Exhibit R-2, RDT&E Budget Item Justification: PB 2022 Army											**Date:** May 2021	
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*					**R-1 Program Element (Number/Name)** PE 0602141A / *Lethality 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**
Total Program Element	-	68.852	117.484	64.126	-	64.126	-	-	-	-	-	-
AH5: *Projectile and Multi-Function Warhead Technologies*	-	3.305	-	-	-	-	-	-	-	-	-	-
AH6: *Disruptive Energetics and Propulsion Technologies*	-	7.934	8.124	8.413	-	8.413	-	-	-	-	-	-
AH7: *Lethal and Scalable Effects Technologies*	-	1.792	1.018	1.911	-	1.911	-	-	-	-	-	-
AH8: *Lethality Materials and Processes Technology*	-	3.791	4.007	4.019	-	4.019	-	-	-	-	-	-
AH9: *Advanced Warheads Technology*	-	9.030	22.933	25.032	-	25.032	-	-	-	-	-	-
AI1: *Advanced Terrain Shaping Technology*	-	-	4.902	-	-	-	-	-	-	-	-	-
BS6: *Lethality Technology (CA)*	-	43.000	76.500	-	-	-	-	-	-	-	-	-
CF7: *Solid-state Laser Concepts and Architectures*	-	-	-	7.547	-	7.547	-	-	-	-	-	-
CF8: *Terminal Effects Against Critical Targets Tech*	-	-	-	4.040	-	4.040	-	-	-	-	-	-
CG4: *Advanced Radar Concepts and Technologies*	-	-	-	4.687	-	4.687	-	-	-	-	-	-
CJ1: *Lethality Enabling University Applied Research*	-	-	-	5.794	-	5.794	-	-	-	-	-	-
CJ6: *Advanced Energetics for Missile Technologies*	-	-	-	1.185	-	1.185	-	-	-	-	-	-
CJ7: *Future Air Defense Missile Enabling Tech*	-	-	-	1.498	-	1.498	-	-	-	-	-	-

Exhibit R-2, RDT&E Budget Item Justification: PB 2022 Army	**Date:** May 2021
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602141A / *Lethality Technology*

A. Mission Description and Budget Item Justification

Work done in this PE researches technologies, methodologies, and models required to enable next generation lethality. The effort focuses on: lethal mechanism technologies for projectiles and warheads that provide revolutionary capability to defeat Tier 1 adversary vehicle and body armors; selection of propulsion and energetic materials and technology to validate novel energetic materials concepts to exploit controllable energy release for future gun/missile systems; scalable effects for mixed target defeat while simultaneously decreasing warhead mass; development of materials solutions for improvement of weight and volume efficiency, lethal effects and sustainability for the warfighter in the Army of today and beyond; and multiple pathways to enhance lethal effects by investigating synergistic effects of novel micro warheads using advanced materials. Funding in this PE is a continuation of work done in PEs 0602105A (Materials Technology), 0602618A (Ballistics Technology), and 0602624A (Weapons and Munitions Technology).

Work in this PE complements PEs 0602147A (Long Range Precision Fires Technology), 0602150A (Air and Missile Defense Technology), 0602143A (Soldier Lethality Technology), 0602144A (Ground Technology), 0602145A (Next Generation Combat Vehicle Technology), and 0603116A (Lethality Advanced Technology).

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

Work in this Project is performed by the United States (US) Army Futures Command (AFC).

B. Program Change Summary ($ in Millions)	**FY 2020**	**FY 2021**	**FY 2022 Base**	**FY 2022 OCO**	**FY 2022 Total**
Previous President's Budget	69.961	42.425	45.824	-	45.824
Current President's Budget	68.852	117.484	64.126	-	64.126
Total Adjustments	-1.109	75.059	18.302	-	18.302
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	76.500			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-1.109	-1.441			
• Adjustments to Budget Years	-	-	18.302	-	18.302

Congressional Add Details ($ in Millions, and Includes General Reductions)	**FY 2020**	**FY 2021**
Project: BS6: *Lethality Technology (CA)*		
Congressional Add: *Medium Range Railgun Weapon System*	20.000	-
Congressional Add: *Additive Manufacturing Research*	5.000	-
Congressional Add: *Mobile Environment Contaminant Sensors*	5.000	-

