Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Missile Defense Agency											Date: February 2018	
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide I* BA 3: *Advanced Technology Development (ATD)*					R-1 Program Element (Number/Name) PE 0603180C *I Advanced Research*							
COST ($ in Millions)	**Prior Years**	**FY 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**	**FY 2020**	**FY 2021**	**FY 2022**	**FY 2023**	**Cost To Complete**	**Total Cost**
Total Program Element	57.992	27.185	20.184	20.365	-	20.365	20.778	21.194	21.652	22.036	Continuing	Continuing
MD25: *Advanced Technology Development*	57.066	26.364	19.302	19.461	-	19.461	19.848	20.239	20.643	21.033	Continuing	Continuing
MD40: *Program-Wide Support*	0.926	0.821	0.882	0.904	-	0.904	0.930	0.955	1.009	1.003	Continuing	Continuing
Program MDAP/MAIS Code: 362												

Note

FY 2017 Amended Budget Request Justification: $+4.300M was received to address Joint Emergent Operational Need requirement to ensure readiness of the BMDS. $ +4.300M Project MD25 - Advanced Technology Development/Advanced Research to begin FY 2017 National Defense Authorization Act (NDAA) required development of a Hypersonic Threat Defense program. Leverages Army Night Vision Lab and other Services' investments in large Focal Panel Arrays (FPA) that can maintain high sensitivity at higher operating temperature.

A. Mission Description and Budget Item Justification

The Advanced Research PE conducts leading edge advanced research and development to create and enable future missile defense capabilities. Missile Defense Agency executes this mission by capitalizing on the creativity and innovation of the brightest minds in our Nation's universities and small businesses, collaborative research partnerships between allied country academic institutions, and innovative ideas from industry. This includes a focus on facilitating the transition of technology to the Ballistic Missile Defense System (BMDS) through a Commercialization and Transition Office and the execution of the Rapid Innovation Fund Program.

FY 2017 Amended Budget Request Justification: $+4.300M was received to address Joint Emergent Operational Need requirement to ensure readiness of the BMDS. $ +4.300M Project MD25 - Advanced Technology Development/Advanced Research to begin FY 2017 National Defense Authorization Act (NDAA) required development of a Hypersonic Threat Defense program. Leverages Army Night Vision Lab and other Services' investments in large Focal Panel Arrays (FPA) that can maintain high sensitivity at higher operating temperature.

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Missile Defense Agency					Date: February 2018
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide I* BA 3: *Advanced Technology Development (ATD)*			R-1 Program Element (Number/Name) PE 0603180C *I Advanced Research*		
B. Program Change Summary ($ in Millions)	**FY 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**
Previous President's Budget	27.733	20.184	20.695	-	20.695
Current President's Budget	27.185	20.184	20.365	-	20.365
Total Adjustments	-0.548	0.000	-0.330	-	-0.330
• Congressional General Reductions	0.000	0.000			
• Congressional Directed Reductions	0.000	0.000			
• Congressional Rescissions	0.000	0.000			
• Congressional Adds	0.000	0.000			
• Congressional Directed Transfers	0.000	0.000			
• Reprogrammings	0.000	0.000			
• SBIR/STTR Transfer	-0.548	0.000			
• FY 2017 Request for Additional Appropriations	0.000	0.000	0.000	-	0.000
• Missile Defeat and Defense Enhancement	0.000	0.000	0.000	-	0.000
• Other Adjustment	0.000	0.000	-0.330	-	-0.330

Change Summary Explanation

FY 2017 Amended Budget Request Justification: $+4.300M was received to address Joint Emergent Operational Need requirement to ensure readiness of the BMDS. $+4.300M Project MD25 - Advanced Technology Development/Advanced Research to begin FY 2017 National Defense Authorization Act (NDAA) required development of a Hypersonic Threat Defense program. Leverages Army Night Vision Lab and other Services' investments in large Focal Panel Arrays (FPA) that can maintain high sensitivity at higher operating temperature.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Missile Defense Agency			Date: February 2018
Appropriation/Budget Activity 0400 / 3	R-1 Program Element (Number/Name) PE 0603180C / *Advanced Research*	Project (Number/Name) MD25 / *Advanced Technology Development*	

