Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Air Force											Date: February 2020	
Appropriation/Budget Activity 3600: *Research, Development, Test & Evaluation, Air Force* / BA 2: *Applied Research*					R-1 Program Element (Number/Name) PE 0602602F / *Conventional Munitions*							
COST ($ in Millions)	**Prior Years**	**FY 2019**	**FY 2020**	**FY 2021 Base**	**FY 2021 OCO**	**FY 2021 Total**	**FY 2022**	**FY 2023**	**FY 2024**	**FY 2025**	**Cost To Complete**	**Total Cost**
Total Program Element	-	100.573	142.772	132.425	0.000	132.425	147.652	134.767	137.765	139.838	Continuing	Continuing
622068: *Advanced Guidance Technology*	-	51.260	80.641	73.248	0.000	73.248	79.701	66.496	67.970	69.021	Continuing	Continuing
622502: *Ordnance Technology*	-	49.313	62.131	59.177	0.000	59.177	67.951	68.271	69.795	70.817	Continuing	Continuing

A. Mission Description and Budget Item Justification

This program investigates, develops, and establishes the technical feasibility and military utility of guidance and ordnance technologies for conventional air-launched munitions. The effort supports core technical competencies of fuze technology; energetic materials; damage mechanisms; munitions aerodynamics, guidance, navigation, and control; terminal seeker sciences; and munition systems effects. Technologies to be developed include blast, fragmentation, penetrating and low-collateral damage war-heads, hard-target fuzing, precise terminal guidance, and high-performance and insensitive explosives.

This program element may include necessary civilian pay expenses required to manage, execute, and deliver science & technology capabilities. The use of such program funds in this PE would be in addition to the civilian pay expenses budgeted in program elements 0601102F, 0602102F, 0602201F, 0602202F, 0602203F, 0602204F, 0602605F, 0602788F, 1206601SF, and 0602298F.

This program is in Budget Activity 2, Applied Research because this budget activity includes studies, investigations, and non-system specific technology efforts directed toward general military needs with a view toward developing and evaluating the feasibility and practicality of proposed solutions and determining their parameters.

B. Program Change Summary ($ in Millions)	**FY 2019**	**FY 2020**	**FY 2021 Base**	**FY 2021 OCO**	**FY 2021 Total**
Previous President's Budget	112.841	142.772	150.085	0.000	150.085
Current President's Budget	100.573	142.772	132.425	0.000	132.425
Total Adjustments	-12.268	0.000	-17.660	0.000	-17.660
• 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	-1.409	0.000			
• Other Adjustments	-10.859	0.000	-17.660	0.000	-17.660

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Air Force	Date: February 2020
Appropriation/Budget Activity 3600: *Research, Development, Test & Evaluation, Air Force* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602602F / *Conventional Munitions*

Change Summary Explanation

Decrease in FY 2019 in Other Adjustments of $10.859 million is due to realignment of funds to PE 0602212F to support Research and Development Projects, 10 U.S.C. Section 2363, an amendment to PL 110-417, 10 U.S.C. Section 2358 and 10 U.S.C. 2805(d)(1)(B).

Decrease in FY 2021 is due to the realignment and consolidation of the Future AF Capabilities Applied Research efforts/activities to PE 0602020F, Future AF Capabilities Applied Research, Project 620200, Enterprise Transformational Applied Research, to better align with the Air Force S&T Strategy SECAF April 2019 and provide Congress with increased transparency on transformational Air Force S&T activities.

Exhibit R-2A, RDT&E Project Justification: PB 2021 Air Force			Date: February 2020
Appropriation/Budget Activity 3600 / 2	R-1 Program Element (Number/Name) PE 0602602F / *Conventional Munitions*	Project (Number/Name) 622068 / *Advanced Guidance Technology*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
622068: *Advanced Guidance Technology*	-	51.260	80.641	73.248	0.000	73.248	79.701	66.496	67.970	69.021	Continuing	Continuing