Exhibit R-2, RDT&E Budget Item Justification: PB 2022 Army	Date: May 2021
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602141A / *Lethality Technology*

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2020	FY 2021
Congressional Add: *Hybrid Additive Manufacturing*	8.000	-
Congressional Add: *Next Generation Air-Breathing Propulsion Technology*	5.000	-
Congressional Add: *Program increase - next generation remote sensing*	-	5.000
Congressional Add: *Program increase - Advanced lethality concepts and analysis*	-	7.500
Congressional Add: *Program increase - counter UAS technology in arctic environments*	-	10.000
Congressional Add: *Program Increase- Hybrid additive manufacturing*	-	10.000
Congressional Add: *Program increase - novel and sustainable energetic materials*	-	24.000
Congressional Add: *Program increase - quantum technologies for armament systems*	-	10.000
Congressional Add: *Program increase - solid fuel propulsion technology*	-	10.000
Congressional Add Subtotals for Project: BS6	43.000	76.500
Congressional Add Totals for all Projects	43.000	76.500

Change Summary Explanation

Increases in Program Element funding in Fiscal Year (FY) 2022 support new efforts in Projects CF7 (Solid-state Laser Concepts and Architectures), CG4 (Advanced Radar Concepts and Technologies), CJ1 (Lethality Enabling University Applied Research), CJ6 (Advanced Energetics for Missile Technologies), and CJ7 (Future Air Defense Missile Enabling Tech).

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army			Date: May 2021
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602141A / *Lethality Technology*	**Project (Number/Name)** AH5 / *Projectile and Multi-Function Warhead Technologies*	

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
AH5: *Projectile and Multi-Function Warhead Technologies*	-	3.305	-	-	-	-	-	-	-	-	-	-

A. Mission Description and Budget Item Justification

This Project designs and validates novel lethal mechanism technologies to reduce energy or mass required to defeat emerging armor threats and provide multipurpose options for revolutionary capability to include defeat of advanced Tier 1 adversary vehicle and body armors.

This research is coordinated with PE 0602141A (Lethality Technology) / Project AH7 (Lethal and Scalable Effects Technologies), PE 0602143A (Soldier Lethality Technology / Project AY6 (Soldier Squad Small Arms Armaments Technology), and PE 0603462A (Next Generation Combat Vehicle Advanced Technology) / Project BF5 (Adv Lethality & Accuracy System for Med Cal Adv Tech) and builds upon weapon target interaction research in PE 0601102A Defense Research Sciences / Project AA7 (Mechanics and Ballistics).

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

Work in this Project is performed by the United States (US) Army Futures Command (AFC).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
Title: Defeat of Adversary Vehicle Armors ***Description:*** This effort designs, models and evaluates longer range, higher velocity munitions though reduction of parasitic mass required to launch and deliver lethality via new composite materials and architecture; Develops higher energy, more lethal cannon (1.5X M256) through modification of blast field. This effort provides testing and modeling and simulation of Lightweight 50mm Armor Piercing round for advanced, direct-fire medium caliber weapons.	2.234	-	-
Title: Defeat of Adversary Body Armor ***Description:*** This effort designs, models and evaluates defeat mechanisms for adversary body armor through time-resolved penetration mechanics and energy efficient munitions. This effort supports the development of small caliber lethal mechanisms for PE 0602143A (Soldier Lethality Technology) / Project AY6 (Soldier Squad Small Arms Armaments Technology).	1.071	-	-
Accomplishments/Planned Programs Subtotals	3.305	-	-

C. Other Program Funding Summary ($ in Millions)

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602141A / *Lethality Technology*	**Project (Number/Name)** AH5 / *Projectile and Multi-Function Warhead Technologies*

C. Other Program Funding Summary ($ in Millions)

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army			Date: May 2021
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602141A / *Lethality Technology*	**Project (Number/Name)** AH6 / *Disruptive Energetics and Propulsion Technologies*	

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
AH6: *Disruptive Energetics and Propulsion Technologies*	-	7.934	8.124	8.413	-	8.413	-	-	-	-	-	-

