| Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Missile Defense Agency | | | | | | | | | | | Date: February 2018 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Appropriation/Budget Activity<br>0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 3: *Advanced Technology Development (ATD)* | | | | | R-1 Program Element (Number/Name)<br>PE 0603178C / *Weapons Technology* | | | | | | | |
| **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 | 156.927 | 47.403 | 5.495 | 0.000 | - | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | Continuing | Continuing |
| MD69: *Directed Energy Research* | 72.320 | 24.173 | 5.495 | 0.000 | - | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | Continuing | Continuing |
| MD72: *Interceptor Technology* | 81.771 | 21.110 | 0.000 | 0.000 | - | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | Continuing | Continuing |
| MD40: *Program-Wide Support* | 2.836 | 2.120 | 0.000 | 0.000 | - | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | Continuing | Continuing |
| **Program MDAP/MAIS Code:** 362 | | | | | | | | | | | | |

**Note**

In FY 2018, the Weapons Technology Program Element (PE) (0603178C) concludes the Federally Funded Research Development Center (FFRDC) laboratory directed energy laser activity. Laser scaling efforts will be addressed in the Technology Maturation Initiatives (TMI) PE (0604115C).

**A. Mission Description and Budget Item Justification**

The Weapons Technology Program Element develops and tests a high-powered directed energy laser to build the foundation of the next-generation laser system on a high altitude unmanned airborne platform. The MDA's High Energy Laser (HEL) investment incrementally develops scalable, efficient, and compact HEL technology in the laboratory before beginning a high power laser flight test program. The technology required for tracking the target, aiming the laser, and building flight demonstrators is developed under the TMI PE (0604115C).

MDA collaborates with the Office of the Assistant Secretary of Defense for Research and Engineering, the Defense Advanced Research Projects Agency (DARPA), the High Energy Laser Joint Technology Office (HELJTO), and the Air Force in a systems engineering based strategy to research, develop and test directed energy weapons technology. MDA is developing a set of common core technology that will enable both missile defense and air dominance missions. These core technologies include fiber launchers; high brightness, high efficiency diode pump modules; and high power, high efficiency fiber amplifiers. In FY 2017, MDA, DARPA and the Air Force will complete a 30 kilowatt packaged Fiber Combined Laser (FCL) system at the Massachusetts Institute of Technology Lincoln Laboratory. The system consists of the laser, batteries and thermal device. MDA will also upgrade the Diode Pumped Alkali Laser (DPAL) testbed at Lawrence Livermore National Laboratory to conduct a 30 kilowatt demonstration with improved beam quality. In FY 2018, MDA will complete these final milestones and conclude the FFRDC laboratory high-powered directed energy laser activity.

The Agency will make the directed energy technology developed under this PE available to industry for incorporation into the Low Power Laser Demonstrator and for further laser scaling development to power levels required for robust, speed of light missile defense.

The Common Kill Vehicle Technology PE 0603294C will address any future technology investments in Solid Divert and Attitude Control System (SDACS) beginning in FY 2018.

| Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Missile Defense Agency | | | | | Date: February 2018 |
|---|---|---|---|---|---|
| Appropriation/Budget Activity<br>0400: *Research, Development, Test & Evaluation, Defense-Wide I* BA 3: *Advanced Technology Development (ATD)* | | | R-1 Program Element (Number/Name)<br>PE 0603178C *I Weapons Technology* | | |
| **B. Program Change Summary ($ in Millions)** | **FY 2017** | **FY 2018** | **FY 2019 Base** | **FY 2019 OCO** | **FY 2019 Total** |
| Previous President's Budget | 71.843 | 5.495 | 0.000 | - | 0.000 |
| Current President's Budget | 47.403 | 5.495 | 0.000 | - | 0.000 |
| Total Adjustments | -24.440 | 0.000 | 0.000 | - | 0.000 |
| • Congressional General Reductions | 0.000 | 0.000 | | | |
| • Congressional Directed Reductions | -22.200 | 0.000 | | | |
| • Congressional Rescissions | 0.000 | 0.000 | | | |
| • Congressional Adds | 0.000 | 0.000 | | | |
| • Congressional Directed Transfers | 0.000 | 0.000 | | | |
| • Reprogrammings | -1.087 | 0.000 | | | |
| • SBIR/STTR Transfer | -1.153 | 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 | 0.000 | - | 0.000 |

**Change Summary Explanation**

N/A

| Exhibit R-2A, RDT&E Project Justification: PB 2019 Missile Defense Agency | | | Date: February 2018 |
|---|---|---|---|
| Appropriation/Budget Activity<br>0400 / 3 | R-1 Program Element (Number/Name)<br>PE 0603178C / *Weapons Technology* | Project (Number/Name)<br>MD69 / *Directed Energy 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MD69: *Directed Energy Research* | 72.320 | 24.173 | 5.495 | 0.000 | - | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | Continuing | Continuing |

**Note**

In FY 2018, the Directed Energy Research project (MD69) concludes the FFRDC laboratory high-powered directed energy laser activity. Laser scaling efforts transfer to the TMI PE (0604115C) under the Directed Energy Demonstrator Development project (MD98).

