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Exhibit R-2, RDT&E Budget Item Justification: PB 2022 Office of the Secretary Of Defense **Date:** May 2021

Appropriation/Budget Activity 0400: <i>Research, Development, Test & Evaluation, Defense-Wide I BA 3: Advanced Technology Development (ATD)</i>	R-1 Program Element (Number/Name) PE 0603000D8Z <i>I Joint Munitions Advanced Technology</i>
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COST (\$ in Millions)	Prior Years	FY 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total	FY 2023	FY 2024	FY 2025	FY 2026	Cost To Complete	Total Cost
Total Program Element	-	25.399	22.905	23.213	-	23.213	-	-	-	-	-	-
002: <i>Insensitive Munitions Advanced Technology</i>	-	18.825	0.000	0.000	-	0.000	-	-	-	-	-	-
301: <i>Enabling Fuze Advanced Technology</i>	-	6.574	6.621	0.000	-	0.000	-	-	-	-	-	-
077: <i>Enhanced Munitions Advanced Technology</i>	-	0.000	16.284	23.213	-	23.213	-	-	-	-	-	-

Note
New FY 2021 Project Code 077; funding re-aligned from P002 Insensitive Munitions.

This Program Element (PE) aligns with PE 0602000D8Z, Joint Munitions Advanced Technology. The two project codes within each PE form the 6.2 applied research and 6.3 technology demonstration components of the Joint Enhanced Munitions Technology Program (JEMTP) and the Joint Fuze Technology Program (JFTP). The JEMTP funds applied research efforts from PE 0602000D8Z Project code (P) 076 Enhanced Munitions and technology demonstration efforts from PE 0603000D8Z P077.

The JFTP funds applied research efforts from PE 0602000D8Z P204 Enabling Fuze Technology and technology demonstration efforts from PE 0603000D8Z P301. In FY 2022 the JFTP and JEMTP will merge and the program scope will expand to exploit technology developments and accelerate their application to enable next generation kinetic weapons capabilities in the areas of energetic materials, propulsion, warhead effects, fuzing, power sources, guidance, navigation & control, communications and munitions airframe applied technologies.

With the JFTP and JEMTP merge in FY 2022, the P301: Enabling Fuze Advanced Technology line and budget will combine into P077: Enhanced Munitions Advanced Technology.

A. Mission Description and Budget Item Justification

This program advances, demonstrates and transitions joint, pervasive munitions enhancing technologies (warheads, propulsion systems, advanced lethality mechanisms, fuzes and fuze components, and targeting). The goal is to demonstrate joint enabling technologies that increase and improve the performance, lethality, range, reliability, safety, and survivability for existing and inform development of future weapons systems. The program strategically develops and demonstrates advanced munitions technologies that ensure warfighter technical superiority and enable outcomes in the Joint fight. The program technology objectives include: high-speed weapon delivery, longer-range precision effects, networked and collaborative systems of systems, agility at the engagement level, increased capacity/affordable munitions, survivability during deployment and target engagement, and open systems architecture. This program's Joint Munitions Advanced Technologies are vital to guide, coordinate and maximize DoD and Service S&T munitions investments into follow-on system demonstration and integration activities.

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Appropriation/Budget Activity 0400: <i>Research, Development, Test & Evaluation, Defense-Wide I BA 3: Advanced Technology Development (ATD)</i>	R-1 Program Element (Number/Name) PE 0603000D8Z I <i>Joint Munitions Advanced Technology</i>
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The program prioritizes investments from a Joint Service perspective and demonstrates technologies that inform capabilities, thus maximizing efficiencies and ensuring the development of technologies with the broadest applicability to ensure good stewardship of taxpayer dollars. This munitions Science and Technology (S&T) program focuses on enhancements in weapon speed, range, and lethality while largely utilizing existing advanced insensitive munitions (IM) technology to maximize weapon safety.