A. Mission Description and Budget Item Justification

This project investigates, develops, and evaluates conventional munitions guidance technologies to establish technical feasibility and military utility of innovative munition seekers, weapon aerodynamics, navigation and control, and guidance subsystem integration/simulation. Project payoffs include adverse-weather, Global Positioning System (GPS)-degraded and Global Positioning System-denied, networked, and autonomous precision munition guidance capability; increased number of kills per sortie; increased aerospace vehicle survivability; improved weapon reliability and affordability; and improved weapon survivability and effectiveness.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Seeker Technologies	6.805	9.416	9.463
Description: Develops seeker technologies for air-delivered munitions to provide high-confidence target discrimination and classification, precise target location, and robust terminal tracking. ***FY 2020 Plans:*** Continue to emphasize technology development of multi-function sensors, rapid data compression for targeting, bio-inspired information processing and data fusion, and low-power computation. Continue to develop technologies that simplify, increase flexibility and reduce the cost of advanced seeker concepts to include biologically inspired low-cost concepts. Continue to develop algorithmic and mathematical approaches to integrate weapons into the kill chain to enable distributive, flexible seeker imaging targeting with or without an operator-in-the-loop. Continue development and testing of innovative air-to-air engagements for fifth generation aircraft and beyond with emphasis on radome and aperture materials that improve optical performance, as well as provide increased protection from operational environments including directed energy and rain. Continue to explore incorporation of open architecture principles to reduce cost and enable technology refresh within seeker subsystems. Continue to explore specific techniques for seeker cost reduction with performance improvement; novel technical approaches such as sparse and compressive sensing will be investigated. Continue to conduct research on integrated processing techniques to enable networked systems to include early collaborative global positioning system denied navigation and miniature self-defense seeker design. Continue to develop open seeker architecture software-in-the-loop integration laboratory. Continue to investigate the technical challenges of cooperative radio frequency functions including coherent on-transmit/on-receive operation. Continue to refine the software development kit for Open Seeker Architecture to enable rapid technology insertion into software-defined, multi-function seekers.			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Air Force		Date: February 2020
Appropriation/Budget Activity 3600 / 2	**R-1 Program Element (Number/Name)** PE 0602602F / *Conventional Munitions*	**Project (Number/Name)** 622068 / *Advanced Guidance Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Continue to refine and further development of tools for evaluation of deep-learning networks to evaluate feasibility for weapon seekers. Continue analysis of Open Seeker Architecture cyber vulnerabilities and formulate software resilient techniques. Continue data collection experiments to support cooperative radio frequency systems. ***FY 2021 Plans:*** Continue to emphasize technology development of multi-function sensors, rapid data compression for targeting, bio-inspired information processing and data fusion, and low-power computation. Continue to develop technologies that simplify, increase flexibility, and reduce the cost of advanced seeker concepts. Continue to develop algorithmic approaches integrating weapons into the kill chain to enable distributive, flexible seeker targeting with or without an operator in the loop. Continue development and testing of innovative engagements for fifth generation aircraft and beyond. Continue materials research efforts on radomes and apertures, to improve transmission and optical performance while increasing protection from operational environments including directed energy and rain. Continue to explore incorporation of open architecture principles to reduce cost and enable technology refresh within seeker subsystems. Continue to explore specific techniques for seeker cost reduction with performance improvement such as sparse sensing and compressive sensing. Continue research on integrated processing techniques to enable networked systems. Continue multi-function radio frequency technique development to enable coherent multi-weapon operation. Further development of Open Seeker Architecture with extended view to integrate into weapon mission computer to enable cooperative weapon operation. Continue integration of the Open Seeker architecture into the Weapon Open System Architecture and evaluate the impact with respect to cyber vulnerability. Continue to develop and demonstrate coherent collaborative radio frequency seeker operation. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** FY 2021 increased compared to FY 2020 by $0.047 million. Funding increased due to added emphasis in autonomy and machine learning with legacy weapons research in support of cooperative / collaborative weapon technologies.			
Title: Aerodynamics, Navigation, and Control Technologies	24.391	29.367	40.364
