Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Missile Defense Agency											Date: March 2019	
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 2018**	**FY 2019**	**FY 2020 Base**	**FY 2020 OCO**	**FY 2020 Total**	**FY 2021**	**FY 2022**	**FY 2023**	**FY 2024**	**Cost To Complete**	**Total Cost**
Total Program Element	85.177	23.765	42.565	20.674	-	20.674	21.154	21.521	22.041	22.465	Continuing	Continuing
MD25: *Advanced Technology Development*	83.430	22.897	41.661	19.793	-	19.793	20.160	20.563	20.951	21.371	Continuing	Continuing
MD40: *Program-Wide Support*	1.747	0.868	0.904	0.881	-	0.881	0.994	0.958	1.090	1.094	Continuing	Continuing
Program MDAP/MAIS Code: 362												

Note

Increase in FY 2019 reflects the congressional adjustment ($22.200 million) to accelerate Hypersonic Defense (HD) technologies to raise the technology readiness levels (TRL) of new hypersonic components and to integrate into the HD architecture to include: kinetic, non-kinetic, sensors, communications, command and control (C2), and modeling and simulation (M&S).

Other Hypersonic Defense efforts are funded in PE 0604181C in FY 2020 and outyears.

A. Mission Description and Budget Item Justification

The Advanced Research program element (PE) conducts leading edge advanced research and development to create and enable future missile defense capabilities. The Missile Defense Agency (MDA) 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 countries, 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.

B. Program Change Summary ($ in Millions)	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
Previous President's Budget	20.184	20.365	20.778	-	20.778
Current President's Budget	23.765	42.565	20.674	-	20.674
Total Adjustments	3.581	22.200	-0.104	-	-0.104
• Congressional General Reductions	0.000	0.000			
• Congressional Directed Reductions	0.000	0.000			
• Congressional Rescissions	0.000	0.000			
• Congressional Adds	0.000	22.200			
• Congressional Directed Transfers	0.000	0.000			
• Reprogrammings	0.000	0.000			
• SBIR/STTR Transfer	-0.455	0.000			
• Missile Defeat and Defense Enhancement	0.000	0.000	0.000	-	0.000

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• Other Adjustment	4.036	0.000	-0.104	-	-0.104

Change Summary Explanation

Increase in FY 2019 from PB19 to PB20 reflects the enacted congressional adjustment to accelerate Hypersonic Defense technologies.

Exhibit R-2A, RDT&E Project Justification: PB 2020 Missile Defense Agency			Date: March 2019
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 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
MD25: *Advanced Technology Development*	83.430	22.897	41.661	19.793	-	19.793	20.160	20.563	20.951	21.371	Continuing	Continuing

Note

Increase in FY 2019 reflects the congressional adjustment ($22.200 million) to accelerate Hypersonic Defense (HD) technologies to raise the technology readiness levels (TRL) of new hypersonic components and to integrate into the HD architecture to include: kinetic, non-kinetic, sensors, communications, command and control (C2), and modeling and simulation (M&S).

Other Hypersonic Defense efforts are funded in PE 0604181C in FY 2020 and outyears.

A. Mission Description and Budget Item Justification

MDA explores potential new 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 (SBIR) program element (PE), 0605502C. SBIR topics and projects are selected annually based on 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 technologies targeted for application and insertion into the BMDS. This work facilitates the commercialization and transition of promising technologies into the BMDS by promoting a cooperative environment to reduce cost and increase return on investment between small businesses, prime contractors, and MDA elements.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
Title: Advanced Research	22.897	41.661	19.793
Description: This activity funds technology and 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 - Pursue advanced technology investments for defense against non-ballistic hypersonic 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 SBIR and technology applications programs to assist MDA funded technology developers in finding and entering technology transfer opportunities to missile defense applications			