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
MD25: *Advanced Technology Development*	57.066	26.364	19.302	19.461	-	19.461	19.848	20.239	20.643	21.033	Continuing	Continuing

Note

N/A

A. Mission Description and Budget Item Justification

MDA explores potential new Ballistic Missile Defense (BMDS) capabilities by leveraging the creativity and innovation of the Nation's small businesses and universities to conduct advanced technology development. MDA also pursues advanced technology development through cooperative international research agreements between U.S. and foreign universities of allied nations. The program manages the selection process and administers the Missile Defense Small Business Innovation Research program element, 0605502C. Small Business Innovation Research topics and projects are selected annually based on identified needs across the BMDS and executed in partnership with sponsoring intra-agency organizations.

MDA's Advanced Technology Development Project pursues a broad range of emerging technology targeted for application and insertion into the BMDS. This work facilitates the commercialization and transition of promising technology into the BMDS by promoting a cooperative environment to reduce cost and increase return on investment between small business, prime contractors, and MDA elements.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Advanced Research	26.364	19.302	19.461
Description: This activity funds technology/research initiatives. -Conduct systems engineering, integration, research, and material solution analysis to identify initiatives and technology to include missiles, sensors, and command and control components in the defense against current and future threats -Utilize NanoSat technology demonstrations to conduct testing and reduce risk for new and advanced technologies for the BMDS -Leverage university to university international research opportunities with allied nations to enhance BMDS advanced technology initiatives and build stronger relationships with allies and partners -Manage the selection process of Small Business Innovation Research and Technology Applications programs to assist MDA-funded technology developers in finding and entering technology transfer opportunities to missile defense applications Specific and/or unique accomplishments to each FY are as follows:			
FY 2018 Plans: -Partner with industry, universities and national laboratories through advanced technology initiatives to develop improvements, including: --Nano-technology initiatives ---Propellants			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Missile Defense Agency		Date: February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603180C / *Advanced Research*	**Project (Number/Name)** MD25 / *Advanced Technology Development*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
---Batteries ---Electronics ---Multifunctional structures ---Thermal management ---Electro-optics --Additive manufacturing technology initiatives for interceptor propulsion and structural components --Space and sensor technology ---Nanosat technology demonstrations ---Radiation hardened mirror technology ---Radiation hardened strained-layer superlattice focal plane arrays ---BMDS nosecone test program to mature nosecone manufacturing technology to a high technology readiness level for implementation into the BMDS ---4D carbon-carbon manufacturing process addressing obsolescence issue ---Next generation seeker window development ---Deep learning algorithms for missile discrimination --Directed energy technology ---High power optical fibers ---Quick recovery high energy diodes ---Ultra low size weight and power diode pump modules ---Large stroke, high spatial bandwidth, deformable mirrors ---Light weight, dampened optical benches ---Optics and coatings for alkali environments --Interceptor technology ---Aerospace-grade Rayon technology development ---Liquid bipropellant combustion models ---Liquid propellant neutralization ---Navigation algorithm technology development --Future Ballistic Missile Defense System concept development ---Advanced sensor algorithm initiative ---Aerospace vehicle target, tracking, and discrimination ---Radar interferometric processing for electro magnetic rail gun -Pursue on-going scientific and engineering university research initiatives and projects, including: --Johns Hopkins University: Improvements in Thermal Battery Capabilities --North Carolina State University/Czech Tech University: Space Debris Exploration: Modeling and Fusion Algorithms			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Missile Defense Agency		Date: February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603180C / *Advanced Research*	**Project (Number/Name)** MD25 / *Advanced Technology Development*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
--Penn State University: Development of High Performance W-Based Alloys with Sub-Grained Microstructure by Field Assisted Sintering Technology for Rocket Nozzles: --Purdue University: Development and Characterization of Hypergolic Propellants --Purdue University: Investigation of Root Causes of Combustion Instability --Purdue University: Reliability Risk Management of Gold Contaminated Tin-Lead and Lead-Free Solder Joints in Military Electronics --Texas A&M University: Propellant Formulations for Suppressing Combustion Instability in Solid Rocket Motors --Texas A&M University: Hysteresis Engineering of Adaptive Materials for Electronic and Opto-Electric Devices --University of Michigan: Narrow-Band Infrared Spectral Filtering via Silicon Sub-Wavelength Dielectric Gratings --Washington State University: Reliability of Through Silicon Vias and Solder Microbumps in 3D Electronics for High Performance Defense Applications -Sponsor breakthrough technology and innovative solutions from private industry, qualified accredited domestic educational institutions, and nonprofit organizations, using the Advanced Technology Innovation Broad Agency Announcement, to include research in: -- Radar Systems -- Directed Energy Systems -- Electro-Optical Infrared Sensor Systems -- Computer Science, Signal, and Data Processing -- Mechanical and Aerospace engineering -- Decision Theory -- Modeling & Simulation -- Interceptor Technology -- Sensor Technology -Continue an International Cooperative Agreement between the DoD and the Ministry of Defense of the Kingdom of Denmark concerning radar technology for ballistic missile defense applications			