Description: Develops weapon aerodynamic control, navigation, and networking technologies for air-delivered munitions to provide precise, agile flight, networked effects, and immunity to countermeasures. ***FY 2020 Plans:*** Complete and transition the hypersonic flight performance aero-structural-thermal computational tools and prototype concept development tools to the program office. Complete the integration of algorithms to support distributed, multi-strategy weapon concept-of-operations to defeat enemy defenses. Continue execution of Position, Navigation and Timing acceleration research to integrate emitter geo-location and Electronic Intelligence into M-Code compliant anti-jam Global Position System chip set. Continue development of weapon platform interfaces to include concepts for double increased weapons load-out. Continue ground testing of advanced guidance laws and actuators to enable innovative air-to-air engagements and hyper-agility including hit-to-kill. Continue experiments demonstrating precision navigation using celestial aiding for long-range flights at high and low			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Air Force		Date: February 2020
Appropriation/Budget Activity 3600 / 2	**R-1 Program Element (Number/Name)** PE 0602602F / *Conventional Munitions*	**Project (Number/Name)** 622068 / *Advanced Guidance Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
altitudes. Continue small, air-to-air, self-defense munitions research efforts. Continue cooperative/collaborative small cruise missile swarm flight demonstration to locate and overwhelm targets. Continue flight test of a multi-vehicle mapping (without Global Positioning System) and saturation approach of the entrance of a hardened-deeply-buried facility or tunnel target. Continue ground tests of rocket motor component technologies to evaluate their ability to increase weapon range and reduce size/weight. Continue development of defensive cyber algorithms for autopilot and navigation functions, including swarm. Continue execution of Joint Capability Technology Demonstration program with system program office and Combatant Command user for Global Position System-denied navigation suite for cruise missiles. Continue efforts to identify cyber vulnerabilities in software define radios used on weapons by testing meshing radios. Continue munition cyber-hardening demonstration coordinated with Cyber Command and extend to an integrated systems test environment. Continue intramural Air Force study of high fidelity models for store separation from aircraft using advanced dispense technologies. Initiate trade study of low-cost navigation grade Inertial Measurement Units, build weapon Size-Weight-And-Power celestial aiding sensor for upcoming high-altitude hypersonic test, use tactical software defined radio to flight test network aiding using meshing waveform. Initiate scaled flight demonstrations of advanced guidance laws for self-defense and multi-shot air-to-air missiles. ***FY 2021 Plans:*** Continue execution of Global Positioning System denied navigation demonstration programs. Initiate cooperative weapon swarming playbooks, demonstrating autonomous and collaborative behaviors, with various legacy weapon systems. Continue experiments demonstrating precision navigation, emphasizing cruise missile, form-factored optics and tracker for celestial aided navigation at supersonic cruise missile speeds and trajectory. Continue flight testing of articulating head missile at supersonic speeds at full scale. Continue flight demonstration on heterogeneous capability integrating kinetic swarm plays with electronic attack swarm plays. Continue flight demonstration of network aided navigation autonomy playbook. Continue flight demonstration of high-speed, high-performance weaponized quadrotor in a complex environment. Continue to use machine learning of a visual servo; learn servo commands from drone pilots using front looking camera. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** FY 2021 increased compared to FY 2020 by $10.997 million. Funding increased due to added emphasis in autonomy and machine learning with legacy weapons research in support of cooperative / collaborative weapon technologies.			
Title: Guidance Technologies	20.064	22.192	23.421
Description: Develops guidance subsystem integration and evaluation technologies to provide open and closed-loop ground testing, flight test risk reduction, and digital simulation of novel concepts. ***FY 2020 Plans:*** Complete transition of reconfigurable Radio Frequency Target Simulator to prime contractors to support hypersonic weapon development. Complete and refine the Modeling and Simulation capability with multi-level security enabling cross-domain, distributed Modeling and Simulation activities. Continue flight demonstration of critical behaviors for Distributed, Cooperative,			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Air Force		Date: February 2020
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Collaborative strategies and other advanced guidance capabilities. Continue to improve constructive and virtual analysis tools for design, development, and analysis of advanced cruise missile concepts in representative environments and provide design, performance, and trade space analysis for hypersonic and air-to-air weapon concepts to the program offices. Continue to improve simulation technologies that evaluate innovative air-to-air and air-to-surface engagements to include guidance and control evaluation. Continue to develop a real-time radar/millimeter wave signature generation capability for testing algorithms in real-time software and hardware-in-the-loop environments to include additional targets and improved terrain resolution to multi-spectral signature generation capability for testing algorithms in real-time software and hardware-in-the-loop environments. Continue to develop simulation technologies that evaluate cooperative, flexible munition target engagements. Continue