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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 2018	FY 2019	FY 2020
Specific and/or unique accomplishments to each FY are as follows: ***FY 2019 Plans:*** - Partner with industry, universities and national laboratories through advanced technology initiatives to develop improvements for example: -- Additive manufacturing technology initiatives for interceptor propulsion and structural components -- Space & sensor technology --- 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 BMDS 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			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
- HD component technology: develop technology to raise TRL of new hypersonic components and integrate into the HD architecture, to include: kinetic, non-kinetic, sensors, communications, C2, and M&S - Nanosat Testbed Initiative: providing risk reduction in the development of new and advanced technologies, in support of the BMDS, by testing and demonstrating capabilities under realistic environmental conditions -- CubeSat Networked Communications Experiments demonstrate notional Multi Object Kill Vehicle communications CONOPS -- CubeSat Based Laser Communications Network demonstrate low-latency crosslink in a low-size, weight and power configuration - Accelerate technology in defense of hypersonic threats to include material characterization for hypersonic flight regime for seeker windows, focal plane array, low latency communication and thermal protection system - Mature component technologies and 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 -- Pennsylvania 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 non-profit organizations, using the Advanced Technology Innovation Broad Agency Announcement (BAA), to include research in: -- Radar systems -- Directed energy systems -- Electro-Optical Infrared Sensor Systems			

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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 2018	FY 2019	FY 2020
-- Computer science, signal, and data processing -- Mechanical and aerospace engineering -- Left through right of launch integration -- Decision theory -- M&S -- Interceptor technology -- Sensor technology ***FY 2020 Plans:*** - Sponsor breakthrough technology and innovative solutions, as funds allow, from private industry, qualified accredited domestic educational institutions, and non-profit organizations, using the Advanced Technology Innovation BAA, for example: -- Additive manufacturing technology initiatives for interceptor propulsion and structural components -- Space & sensor technology -- Directed energy technology -- Radar systems -- Electro-Optical Infrared sensor systems -- Computer science, signal, and data processing -- Mechanical and aerospace engineering -- Left through right of launch integration -- Decision theory -- M&S -- Interceptor technology -- Future BMDS concept development -- 3D printing of diamond composite structures -- HD component technologies --- Technology development to raise TRL of new hypersonic components and integrate into the HD architecture ---- Kinetic ---- Non-kinetic ---- Sensors ---- Communications ---- C2 ---- M&S - Nanosat Testbed Initiative: providing risk reduction in the development of new and advanced technologies, in support of the BMDS, by testing and demonstrating capabilities under realistic environmental conditions			

Exhibit R-2A, RDT&E Project Justification: PB 2020 Missile Defense Agency		Date: March 2019
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 2018	FY 2019	FY 2020
- Mature component technology and reduce technology risk using sounding rockets to demonstrate interceptor in a relevant environment ***FY 2019 to FY 2020 Increase/Decrease Statement:*** Decrease from FY 2019 to FY 2020 reflects a $22.200 million congressional plus-up for the acceleration of Hypersonic Defense technologies. Other Hypersonic Defense efforts are funded in PE 0604181C in FY 2020 and outyears.			
Accomplishments/Planned Programs Subtotals	22.897	41.661	19.793

C. Other Program Funding Summary ($ in Millions)

Line Item	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
• 0603176C: *Advanced Concepts and Performance Assessment*	17.683	13.017	14.208	-	14.208	14.904	15.142	16.262	16.574	Continuing	Continuing
• 0603178C: *Weapons Technology*	28.894	13.400	10.000	-	10.000	10.000	10.000	0.000	0.000	Continuing	Continuing
• 0603294C: *Common Kill Vehicle Technology*	55.562	56.753	13.600	-	13.600	13.475	16.187	18.232	22.949	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 BAA; the Advanced Technology Innovation BAA; the SBIR and the Small Business Technology Transfer program.

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2020 Missile Defense Agency			Date: March 2019
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 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
MD40: *Program-Wide Support*	1.747	0.868	0.904	0.881	-	0.881	0.994	0.958	1.090	1.094	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 personnel to support global deployments performing deployment site preparation and activation, and provides facility capabilities for MDA Executing Agent locations. Other MDA wide costs include: 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 across most Agency PEs and therefore fluctuates per PE by fiscal year based on the total Agency budget in that fiscal year.