduct congressionally directed effort in low-cost special aerospace metals.			
Congressional Adds Subtotals		8.000	9.000
C. Other Program Funding Summary (\$ in Millions)			
N/A			
Remarks			
D. Acquisition Strategy			
N/A			

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E. Performance Metrics Please refer to the Performance Base Budget Overview Book for information on how Air Force resources are applied and how those resources are contributing to Air Force performance goals and most importantly, how they contribute to our mission.		

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