to transition refined engineering models to Air Force mission level simulation for analysis. Continue to improve capabilities of our reconfigurable radio-frequency hardware-in-the-loop chamber to handle faster and more complex scenes to include demonstrating real-time fluid thermal structural interaction effects during hardware-in-the-loop simulation of hypersonic weapons. Continue to develop new infrared projection capabilities to evaluate a new class of multi-aperture sensor systems to include demonstrating increased scene complexity and closed-loop real-time interface and high-density Infrared Light Emitting Diode array with improved performance. Continue development of "help desk" high-fidelity modeling and scene generation modules for the extended modeling and simulation community using Air Force Simulation. Continue constructive and virtual analysis on numerous weapon concepts to provide design, performance, and trade space analysis to the program offices. Initiate refurbishment of main Kinetic Hardware-In-the-Loop System facility. Initiate distributed connectivity capability between multiple Air Force facilities for cross-domain, distributed, multi-level security modeling and simulation activities.			
FY 2021 Plans: Continue low-cost cruise missile demonstration of critical behaviors for distributed, cooperative, collaborative strategies and other advanced guidance capabilities. Further improve constructive and virtual analysis tools for design, development, and analysis of advanced low cost cruise missile concepts in representative environments. Continue engagement level analysis on hypersonic and air-to-air weapon concepts providing design, performance, and trade space analysis to the program offices. Continue to improve simulation technologies evaluating innovative air-to-air and air-to-surface engagements to include guidance and control evaluation. Continue to add additional targets and improved terrain resolution to radar/millimeter wave/infrared/ ultraviolet signature generation capability for testing algorithms in real-time software and hardware in-the-loop environments. Continue development of hypersonic hardware-in-the-loop simulation technology, including thermal environment, aerodynamic control uncertainty, seeker modeling, and navigation sensor effectiveness. Initiate simulator upgrades to accommodate resolution requirements for navigation quality synthetic aperture radar target and background modeling. Continue development of infrared light emitting diode infrared target simulator technology to create higher framerate and higher resolution target simulator technology. Continue providing multi-security level, cross-domain distributed modeling and simulation support for munition research and development using distributed connectivity between multiple Eglin Air Force Base facilities. Continue development of 6-degrees of freedom and scene generation modules for the extended modeling and simulation community using Air Force			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Air Force		Date: February 2020
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Simulator. Initiate hardware-in-the-loop activities in support of international cooperative research efforts. Complete hardware-in-the-loop facility expansion by adding optics lab for infrared target simulator development. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** FY 2021 increased compared to FY 2020 by $1.229 million. Funding increased due to additional emphasis in modeling and simulation activities.			
Title: Future AF Capabilities Applied Research ***Description:*** Investigate, design, and develop science and technologies supporting future Air Force capabilities to provide compelling advantage to the warfighter. To the greatest extent practical, research efforts will utilize modeling and simulation and cross-discipline systems integration (For example: air and space vehicles, avionics, propulsion, materials, human performance, cybersecurity, command, control, communications, computer and intelligence, sensors, electronic warfare, and conventional/ unconventional weapons). The National Defense Strategy and Air Force Science and Technology (S&T) Strategy will inform investments over the FYDP. In FY 2019, this work was performed under multiple projects and efforts within the following Air Force S&T Programs: 0602102F, Materials; 0602201F, Aerospace Vehicle Technologies; 0602202F, Human Effectiveness Applied Research; 0602203F, Aerospace Propulsion; 0602204F, Aerospace Sensors; 1206601F, Space Technology; 0602602F, Conventional Munitions; 0602605F, Directed Energy Technology; and 0602788F, Dominant Information Science and Methods. ***FY 2020 Plans:*** Investigate and mature science and technology that enables future warfighting concepts to provide leap-ahead capabilities. The National Defense Strategy and Air Force S&T Strategy focus this science and technology toward, but not limited to, the following capabilities: 1) global persistent awareness; 2) resilient information sharing; 3) rapid, effective decision-making; 4) complexity, unpredictability, and mass; and 5) speed and reach of disruption and lethality. ***FY 2021 Plans:*** Starting in FY 2021, this work is performed in PE 0602020F, Future AF Capabilities Applied Research, Project 620200, Enterprise Transformational Applied Research, Transformational Capability Incubator effort. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** FY 2021 decreased compared to FY 2020 due to realignment and consolidation of Future AF Capabilities Applied Research efforts to PE 0602020F, Future Air Force Capabilities Applied Research, Project 620200, Enterprise Transformational Applied	0.000	19.666	0.000