U.S. power projection capabilities are comparable to near peer adversaries, and there is an urgent need to provide U.S. warfighters with augmented or new capabilities to ensure technical superiority. The program follows a threat/opportunity analysis to develop kinetic capabilities that enable scenario-based effects from a Joint Fight perspective by exploring technological advances that are beyond Service investment risk acceptance and target asymmetric advantage. The goal is to enable military dominance to ensure effective deterrence of adversary aggression.

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B. Program Change Summary (\$ in Millions)	<u>FY 2020</u>	<u>FY 2021</u>	<u>FY 2022 Base</u>	<u>FY 2022 OCO</u>	<u>FY 2022 Total</u>
Previous President's Budget	25.779	22.920	23.483	-	23.483
Current President's Budget	25.399	22.905	23.213	-	23.213
Total Adjustments	-0.380	-0.015	-0.270	-	-0.270
• Congressional General Reductions	-	-0.015			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.376	-			
• Program Adjustment	-	-	-0.270	-	-0.270
• Cancelled Account	-0.004	-	-	-	-

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Exhibit R-2A, RDT&E Project Justification: PB 2022 Office of the Secretary Of Defense										Date: May 2021		
Appropriation/Budget Activity 0400 / 3					R-1 Program Element (Number/Name) PE 0603000D8Z / Joint Munitions Advanced Technology				Project (Number/Name) 002 / Insensitive Munitions Advanced Technology			
COST (\$ in Millions)	Prior Years	FY 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total	FY 2023	FY 2024	FY 2025	FY 2026	Cost To Complete	Total Cost
002: <i>Insensitive Munitions Advanced Technology</i>	-	18.825	0.000	0.000	-	0.000	-	-	-	-	-	-
Quantity of RDT&E Articles	-	-	-	-	-	-	-	-	-	-		

Note

In FY 2021, funds re-aligned to new Project Code (Pcode) 077: Enhanced Munitions Advanced Technology.

A. Mission Description and Budget Item Justification

The Enhanced Munitions Advanced Technology effort will demonstrate enabling technologies and perform associated applied research that will improve the performance, range, and lethality of existing and inform development of future weapons systems.

This effort will take promising technologies demonstrated at the laboratory scale and transition them into demonstration programs utilizing generic hardware-based munitions relevant environments in the concept and development stages. These demonstrated Enhanced Munitions technologies can then be transitioned, thereby decreasing acquisition program costs and schedule risk. Technologies demonstrated can improve the performance, lethality, and range of weapons to ensure the U.S. is not outgunned and outranged on the battlefield of the future. The Joint Enhanced Munitions Technology Program (JEMTP) investments focus on five Munition Areas: 1) High Performance Rocket Propulsion; 2) Minimum Signature Rocket Propulsion; 3) Blast and Fragmentation Warheads (Area Effects Warheads); 4) Anti-Armor Warheads (Hard Target Effects Warheads); and 5) Gun Propulsion. Munition Area Technology Groups (MATG), under tri-service leadership, have developed technology roadmaps for each Munition Area that guides investments based on goals consistent with the DoD priorities. These technologies, alone or in combination, will be incorporated in hardware, simulating real-world munitions, to demonstrate their utility and feasibility as part of Technology Transition Agreements with Program Executive Offices (PEOs).

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

	FY 2020	FY 2021	FY 2022
Title: Enhanced Munitions Advanced Technology (previously Insensitive Munitions Advanced Technology)	18.825	-	-
<p>Description: Enhanced Munitions Advanced Technology focuses on the following key areas:</p> <ul style="list-style-type: none"> - High Performance Propulsion - develops technologies to improve weapon range and speed, rocket motors with Ammonium Perchlorate, with or without a metal fuel, for rockets and missiles launched from air, ground, and sea platforms as well as advanced air breathing systems. - Minimum Signature Rocket Propulsion (MSP) - focuses on the development and demonstration of technologies to improve MS rocket propellant formulations and ingredients, including synthesis, characterization and scale-up; case and packaging design; active and passive venting techniques; rocket motor case design; ignition systems; and thrust mitigation techniques. - Blast and Fragmentation Warheads (BFW) - focuses on the development and demonstration of technologies that when applied enhance the lethality of Blast/Fragmentation munitions. 			