**A. Mission Description and Budget Item Justification**

The MDA mission is to develop a robust system to defend the United States against ballistic missile attacks at all ranges, in all phases of flight. Using Directed Energy weapons to negate a ballistic missile in boost phase, before a threat missile can deploy countermeasures, will revolutionize missile defense by dramatically reducing the role of interceptors. In FY 2010, the Airborne Laser program proved it is possible to acquire, track and destroy a boosting missile, addressing many aspects of the boost phase kill, but also underscoring the complexity and challenges of fielding such a weapon system. The experience gained from that successful first foray into directed energy system illuminates a new path that integrates a highly efficient, compact electric laser into a high altitude, low-Mach Unmanned Aerial Vehicle capable of flying in the stratosphere. Flying at low speed in relatively calm air at 60,000 feet significantly reduces the need for the complex beam pointing and atmospheric jitter compensation systems that were challenges for the Airborne Laser program. The key to realizing this future high altitude, unmanned directed energy system is the laser.

The Directed Energy Research project funds the laboratory development of two high energy laser technologies, the DPAL with Lawrence Livermore National Laboratory (LLNL) and FCL with the Massachusetts Institute of Technology Lincoln Laboratory (MIT/LL). Both laser technologies have considerable promise for scaling to very high average power while simultaneously achieving high system electrical-to-optical efficiencies, exceeding 40 percent, and very low system weight and volume.

The MDA strategy is to reduce technical risk through dual path laboratory development and transition the laboratory development to industry in FY 2018 for high altitude unmanned platform integration and test.

| B. Accomplishments/Planned Programs ($ in Millions) | FY 2017 | FY 2018 | FY 2019 |
|---|---|---|---|
| ***Title:*** Directed Energy Research | 24.173 | 5.495 | 0.000 |
| ***Description:*** Directed Energy Research funds two promising laser technologies: LLNL's DPAL and MIT/LL's FCL. Each technology takes a unique approach to attaining high power. The DPAL scales in power by increasing the size of a single laser gain cell. This approach has the benefit of simplicity of design, but must address very high energy levels within the single cell. LLNL successfully demonstrated over 16 kilowatts (kW) in FY 2016; will demonstrate 30 kWs in FY 2018.<br><br>MDA's key fiber laser investments are targeted at driving the weight per kilowatt of power in the fiber amplifier system down while increasing the individual fiber amplifier power output. MDA joined with DARPA and the Air Force to demonstrate 44 kWs in a room-sized, 40 kilogram per kilowatt configuration in FY 2015, to a packaged 7 kilograms per kilowatt 30 kW system in FY 2018. | | | |

| Exhibit R-2A, RDT&E Project Justification: PB 2019 Missile Defense Agency | | Date: February 2018 |
|---|---|---|
| **Appropriation/Budget Activity**<br>0400 / 3 | **R-1 Program Element (Number/Name)**<br>PE 0603178C / *Weapons Technology* | **Project (Number/Name)**<br>MD69 / *Directed Energy Research* |

| B. Accomplishments/Planned Programs ($ in Millions) | FY 2017 | FY 2018 | FY 2019 |
|---|---|---|---|
| Specific and/or unique accomplishments to each FY are as follows:<br><br>***FY 2018 Plans:***<br>- SEE ABOVE.<br><br>***FY 2019 Plans:***<br>N/A<br><br>***FY 2018 to FY 2019 Increase/Decrease Statement:***<br>The decrease in FY 2019 reflects the conclusion of the Federally Funded Research Development Center (FFRDC) laboratory high-powered directed energy laser activity. Laser scaling efforts will be addressed in the Technology Maturation Initiative (TMI) PE (0604115C) in FY 2019. | | | |
| **Accomplishments/Planned Programs Subtotals** | 24.173 | 5.495 | 0.000 |

**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 |
| • 0603179C: *Advanced C4ISR* | 3.489 | 0.000 | 0.000 | - | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 3.489 |
| • 0603180C: *Advanced Research* | 27.185 | 20.184 | 20.365 | - | 20.365 | 20.778 | 21.194 | 21.652 | 22.036 | Continuing | Continuing |
| • 0603890C: *BMD Enabling Programs* | 435.203 | 465.642 | 540.926 | - | 540.926 | 542.326 | 608.210 | 489.637 | 496.313 | Continuing | Continuing |
| • 0604115C: *Technology Maturation Initiatives* | 84.514 | 128.406 | 148.822 | - | 148.822 | 172.423 | 143.240 | 143.938 | 174.770 | Continuing | Continuing |

**Remarks**

**D. Acquisition Strategy**

The acquisition strategy for the MD69, Directed Energy Research, consists of partnering with Industry, the DARPA, the Air Force, Federally Funded Research and Development Centers and University Affiliated Research Centers. The MDA will leverage Agency and partner subject matter experts and use government model based assessments to inform Better Buying Power philosophy acquisition decisions. The MDA will then award contracts to industry and universities via the Advanced Technology Innovation Broad Agency Announcement and competitive procurements to develop and demonstrate promising components and integrated systems in realistic test environments.