Exhibit R-2A, RDT&E Project Justification: PB 2021 Air Force		Date: February 2020
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Research, Transformational Capability Incubator effort, to better align with the Air Force S&T Strategy SECAF April 2019 and provide Congress with increased transparency on transformational Air Force S&T activities.			
Accomplishments/Planned Programs Subtotals	51.260	80.641	73.248

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

Not Applicable

Exhibit R-2A, RDT&E Project Justification: PB 2021 Air Force			Date: February 2020
Appropriation/Budget Activity 3600 / 2	R-1 Program Element (Number/Name) PE 0602602F / *Conventional Munitions*	Project (Number/Name) 622502 / *Ordnance Technology*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
622502: *Ordnance Technology*	-	49.313	62.131	59.177	0.000	59.177	67.951	68.271	69.795	70.817	Continuing	Continuing

A. Mission Description and Budget Item Justification

This project investigates, develops, and evaluates conventional ordnance technologies to establish technical feasibility and military utility for advanced explosives, fuzes, warheads, sub-munitions, and weapon airframes, carriage, and dispensing. The project also assesses the lethality and effectiveness of current and planned conventional weapons technology programs and assesses target vulnerability. The payoffs include improved storage capability and transportation safety of fully assembled weapons, improved warhead and fuze effectiveness, improved sub-munitions dispensing, low-cost airframe/subsystem components and structures, and reduced aerospace vehicle and weapon drag.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Energetic Materials Technology	2.667	3.509	3.833
Description: Investigates and develops energetic materials and technology that safely and securely optimize survivability, cost, and weapon lethality for air-delivered munitions. ***FY 2020 Plans:*** Continue to mature and develop selected energetic materials to increase energy density over that of traditional explosives while enhancing damage mechanisms and lethality for mass and volume-constrained applications. Continue to build and implement experimental techniques/capabilities to quantify dynamic and mechanical properties as well as survivability of energetic materials in extreme temperature and vibrational environments. Continue to develop theoretical and virtual formulation and processing techniques for energetic materials and provide the second release of the tool/software to the energetics community. Continue to develop tools and analysis techniques to further understanding of energy partitioning in order to optimize lethality against a broad spectrum of targets. Continue to formulate and test liner technologies to improve Insensitive Munitions performance. Continue to mature additive manufacturing techniques to increase the design space for kinetic weapon lethality. Initiate formulation of novel explosive fill to satisfy severe environmental constraints. Initiate development of large scale nano-energetic material fabrication. ***FY 2021 Plans:*** Continue to advance and develop selected energetic materials to increase energy density over traditional explosives while enhancing damage mechanisms and lethality for mass and volume-constrained applications. Continue to build and implement experimental techniques/capabilities to quantify dynamic and mechanical properties as well as survivability of energetic materials in extreme temperature and vibrational environments. Continue to develop tools and analysis techniques to further understanding of energy partitioning in order to optimize lethality against a broad spectrum of targets. Continue to formulate and test liner technologies to improve Insensitive Munitions performance. Continue to mature additive manufacturing techniques to increase			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Air Force		Date: February 2020
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
the design space for kinetic weapon lethality. Continue formulation of novel explosive fill to satisfy severe environmental constraints. Continue development of large scale nano-energetic material fabrication. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** FY 2021 increased compared to FY 2020 by $0.324 million. Justification for the increase is described in the plans above.			
Title: Fuze Technologies ***Description:*** Investigate and develop fuzing technology for air-delivered weapons to ensure reliable and optimal function to maximize weapon lethality for all engagement scenarios. ***FY 2020 Plans:*** Continue to develop testing capabilities for munitions penetration scenarios and increase Modeling and Simulation capabilities to reduce research and development costs and timelines. Continue to develop and demonstrate alternative packaging technology for survivable fuze electronic components. Continue to investigate the reliability and survivability of electronic components to predict and measure fuze performance during monition penetration at high-impact speeds. Continue research to facilitate tailored lethal effects and enable optimum fuzing solutions across the spectrum of weapon and target interactions. Continue research for distributed and multi-point fuzing concepts. Continue implementing additive manufacturing techniques to increase fuze reliability. Initiate fuze explosive interfaces analysis for robust definition of explosive train reliability and performance. Initiate fuze endgame, active imaging for target detection and aim point selection. ***FY 2021 Plans:*** Continue to develop testing capabilities for munitions penetration scenarios and increase Modeling and Simulation capabilities to reduce research and development costs and timelines. Continue to develop and demonstrate alternative packaging technology for survivable fuze electronic components. Continue to investigate the reliability and survivability of electronic components to predict and measure fuze performance during monition penetration at high-impact speeds. Continue research to facilitate tailored lethal effects and enable optimum fuzing solutions across the spectrum of weapon and target interactions. Continue research for distributed and multi-point fuzing concepts. Continue implementing additive manufacturing techniques to increase fuze reliability. Continue fuze explosive interfaces analysis for robust definition of explosive train reliability and performance. Continue fuze endgame, active imaging for target detection and aim point selection. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** FY 2021 decreased compared to FY 2020 by $0.526 million. Justification for the decrease is described in the plans above.	3.578	5.303	4.777
Title: Warhead Technologies ***Description:*** Investigate and develop innovative warhead kill mechanisms for air-delivered weapons that maximize weapon lethality for all engagement scenarios.	8.580	12.158	7.791