FY 2019 Plans: -Partner with industry, universities and national laboratories through advanced technology initiatives to develop improvements, including: --Additive manufacturing technology initiatives for interceptor propulsion and structural components --Space & Sensor technology			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Missile Defense Agency		Date: February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603180C / *Advanced Research*	**Project (Number/Name)** MD25 / *Advanced Technology Development*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
---Continue radiation hardened mirror technology ---Continue radiation hardened strained-layer superlattice focal plane arrays ---Radiation insensitive electronics ---4D carbon-carbon manufacturing process addressing obsolescence issue ---Next generation seeker window development ---Deep learning algorithms for missile discrimination --Directed energy technology ---High power optical fibers ---Quick recovery high energy diodes ---Ultra low size weight and power diode pump modules ---Large stroke, high spatial bandwidth, deformable mirrors ---Light weight, dampened optical benches ---Optics and coatings for alkali environments --Interceptor technology ---Domestic source aerospace-grade Rayon replacement technology ---High power and energy density batteries ---High temperature and radiation hardened electronics ---Design criteria for stable bipropellant combustion ---Navigation algorithm technology development ---Propellants ---Multifunctional structures ---Thermal management ---Electro-optics --Future Ballistic Missile Defense System concept development ---Advanced sensor algorithm initiative ---Aerospace vehicle target, tracking, and discrimination ---Radar interferometric processing for electromagnetic rail gun --3D Printing of diamond composite structures -Nanosat Testbed Initiative: providing risk reduction in the development of new and advanced technologies, in support of the Ballistic Missile Defense System, by testing and demonstrating capabilities under realistic environmental conditions --CubeSat Networked Communications Experiments demonstrate notional Multi Object Kill Vehicle (MOKV) communications CONOPS --CubeSat Based Laser Communications Network demonstrate low-latency crosslink in a low-size, weight and power configuration			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Missile Defense Agency		Date: February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603180C / *Advanced Research*	**Project (Number/Name)** MD25 / *Advanced Technology Development*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
-Hypersonic Component Testbed Initiative: Block 1: develop the testbed to understand capabilities of materials and components in a hypersonic environment -Suborbital Flight Test Program: reduce risk using sounding rockets to flight test and demonstrate interceptor and kill vehicle technology -Pursue on-going scientific and engineering university research initiatives and projects, including: --Auburn University: Survivability of Flexible Hybrid Electronics in Missile Applications --Johns Hopkins University: Improvements in Thermal Battery Capabilities --North Carolina State University/Czech Tech University: Space Debris Exploration: Modeling and Fusion Algorithms --Penn State University: Development of High Performance W-Based Alloys with Sub-Grained Microstructure by Field Assisted Sintering Technology for Rocket Nozzles --Purdue University: Investigation of Root Causes of Combustion Instability --Purdue University: Reliability Risk Management of Gold Contaminated Tin-Lead and Lead-Free Solder Joints in Military Electronics --Texas A&M University: Hysteresis Engineering of Adaptive Materials for Electronic and Opto-Electric Devices --University of Michigan: Narrow-Band Infrared Spectral Filtering via Silicon Sub-Wavelength Dielectric Gratings --U.S. Air Force Academy: Interceptor Flight Control Mechanism Efficiency -Sponsor breakthrough technology and innovative solutions from private industry, qualified accredited domestic educational institutions, and nonprofit organizations, using the Advanced Technology Innovation Broad Agency Announcement, to include research in: -- Radar Systems -- Directed Energy Systems -- Electro-Optical Infrared Sensor Systems -- Computer Science, Signal, and Data Processing -- Mechanical and Aerospace engineering -- Left and right of launch integration -- Decision Theory -- Modeling & Simulation -- Interceptor Technology			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Missile Defense Agency		Date: February 2018
Appropriation/Budget Activity 0400 / 3	**R-1 Program Element (Number/Name)** PE 0603180C / *Advanced Research*	**Project (Number/Name)** MD25 / *Advanced Technology Development*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
-- Sensor Technology			
FY 2018 to FY 2019 Increase/Decrease Statement: N/A			
Accomplishments/Planned Programs Subtotals	26.364	19.302	19.461