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Appropriation/Budget Activity 0400 / 3	R-1 Program Element (Number/Name) PE 0603000D8Z / <i>Joint Munitions Advanced Technology</i>	Project (Number/Name) 002 / <i>Insensitive Munitions Advanced Technology</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2020	FY 2021	FY 2022
<p>- Anti-Armor Warheads (AAW) - focuses on the development of explosive ingredients, explosives, and warhead technologies for improving performance of AAW munitions.</p> <p>- Gun Propulsion (GP) - focuses on the development and demonstration of technologies in the area of GP systems. The development and demonstration of gun propulsion technologies, when applied to munition systems, will improve the range and/or time to target of all gun launched munitions to include small/medium caliber, tank/mortar and large caliber propulsion systems.</p> <p>FY 2020 Accomplishments</p> <p>- Completed binder reformulation and scale up of a new propellant in a new nozzle system for a large diameter missile system. Demonstrated venting solution for medium sized rocket motor casing applicable to air-to-air missiles. Manufactured motors and conducted baseline testing for a large missile boost motor demonstration. Completed case design and motor geometry for reduced time to target for a surface-to-air system using an advanced composite rocket motor case.</p> <p>- Manufactured components and propellant, for assembly and prep for testing an extruded propellant to improve flight motor for air to ground small missile system. Completed hardware design and manufacture for small diameter rocket motor with minimum signature propellant.</p> <p>- Conducted analysis and optimized the energy management of a small diameter rocket motor system. Designed and began fabrication of components for new rocket motor design.</p> <p>- Conducted modelling and simulation on down-selected formulations and conducted functionality testing on indirect fire munitions to demonstrate improved performance. Conducted preliminary analysis for water pit testing to conduct lethality assessment on novel warhead design for indirect fire ammunition warhead. Began design and analysis for an optimized warhead with fragmentation features using additive manufacturing (AM). Conducted initial scale up preparations of novel warhead initiation booster material.</p> <p>- Conducted modeling and simulation of medium caliber ammunition warhead designs, optimized the design, and started warhead fabrication.</p> <p>- Scaled up and manufactured improved performance explosive, loaded formulations into warheads to conduct basic testing. Procured novel high explosive materials, manufactured samples, and prepared to conduct penetration tests on representative hardware.</p> <p>- Developed a novel ignition system and associated breech assembly for a longer-range gun system that enables a highly efficient ignition of the propelling charge. Developed a novel material cartridge case that enables an increase in efficiency of a gun propulsion system that exhibits the potential to increase projectile muzzle velocity.</p>				
Accomplishments/Planned Programs Subtotals		18.825	-	-
C. Other Program Funding Summary (\$ in Millions)				
N/A				

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Appropriation/Budget Activity 0400 / 3	R-1 Program Element (Number/Name) PE 0603000D8Z / <i>Joint Munitions Advanced Technology</i>	Project (Number/Name) 002 / <i>Insensitive Munitions Advanced Technology</i>

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

Remarks

D. Acquisition Strategy

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2022 Office of the Secretary Of Defense **Date:** May 2021

Appropriation/Budget Activity 0400 / 3					R-1 Program Element (Number/Name) PE 0603000D8Z / Joint Munitions Advanced Technology				Project (Number/Name) 301 / Enabling Fuze Advanced Technology			
COST (\$ in Millions)	Prior Years	FY 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total	FY 2023	FY 2024	FY 2025	FY 2026	Cost To Complete	Total Cost
301: <i>Enabling Fuze Advanced Technology</i>	-	6.574	6.621	0.000	-	0.000	-	-	-	-	-	-
Quantity of RDT&E Articles	-	-	-	-	-	-	-	-	-	-		