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
FY 2020 Plans: Continue to mature small, multi-output warhead technologies for soft-surface targets, to include limited penetration capability of hardened structures. Continue to evolve test capabilities to enhance quantification of the mechanical response under high rate, high-pressure loading conditions for use in high fidelity Modeling and Simulation tools, to include materials used in additive manufacturing processes. Continue to develop additive manufacturing techniques and produce optimized sub-scale articles for test. Continue to demonstrate technologies for effective and survivable high-speed penetration into hard targets. Continue to develop air-to-air missile warhead concepts for the air targets in near-peer engagement scenarios. Continue to research and develop cumulative damage mechanisms that take advantage of distributed blast, as well as shock wave and reactive particle interactions. Continue integration of warhead research with related activities planned for the advanced/integrated ordnance subsystems research capability. Initiate a characterization of Low-Density and High-Density Reactive Materials for use in multi-mission roles. Initiate the development of topological optimization in support of additive manufacturing. Initiate studies of composite based warheads for penetrator/perforator applications. ***FY 2021 Plans:*** Continue to mature small, multi-output warhead technologies for soft-surface targets, to include limited penetration capability of hardened structures. Continue to evolve test capabilities to enhance quantification of the mechanical response under high-rate, high-pressure loading conditions for use in high-fidelity Modeling and Simulation tools, to include materials used in additive manufacturing processes. Continue to develop additive manufacturing techniques and produce optimized sub-scale articles for test. Continue to demonstrate technologies for effective and survivable high-speed penetration into hard targets. Continue to develop warhead concepts for the air targets in near-peer engagement scenarios. Continue to research and develop cumulative damage mechanisms taking advantage of distributed blast, as well as shock wave and reactive particle interactions. Continue integration of warhead research with related activities planned for the advanced/integrated ordnance subsystems research capability. Continue the development of topological optimization in support of additive manufacturing. Continue studies of composite based warheads for penetrator/perforator applications. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** FY 2021 decreased compared to FY 2020 by $4.367 million. Funding decreased due to reduced emphasis in a portion of research in near-peer engagement scenarios with extreme conditions.			
Title: Ordnance Technologies ***Description:*** Investigate and develop ordnance sub-system (energetics, fuzes and war-heads) and integrated system concepts using both high-fidelity and fast-running engineering level Modeling and Simulation tools. ***FY 2020 Plans:*** Continue to develop validated mesoscale Modeling and Simulation tools for computational physics sciences. Continue to mature engineering-level simulation architecture capability to enable weapon sub-system and system-level technology assessments.	34.488	41.161	42.776

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Continue to implement cost-effective and rapid transition war-head technologies for inventory penetrator weapons. Continue to conduct Modeling and Simulation that explores the ordnance technology trade space for low-cost, long-range munition concepts. Continue to develop predictive techniques for munition effectiveness tools used in concept development and assessment as well as studies involving analysis of alternatives. Continue to develop test capability and data collection for Modeling and Simulation tools to characterize lethality, survivability and performance of sub-systems and integrated ordnance systems. Initiate the development of ordnance test and evaluation capabilities that include thermal and vibration management for hypersonic and high-speed flight. ***FY 2021 Plans:*** Continue to develop validated mesoscale Modeling and Simulation tools for computational physics sciences. Continue to develop engineering-level simulation architecture capability to enable weapon sub-system and system-level technology assessments. Continue to implement cost-effective and rapid transition war-head technologies for inventory penetrators. Continue to Modeling and Simulation efforts exploring the ordnance technology trade space for low-cost, long-range munition concepts. Continue to develop predictive techniques for munition effectiveness tools used in concept development and assessment as well as studies involving analysis of alternatives. Continue to develop test capability and data collection for Modeling and Simulation tools to characterize lethality, survivability, and performance of sub-systems and integrated ordnance systems. Continue the development of ordnance test and evaluation capabilities that include thermal and vibration management for hypersonic and high-speed flight. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** FY 2021 increased compared to FY 2020 by $1.615 million. Funding increased due to the additional emphasis in modeling and simulation activities.			
Accomplishments/Planned Programs Subtotals	49.313	62.131	59.177

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

Not Applicable.