C. Other Program Funding Summary ($ in Millions)

Line Item	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
• 0603176C: *Advanced Concepts and Performance Assessment*	14.534	12.996	13.017	-	13.017	14.267	14.899	15.235	16.224	Continuing	Continuing
• 0603178C: *Weapons Technology*	47.403	5.495	0.000	-	0.000	0.000	0.000	0.000	0.000	Continuing	Continuing
• 0603294C: *Common Kill Vehicle Technology*	54.395	252.879	189.753	-	189.753	205.645	254.130	122.494	52.373	Continuing	Continuing

Remarks

D. Acquisition Strategy

The acquisition strategy to conduct these technology development agreements consists of partnering with accredited domestic universities, small businesses, and nonprofit organizations. MDA awards competitive procurements via the MDA Science and Technology Advanced Research Broad Agency Announcement; the Advanced Technology Innovation Broad Agency Announcement; the Small Business Innovation Research program; and the Small Business Technology Transfer program.

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2019 Missile Defense Agency											Date: February 2018	
Appropriation/Budget Activity 0400 / 3					R-1 Program Element (Number/Name) PE 0603180C / *Advanced Research*				Project (Number/Name) MD40 / *Program-Wide Support*			
COST ($ in Millions)	**Prior Years**	**FY 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**	**FY 2020**	**FY 2021**	**FY 2022**	**FY 2023**	**Cost To Complete**	**Total Cost**
MD40: *Program-Wide Support*	0.926	0.821	0.882	0.904	-	0.904	0.930	0.955	1.009	1.003	Continuing	Continuing

A. Mission Description and Budget Item Justification

PWS contains non-headquarters management costs in support of MDA functions and activities across the entire BMDS. It Includes Government Civilians and Contract Support Services. This provides integrity and oversight of the BMDS as well as supports MDA in the development and evaluation of technologies that will respond to the changing threat. Additionally, PWS includes Global Deployment personnel and support performing deployment site preparation and activation, and provides facility capabilities for MDA Executing Agent locations. Other MDA wide costs includes: physical and technical security; civilian drug testing; audit readiness; the Science, Technology, Engineering, and Mathematics (STEM) program; legal services and settlements; travel and agency training; office, equipment, vehicle, and warehouse leases; utilities and base operations; data and unified communications support; supplies and maintenance; materiel and readiness and central property management of equipment; and similar operating expenses. PWS is allocated on a pro-rata basis and therefore, fluctuates by year based on the adjusted RDT&E profile (which excludes: 0305103C Cyber Security Initiative, 0603274C Special Programs, 0603913C Israeli Cooperative Program and 0901598C Management Headquarters).