A. Mission Description and Budget Item Justification

This program will develop and demonstrate advanced fuze technologies needed to develop weapons that address Joint priority capability areas highlighted by the Office of the Under Secretary of Defense for Research and Engineering (OUSD(R&E)) Technology-Focused Modernization and Service Science and Technology (S&T) priorities including High Speed Weapons, Collaborative/Networked Munitions, Counter Unmanned Aerial System (c-UAS) Air Defense and Scalable Lethality. This effort will take promising integrated technologies to maturity and demonstrate capability utilizing weapon hardware derived from priority munitions capabilities and technologies. Demonstrated mature fuze technology will be transitioned, thereby decreasing acquisition program costs and schedule risk and facilitating spin-offs to other munitions within their portfolios. Under the Joint Fuze Technology Program (JFTP), investments are focused on specific capability areas that have been identified by Department strategic guidance and are focused on capability areas that are driven by next generation high speed and advanced weapons. The four capability areas are: 1) Extreme Environment Survivable Fuzing, 2) Tailorable Effects Fuzing and Warhead Initiation, 3) High Reliability Safe and Arm Technology, and 4) Target Detection and Burst Point Control.

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

	FY 2020	FY 2021	FY 2022
<p>Title: Enabling Fuze Advanced Technology</p> <p>Description: Enabling Fuze Advanced Technology focuses on the following key areas:</p> <ul style="list-style-type: none"> - Extreme Environment Survivable Fuzing - develops fuze components to increase the effectiveness of high-speed munitions by improving the prediction tools and testing methodologies to evaluate the survivability and functionality of future fuzes. - Tailorable Effects Fuzing and Warhead Initiation - develops fuzing for tailorable effects weapons that encompasses the ability to selectively vary the output of the weapon (Dial-a-Yield) and/or the ability to generate selectable effects (e.g., directed blast, fragmentation). - High Reliability Safe and Arm Technology - develops high reliability fuzing architectures, fuzing components, and Unexploded Ordnance (UXO) reduction features enabling the next generation of cluster munitions to achieve the required <1% UXO goal while increasing the reliability across the board for future weapon systems. - Target Detection and Burst Point Control develops sensing and algorithm solutions to demonstrate smaller, more capable target detection while meeting or exceeding the performance of existing technologies in order to operate in extreme and challenging weapon environments. <p>FY 2020 Accomplishments:</p>	6.574	6.621	-

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Appropriation/Budget Activity 0400 / 3	R-1 Program Element (Number/Name) PE 0603000D8Z / <i>Joint Munitions Advanced Technology</i>	Project (Number/Name) 301 / <i>Enabling Fuze Advanced Technology</i>

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2020	FY 2021	FY 2022
<ul style="list-style-type: none"> - Developed for 3D printed conformal antenna designs and techniques to support Joint applications of Next Generation Proximity Sensor. - Developed and published for use by DoD fuzing weapon developers, Optimal potting guidelines/solutions for High G confined electronics and fuzes. - Developed and released new version of weapon design software that incorporates improved interface models to more accurately simulate and predict fuze to warhead interaction in high shock, extreme environments. <p><i>FY 2021 Plans:</i></p> <ul style="list-style-type: none"> - Validate tools and modeling that accurately replicate and record extreme high G loading and high temperature on fuzing components and transition capability to the DoD and Industry weapon fuze community. - Develop and demonstrate technologies for efficient/novel generation of firing energy for multi-point fuze systems for advanced high-speed weapon warheads. - Develop integrated miniature fuze sensor technology for applications in miniature Unmanned Aerial Vehicle (UAV) weapons. - Demonstrate precision target detection device (TDD) technology for application in miniature Unmanned Aerial Vehicle (UAV) weapons and transition into Services' Counter Unmanned Aerial System (c-UAS) and weaponized Unmanned Aerial System (UAS) programs. <p><i>FY 2021 to FY 2022 Increase/Decrease Statement:</i> Enabling fuze technology work and resourcing planned for FY 2022 will be transferred to Project Code 077 Enhanced Munitions as a technical area under the Joint Enhanced Munitions Program.</p>			
Accomplishments/Planned Programs Subtotals	6.574	6.621	-