A. Mission Description and Budget Item Justification

This Project investigates, models, and assesses energetic material and propulsion technologies to validate novel concepts such as maximizing total energy density and power delivered on target. This Project also optimizes propellant grains for increased range, and altering gun configurations to increase energy on target in order to exploit the controllable/scalable energy release required for improving effectiveness and reducing vulnerability of future gun/missile systems. This Project builds upon disruptive energetic materials discovery efforts to synthesize new materials with energy content from 50% to up to two times that of Research Department Explosive (RDX) in PE 0601102A (Defense Research Sciences) / Project AA7 (Mechanics and Ballistics). This Project also leverages the advanced additive manufacture efforts of PE 0602144A (Ground Technology) / Project BL1 (Materials and Manufacturing Research Technology).

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

Work in this Project is performed by the United States (US) Army Futures Command (AFC).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
Title: Synthesis, Formulation and Diagnostics of Energetic Materials	4.862	4.764	5.021
Description: This effort pursues novel approaches to synthesize and scale up disruptive and traditional energetic materials with increased performance as well as design new formulation avenues in order to discover new materials and formulations to extend range and increase effect on target. This effort also investigates and develops revolutionary ways to release energy and characterize energetic behavior at early time and small length scales for rapid determination of detonation and propellant performance parameters to enable a ?fail early, fail often? strategy.			
FY 2021 Plans: Continue to develop new materials and formulations with 50% better performance than current state of the art; develop scale-up processes of molecules for transition as melt cast / eutectics formulations (go/no-go depending on passing safety, scale-up, and performance parameters); develop new energetic plasticizers and high-temperature materials; formulate new explosive and propellants using synthesized materials (both energetic and polymer); utilize previous or currently under development micro-scale diagnostic techniques to characterize and assess traditional and disruptive energetic candidates for use as high performing rocket / gun propellants or explosive formulations.			
FY 2022 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602141A / *Lethality Technology*	**Project (Number/Name)** AH6 / *Disruptive Energetics and Propulsion Technologies*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
Will synthesize and scale-up novel high energy density materials, polymer precursors, plasticizers, and high temperature energetics for inclusion in formulations (melt-cast, cast-cure, and additively manufactured) targeting 50% increased performance in explosive and propellant applications; develop novel small scale rapid experimental assessment methodologies and apply these methodologies to characterize novel energetic material candidates and formulations to assess enhancements in both range and lethality. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.			
Title: Modeling and Simulation of Energetics and Munitions ***Description:*** This effort develops, codes, and subsequently employs advanced models to predict multiscale response of energetic materials for both propellant and explosive purposes. Develops new simulation methods for understanding and design of advanced concepts and energetic formulations to rapidly iterate and optimize towards increased range and enhanced lethality. ***FY 2021 Plans:*** Continue to investigate improved predictive capability for gun interior ballistics design into energetics and munitions software and equation of state and reactivity from first principles into the warhead design continuum software suite; will design simulation results with and transitioned to formulators and advanced concept designers. ***FY 2022 Plans:*** Will further develop novel grain scale modeling capability for inclusion into engineering continuum scale codes for explosive applications; predict expanded sets of chemical kinetic rates for usage in continuum propulsion software for modeling of novel propellants and propulsion concepts; support synthesis and formulation chemists in the prediction of material properties prior to synthesis through the development of machine learning toolsets. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.	1.627	1.787	1.804
Title: Advanced Weapon Concepts ***Description:*** This effort investigates new propellants and grain designs, burn rate/combustion modifier ingredients, as well as new gun and munition designs for extended range. ***FY 2021 Plans:***	1.445	1.573	1.588

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602141A / *Lethality Technology*	**Project (Number/Name)** AH6 / *Disruptive Energetics and Propulsion Technologies*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
Continues to develop and assess advanced additively manufactured propellant designs and geometries to produce higher muzzle energy, longer range gun launched munitions; develops new gun geometries to maximize muzzle velocity while decreasing system weight. ***FY 2022 Plans:*** Will develop, validate, and transition novel weapon concepts, advanced additively manufactured propellant designs, printing technologies, and solid fuel ramjet concepts to partners to enable extended ranges, higher muzzle velocities, and reduced system mass. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.			
Accomplishments/Planned Programs Subtotals	7.934	8.124	8.413