**E. Performance Metrics**

N/A

| Exhibit R-2A, RDT&E Project Justification: PB 2019 Missile Defense Agency | | | Date: February 2018 |
|---|---|---|---|
| Appropriation/Budget Activity<br>0400 / 3 | R-1 Program Element (Number/Name)<br>PE 0603178C / *Weapons Technology* | Project (Number/Name)<br>MD72 / *Interceptor Technology* | |

| 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MD72: *Interceptor Technology* | 81.771 | 21.110 | 0.000 | 0.000 | - | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | Continuing | Continuing |

**Note**

The Common Kill Vehicle Technology PE 0603294C will address any future technology investments in Solid Divert and Attitude Control System beginning in FY 2018.

**A. Mission Description and Budget Item Justification**

The Interceptor Technology project developed Divert and Attitude Control System (DACS) technology to enhance operational performance of future Multi Object Kill Vehicle (MOKV). Technology investment focused on DACS subsystem and system elements that support longer operation, multiple discrete DACS firing events, precision attitude control, safe operation and minimum kill vehicle mass. In FY 2017, MDA continued investment in a competitive next generation solid DACS development with industry to reduce propulsion component risk for the MOKV. The concept(s) developed for MOKV application transitioned to implementation with the industry MOKV developers. MDA continued to conduct testing of lightweight, long duration Cooled Gas and Multi-Pulse Attitude Control Systems having application to both a Kill Vehicle and a Third Stage Rocket Motor, while anchoring system sizing and performance prediction models. MDA defined the baseline requirements using analytical tools to identify mature technology capable of supporting MOKV development.

The project also modeled and assessed electromagnetic rail gun projectile technology readiness, suitability, and integration requirements for ballistic missile defense applications.

| B. Accomplishments/Planned Programs ($ in Millions) | FY 2017 | FY 2018 | FY 2019 |
|---|---|---|---|
| ***Title:*** Interceptor Technology | 21.110 | 0.000 | 0.000 |
| ***Description:*** Interceptor Technology focuses on development and test of component and sub-systems for a solid propulsion DACS, including propellant tanks, Attitude Control System and divert thrusters, and pressurant subsystems. This project will also investigate electromagnetic rail gun suitability and integration requirements for ballistic missile defense applications. This is a continuation of systems engineering and analysis that began under the BMD Enabling Programs program element, 0603890C in FY 2014.<br>Specific and/or unique accomplishments to each FY are as follows: | | | |
| ***FY 2018 Plans:***<br>The Common Kill Vehicle Technology PE 0603294C will address any future technology investments in Solid Divert and Attitude Control System (SDACS) beginning in FY 2018. | | | |
| ***FY 2019 Plans:***<br>N/A | | | |
| ***FY 2018 to FY 2019 Increase/Decrease Statement:*** | | | |

| Exhibit R-2A, RDT&E Project Justification: PB 2019 Missile Defense Agency | | Date: February 2018 |
|---|---|---|
| **Appropriation/Budget Activity**<br>0400 / 3 | **R-1 Program Element (Number/Name)**<br>PE 0603178C / *Weapons Technology* | **Project (Number/Name)**<br>MD72 / *Interceptor Technology* |

| B. Accomplishments/Planned Programs ($ in Millions) | FY 2017 | FY 2018 | FY 2019 |
|---|---|---|---|
| N/A | | | |
| **Accomplishments/Planned Programs Subtotals** | 21.110 | 0.000 | 0.000 |

**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 |
| • 0603179C: *Advanced C4ISR* | 3.489 | 0.000 | 0.000 | - | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 3.489 |
| • 0603180C: *Advanced Research* | 27.185 | 20.184 | 20.365 | - | 20.365 | 20.778 | 21.194 | 21.652 | 22.036 | Continuing | Continuing |
| • 0603890C: *BMD Enabling Programs* | 435.203 | 465.642 | 540.926 | - | 540.926 | 542.326 | 608.210 | 489.637 | 496.313 | Continuing | Continuing |
| • 0603892C: *AEGIS BMD* | 889.489 | 860.788 | 767.539 | - | 767.539 | 780.085 | 707.901 | 693.256 | 562.748 | Continuing | Continuing |
| • 0603904C: *Missile Defense Integration and Operations Center (MDIOC)* | 53.483 | 53.265 | 54.925 | - | 54.925 | 58.498 | 57.764 | 59.020 | 61.915 | Continuing | Continuing |
| • 0604894C: *Multi Object Kill Vehicle* | 0.000 | 6.500 | 8.256 | - | 8.256 | 33.935 | 8.277 | 184.118 | 355.060 | 0.000 | 596.146 |

**Remarks**

**D. Acquisition Strategy**

N/A

**E. Performance Metrics**

N/A

| Exhibit R-2A, RDT&E Project Justification: PB 2019 Missile Defense Agency | | | Date: February 2018 |
|---|---|---|---|
| **Appropriation/Budget Activity**<br>0400 / 3 | **R-1 Program Element (Number/Name)**<br>PE 0603178C / *Weapons Technology* | **Project (Number/Name)**<br>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* | 2.836 | 2.120 | 0.000 | 0.000 | - | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 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).