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

N/A

Remarks

D. Acquisition Strategy

N/A

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COST (\$ in Millions)	Prior Years	FY 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total	FY 2023	FY 2024	FY 2025	FY 2026	Cost To Complete	Total Cost
077: Enhanced Munitions Advanced Technology	-	0.000	16.284	23.213	-	23.213	-	-	-	-	-	-
Quantity of RDT&E Articles	-	-	-	-	-	-	-	-	-	-		

Note

New FY 2021 Project Code; funding re-aligned from P002 Insensitive Munitions.

A. Mission Description and Budget Item Justification

The Enhanced Munitions Advanced Technology effort will demonstrate enabling technologies and perform associated applied research that will improve the performance, range, and lethality of existing and future weapons systems. This effort will take promising technologies demonstrated at the laboratory scale and transition them into demonstration programs utilizing generic hardware based munitions in the concept and development stages. Mature demonstrated Enhanced Munitions technology can be transitioned, thereby decreasing the Program Executive Office’s (PEO) program costs and schedule risk, facilitating spin-offs to other munitions within their portfolios. Technologies demonstrated seek to improve the performance, lethality, and range of weapons to ensure the U.S. is not outgunned and outranged on the battlefield of the future.

Through FY 2021, the Joint Enhanced Munitions Technology Program (JEMTP) investments focus on five Munition Areas: 1) High Performance Propulsion - Alternative propulsion designs and systems for increased range, e.g. rotating detonation engines, solid fuel ramjets, highly loaded grain technology, etc.; 2) Minimum Signature Propulsion – new propellant compositions and hybrid propulsion for reduced time to target/increased range; 3) Area Effects Warheads – high performance explosives, reactive materials, multiphase blast, etc.; 4) Hard Target Effects Warheads – improved penetration for shaped charge jets, lethality enhancements for area effects munitions; and 5) Gun Propulsion – novel ignition schemes, advanced propellant design, etc. Munition Area Technology Groups (MATG), under tri- service leadership, have developed technology roadmaps for each Munition Area which are used to guide investments.

In FY 2022, the JFTP and JEMTP will merge and the program scope will expand to exploit technology developments such as hypersonics, machine learning, artificial intelligence, quantum computing, etc. and accelerate their application to enable next generation kinetic weapons capabilities in the areas of energetic materials, advanced propulsion, warhead effects, enabling fuze technologies, and pioneering targeting technologies with a specific focus on enhancing kinetic weapons lethality, range and resultant effects. The program will retain tri-service leadership to inform technology investments accelerating development across the Department. Investments will be informed by a threat-opportunity based analysis that focuses on developing weapons systems that exploit technology dominance to ensure military objectives in Joint Force campaign scenarios. New technology roadmaps for munition technical areas will guide investments consistent with the DoD National Defense Strategy and inform Service technology investments.

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

	FY 2020	FY 2021	FY 2022
Title: Enhanced Munitions Advanced Technology	-	16.284	23.213

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

Description: Enhanced Munitions Advanced Technology focuses on the following key areas:

- High Performance Rocket Propulsion (HPP) - focuses on the development of technologies to improve the range and speed of HPP systems, rocket motors with Ammonium Perchlorate and with or without a metal fuel, for rockets and missiles launched from air, ground, and sea platforms.
- Minimum Signature Rocket Propulsion (MSP) - focuses on the development and demonstration of technologies to improve MS rocket propellant formulations and ingredients, including synthesis, characterization and scale-up; case and packaging design; rocket motor case design; ignition systems; and thrust mitigation techniques, of minimum signature propellant missiles launched from air, ground, and sea platforms.
- Area Effects Warheads (AEW) - focuses on the development and demonstration of technologies that enhance the lethality, and reduce the size and weight of Area Effects munitions.
- Hard Target Effects Warheads (HTEW) - focuses on the development and demonstration of explosive ingredients, explosives, and warhead technologies to improve the performance and lethality of HTEW munitions.
- Gun Propulsion (GP) - focuses on the development and demonstration of technologies in the area of GP systems. The development and demonstration of gun propulsion technologies, when applied to munition systems, will improve the range and/or time to target of all gun launched munitions to include tank/mortar and medium/large caliber propulsion systems, as well as shoulder launched weapon systems.