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army			Date: May 2021
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602141A / *Lethality Technology*	**Project (Number/Name)** AH7 / *Lethal and Scalable Effects Technologies*	

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
AH7: *Lethal and Scalable Effects Technologies*	-	1.792	1.018	1.911	-	1.911	-	-	-	-	-	-

A. Mission Description and Budget Item Justification

Work in this Project designs, determines and assesses technology options for scaling warhead lethality and providing extreme efficiency for highly effective, simultaneous mixed/multi target defeat and collateral damage. This Project will also design and assess scalable structure defeat to mitigate collateral damage for disruptive urban Warfighting. This research is coordinated with Project AH5 (Projectile and Multi-Function Warhead Technologies) and Project AH6 (Disruptive Energetics and Propulsion Technologies) within this PE and builds upon disruptive energetic and ballistic sciences research in PE 06011102A Defense Research Sciences / Project AA7 (Mechanics and Ballistics). The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy. Work in this Project is performed by the United States (US) Army Futures Command (AFC).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
Title: Munition Efficiency and Scalability	1.792	1.018	1.911

Description: This effort investigates, designs, determines, and assesses technologies to produce blast-fragment warheads with tailored fragment geometries to optimize target defeat. This effort identifies and develops warhead impact patterns to optimize target defeat with reduced collateral damage. This effort also designs, models, and assesses technologies for the cost effective, preprogrammed delivery of multiple scalable warheads capable of simultaneously engaging multiple targets. This effort leverages guidance technologies from PE 0602147A (Long Range Precision Fires) / Project AH4 (Precision and Coop Weapons in a Denied Env Tech), and metal additive manufacturing from PE 0602144A (Ground Technology) / Project BL1 (Materials and Manufacturing Research Technology).

FY 2021 Plans:
Conduct experiments, simulations, and analytic analyses to determine spatial and temporal requirements to achieve synergistic effects; continue to design high fidelity models to optimize munition for mixed target sets and improved models for weapons effects in urban environments; perform vulnerability and lethality studies to select lethal mechanisms for modular munitions.

FY 2022 Plans:
Will continue conducting experiments and lethality studies, will select promising materials and mechanisms for preliminary component-level terminal ballistic experiments; will design and develop devices incorporating improved metals and energetics and integrate concepts into warheads for assessments in full-scale experiments.

FY 2021 to FY 2022 Increase/Decrease Statement:

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602141A / *Lethality Technology*	**Project (Number/Name)** AH7 / *Lethal and Scalable Effects Technologies*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
Funding change in FY22 reflects planned lifecycle of this effort.			
Accomplishments/Planned Programs Subtotals	1.792	1.018	1.911

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army			Date: May 2021
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602141A / *Lethality Technology*	**Project (Number/Name)** AH8 / *Lethality Materials and Processes 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
AH8: *Lethality Materials and Processes Technology*	-	3.791	4.007	4.019	-	4.019	-	-	-	-	-	-

A. Mission Description and Budget Item Justification

Work in this Project designs, determines , and assesses innovative materials solutions aimed at achieving leap ahead increases in lethality and weapons effectiveness through improvements in weight and volume efficiency, lethal effects, and sustainability of military systems. This research is coordinated with Projects AH6 (Disruptive Energetics and Propulsion Technology) and Project AH7 (Lethal and Scalable Effects Technologies) within this PE, and PE 0602147A (Long Range Precision Fires Technology) / AH4 (Precision and Cooperative Weapons in a Denied Environment) and builds upon and ballistic sciences research in PE 0601102A (Defense Research Sciences) / Project AA7 (Mechanics and Ballistics).

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy. Work in this Project is performed by the United States (US) Army Futures Command (AFC).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
Title: Materials for Advanced Lethality	3.791	4.007	4.019
Description: This effort researches innovative materials aimed at achieving leap-ahead increases in lethality and weapons effectiveness through improvements in weight and volume efficiency, lethal effects, and sustainability of military systems that can only be achieved through advances in materials technology.			
FY 2021 Plans: Conduct performance testing on C-C composites to withstand the high temperature regimes of large caliber gun launch and flight while retaining structural integrity; conduct three-dimensional printing at 100 micron resolution optimized with energetic propellants to achieve designed progressive burn rates sufficient to increase projectile speeds and ranges in support of PE 0602147A (Long Range Precision Fires Technology).			
FY 2022 Plans: Will develop algorithms to design novel geometries of propellant grains that give progressive or other novel burn behaviors to increase projectile speeds and ranges; assess the effect of ceramic powder modifications for long wave infrared transmission capability on the material toughness and light transmission in the this regime.			
FY 2021 to FY 2022 Increase/Decrease Statement: Funding change reflects planned lifecycle of this effort.			
Accomplishments/Planned Programs Subtotals	3.791	4.007	4.019

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602141A / *Lethality Technology*	**Project (Number/Name)** AH8 / *Lethality Materials and Processes Technology*

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army												Date: May 2021
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602141A / *Lethality Technology*				Project (Number/Name) AH9 / *Advanced Warheads 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
AH9: *Advanced Warheads Technology*	-	9.030	22.933	25.032	-	25.032	-	-	-	-	-	-

A. Mission Description and Budget Item Justification

This Project explores multiple pathways to enhance lethal efforts for future warheads against emerging peer/near peer target sets. Investigates synergistic effects of novel micro warheads using advance materials. This Project investigates innovative energetic materials and novel processing techniques for the next generation of explosives and propulsion applications to enable an increase in range, lethality, and utility of munitions. It also directly supports Army Modernization Priorities through researching and developing energetic (propellant) technologies and processes for increased performance, expanded operation temperature bounds, and improved safety and environmental compliance of missile systems.

Work in this Project complements PE 0602147A (Long Range Precision Fires Technology) / AG6 (Energetic Materials and Advanced Processing Techno), PE 0603464A (Long Range Precision Fires Advanced Technology / AG7 (Energetic Materials and Adv Processing Adv Tech),PE 0602150A (Air and Missile Defense Technology), PE 0602148A (Future Vertical Lift Technology), and 0602145A (Next Generation Combat Vehicle Technology).

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

Work in this Project is performed by the United States (US) Army Futures Command (AFC).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
Title: Advanced Warheads	9.030	10.488	10.763
Description: This effort explores multiple pathways to enhance lethal effects for future warheads against emerging peer/near peer target sets; Investigates synergistic effects of novel warheads using advanced concepts of operations, materials, geometries, and manufacturing processes.			
FY 2021 Plans: Investigate reactive materials and advanced fragmentation technology to increase lethality by imparting additional energy and enhanced effects on target; investigate novel structural materials and tunable warhead technologies that will provide additional lethality while enabling survivability in high-g gun environments.			
FY 2022 Plans: Will continue to investigate reactive and novel materials including advanced fragmentation designs for integration in warheads that can survive high-g gun environments during projectile launch. Will investigate advanced manufacturing methods, designs and materials for warhead and lethal mechanism concepts to create advances in lethality at increased range and standoff across a broad spectrum of applications. Will investigate advanced Explosively Formed Penetrators (EFP) concepts for increased			

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602141A / *Lethality Technology*	**Project (Number/Name)** AH9 / *Advanced Warheads Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
performance. Will design and develop advanced Modeling and Simulation capabilities using deep learning methods to optimize Shape Charge, Fragmentation and EFP Designs. Will conduct experiments to validate these materials and designs for integration into future munition projects. Will investigate the utility of novel warhead geometries for increased lethality in distributed scenarios. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Funding decrease due to realignment to PE 0602141A / Project AH9 Advanced Pyrotechnics for exploration of novel pyrotechnic technologies for application across all Army priorities.			
Title: Advanced Energetics ***Description:*** This effort develops advanced energetic materials and novel processing techniques for future explosives and propulsion applications that enable an increase in range, lethality, and utility of ammunitions. ***FY 2021 Plans:*** Develop nano-energetic component technologies for use in melt-cast formulations. Develop polymer kinetics for amorphous energetics; investigate next-generation melt-cast and cast-cure ingredients for higher energy formulations. Investigate reaction kinetics for ingredient synthesis. Investigate energetic materials to enable novel energy release mechanisms; design and develop processing parameters necessary to produce energetic materials for additive manufacturing; develop new techniques to accurately predict energetic materials performance in novel and unique geometries ***FY 2022 Plans:*** Will investigate novel energetic materials; will conduct experiments of enhanced lethality explosive formulations; will conduct experiments of enhanced novel propellant formulations. Will mature advanced initiation concepts and conduct experiments of high energy formulations in representative munitions. Will validate processing parameters necessary to produce energetic materials for additive manufacturing; will investigate modeling and simulation tools required to accurately predict energetic materials performance in novel and unique geometries. Will investigate analytical and experimental capabilities to characterize advanced energetic materials. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.	-	11.246	12.810
Title: Energetics (Propellants) ***Description:*** This effort investigates new and emerging energetic ingredients and processes for propellant formulations to enable enhanced performance and mission flexibility by extending the reach and effects of tactical and strategic missile systems. ***FY 2021 Plans:***	-	1.199	-