FY 2021 Plans:

- Complete fabrication and static fire testing on half scale improved missile boost motor demonstrator. Complete motor design, component fabrication, and load and burst design testing for air defense system.
- Manufacture preliminary designs for missile motor and case assemblies to support an extended range air to ground small motor testing.
- Complete hardware design and fabrication of improved ground to ground flight motor. Complete designs, fabricate hardware, and conduct testing of a small diameter rocket motor system.
- Conduct modeling and simulation, formulation and set back testing on large diameter indirect fire munitions to demonstrate improved performance while maintaining safety response. Optimize and finalize the design of an AM warhead and prepare to conduct lethality testing to compare to the existing baseline warhead. Complete initial unique warhead design, manufacture test assets, and conduct arena tests to determine improved lethality.
- Build and conduct water-pit testing of medium caliber ammunition warheads with improved lethality on full cartridges. Conduct characterization and performance testing on improved performance explosive material for HTEWs. Conduct initial penetration testing using novel high explosive material loaded hardware and down-select design for improved penetrator.

FY 2020	FY 2021	FY 2022

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B. Accomplishments/Planned Programs (\$ in Millions)		FY 2020	FY 2021	FY 2022
<p>- Scale up and manufactured at the 5 pound batch a novel improved gun propellant formulation in order to fully characterize material, and conduct performance and test firing in medium caliber gun cartridges. Manufacture extended range propellant for indirect fire weapon system at the 2-gallon scale and complete characterization studies to prepare for scale-up.</p> <p>FY 2022 Plans:</p> <ul style="list-style-type: none"> - Complete advanced performance testing on half scale improved missile boost motor demonstrator. Conduct motor preparations and static motor firing for air defense system. - Complete testing and down-selection on preliminary designs for missile motor and case assemblies to support an extended range air to ground missile system, and begin final motor manufacturing. Conduct ground and prepare for flight testing of improved ground to ground flight motor. - Complete final design and static testing of a small diameter rocket motor system. - Conduct down-selection of formulation and lethality testing on large diameter indirect fire munitions to demonstrate improved performance. <p>Finalize unique warhead design, manufacture test assets, conduct set-back testing, and prepare assets for arena tests to determine improved lethality.</p> <ul style="list-style-type: none"> - Conduct final design testing in multi-warhead configuration using novel high explosive material loaded hardware for improved performance. - Scale up a novel improved propellant formulation and conduct performance testing. Scale-up extended range propellant for indirect fire weapon system and conduct initial full-scale weapon tests. - Demonstrate Micro-Electro Mechanical System (MEMs) based sensor/micro valve that enables low cost Safe and Arm devices. - Demonstrate high energy density, thin film battery with thin film heat source for broad applications including artillery, missiles, and miniature munitions. - Develop and demonstrate robust and survivable target sensor solution for high-speed weapons that react in relevant timescales. - Develop high-speed weapon survivable and quick triggering high voltage Electronics Safe and Arm Devices (ESADs) components. - Develop advanced sub-scale testing method and apparatus to rapidly evaluate survivability of fuzing components in high shock, extreme environments. - Develop new multi-mode ultrafast targeting algorithms exploiting advancements in microelectronics and materials. - Demonstrate technologies facilitating weapons communication and networking impacting guidance, target detection, and weapons effectiveness. <p>FY 2021 to FY 2022 Increase/Decrease Statement: New FY 2021 Project Code; funding re-aligned from P002 Insensitive Munitions.</p>				
Accomplishments/Planned Programs Subtotals		-	16.284	23.213

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

N/A

Remarks

D. Acquisition Strategy

N/A