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602141A / *Lethality Technology*	**Project (Number/Name)** AH9 / *Advanced Warheads Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
Investigate current and future substances that provide higher delivered specific impulse density in rocket propellants; novel binders (both energetic and inert); advanced processing techniques to improve mass fraction; investigate improved combustion properties to improve efficiency. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.			
Title: Advanced Pyrotechnics ***Description:*** This effort investigates compositions, components, and technologies to provide novel pyrotechnic formulations and devices to increase overall system performance and survivability. Coordinates research, strategic assessments and development of novel pyrotechnic technologies that will enable disruptive capabilities for Multidomain Operations. This effort supports the Army Modernization Priorities. ***FY 2022 Plans:*** Will investigate novel pyrotechnic materials, components, and configurations. Will investigate pyrotechnic concepts and evaluate the performance and effectiveness for military utility. Will conduct experiments on pyrotechnic components and formulations supporting Army Modernization and Multi-Domain Operations. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Funding increase due to realignment to PE 0602141A / Project AH9 Advanced Warheads for exploration of novel pyrotechnic technologies for application across all Army priorities.	-	-	1.459
Accomplishments/Planned Programs Subtotals	9.030	22.933	25.032

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army												Date: May 2021
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602141A / *Lethality Technology*				Project (Number/Name) AI1 / *Advanced Terrain Shaping 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**
AI1: *Advanced Terrain Shaping Technology*	-	-	4.902	-	-	-	-	-	-	-	-	-

Note

In FY 2022, this Project is realigned to:
PE 0602141A Lethality Technology
*Project CF8 Terminal Effects Against Critical Targets Tech

A. Mission Description and Budget Item Justification

This Project designs and develops engineering tools and high-fidelity modeling and simulation capabilities for materials and structural response to predict high-velocity weapons performance to ensure lethality against structures and critical assets. Through dynamic impact experiments for a broad range of velocities against conventional and advanced structural materials, this project develops engineering tools and technologies to rapidly evaluate and predict weapon performance.

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

Work in this Project is performed by the United States (U.S.) Engineer Research and Development Center (ERDC) in coordination with U.S. Army Futures Command (AFC).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
Title: Advanced Terminal Weapons Effects Technology ***Description:*** This effort develops and validates terminal weapons effects prediction capabilities for Long Range Precision Fires (LRPF) weapons against geomaterials, structures, and other critical assets. ***FY 2021 Plans:*** Conduct laboratory and field experiments to develop and validate modeling and simulation capabilities for accurate prediction of terminal effects and lethality; design and develop fast running engineering tools to support LRPF weapon design optimization and performance evaluation; and design critical structural targets with advanced protective materials to validate weapon performance. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Funding change in FY22 reflects planned lifecycle of this effort; beginning in FY22, work continues under PE 0602141A Project CF8 (Terminal Effects Against Critical Targets Tech).	-	4.902	-
Accomplishments/Planned Programs Subtotals	-	4.902	-

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602141A / *Lethality Technology*	**Project (Number/Name)** AI1 / *Advanced Terrain Shaping Technology*

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army												Date: May 2021
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602141A / *Lethality Technology*				Project (Number/Name) BS6 / *Lethality Technology (CA)*			
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
BS6: *Lethality Technology (CA)*	-	43.000	76.500	-	-	-	-	-	-	-	-	-

Note

Congressional Interest Item funding provided for Lethality Technology.

A. Mission Description and Budget Item Justification

Congressional Interest Item funding provided for Lethality Technology.

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021
Congressional Add: Medium Range Railgun Weapon System ***FY 2020 Accomplishments:*** Program Increase supported applied research on Medium Range Railgun Weapon System. Work executed by Army Futures Command.	20.000	-
Congressional Add: Additive Manufacturing Research ***FY 2020 Accomplishments:*** Program Increase supported applied research on Additive Manufacturing Research. Work executed by Army Futures Command.	5.000	-
Congressional Add: Mobile Environment Contaminant Sensors ***FY 2020 Accomplishments:*** Program Increase supported applied research on Mobile Environment Contaminant Sensors. Work executed by Army Futures Command.	5.000	-
Congressional Add: Hybrid Additive Manufacturing ***FY 2020 Accomplishments:*** Program Increase supported applied research on Hybrid Additive Manufacturing. Work executed by Army Futures Command.	8.000	-
Congressional Add: Next Generation Air-Breathing Propulsion Technology	5.000	-

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602141A / *Lethality Technology*	**Project (Number/Name)** BS6 / *Lethality Technology (CA)*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021
FY 2020 Accomplishments: Program Increase supported applied research on Next Generation Air-Breathing Propulsion Technology. Work executed by Army Futures Command.		
Congressional Add: Program increase - next generation remote sensing ***FY 2021 Plans:*** Conduct applied research in Next Generation Remote Sensing. Work executed by Army Futures Command.	-	5.000
Congressional Add: Program increase - Advanced lethality concepts and analysis ***FY 2021 Plans:*** Conduct applied research in Advanced Lethality Concepts and Analysis. Work executed by Army Futures Command.	-	7.500
Congressional Add: Program increase - counter UAS technology in arctic environments ***FY 2021 Plans:*** Conduct applied research in Counter UAS Technology in Artic Environments. Work executed by Army Futures Command.	-	10.000
Congressional Add: Program Increase- Hybrid additive manufacturing ***FY 2021 Plans:*** Conduct applied research in Hybrid Additive Manufacturing. Work executed by Army Futures Command.	-	10.000
Congressional Add: Program increase - novel and sustainable energetic materials ***FY 2021 Plans:*** Conduct applied research in Novel and Sustainable Energetic Materials. Work executed by Army Futures Command.	-	24.000
Congressional Add: Program increase - quantum technologies for armament systems ***FY 2021 Plans:*** Conduct applied research in Quantum Technologies for Armament Systems. Work executed by Army Futures Command.	-	10.000
Congressional Add: Program increase - solid fuel propulsion technology	-	10.000

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602141A / *Lethality Technology*	**Project (Number/Name)** BS6 / *Lethality Technology (CA)*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021
FY 2021 Plans: Conduct applied research in Solid Fuel Propulsion Technology. Work executed by Army Futures Command.		
Congressional Adds Subtotals	43.000	76.500

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army			Date: May 2021
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602141A / *Lethality Technology*	**Project (Number/Name)** CF7 / *Solid-state Laser Concepts and Architectures*	

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
CF7: *Solid-state Laser Concepts and Architectures*	-	-	-	7.547	-	7.547	-	-	-	-	-	-

Note

This effort has been realigned from PE0602150A Project AD2 in FY 2022.

A. Mission Description and Budget Item Justification

This Project provides the research and development of advanced solid-state laser materials and architectures to support the Army Directed Energy Strategy for laser-based directed energy (DE) weapons. This Project investigates advanced laser technologies based on unconventional solid-state laser concepts and designs, scalable and intelligent power modules, and advanced thermal management systems for the development of less complex, low size, weight, and power (SWaP) Army DE weapons and tactical lasers with much improved capabilities.

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy. Work in this Project is performed by the United States (US) Army Futures Command (AFC).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
Title: High Energy Laser (HEL) Enabling Technologies for Tactical Directed Energy Weapons	-	-	7.547
Description: Investigate novel solid-state laser concepts, architectures, and components in support of the Army?s HEL weapons strategy.; develop innovative laser gain materials with much improved spectral, thermal, thermo-mechanical, and thermo-optical properties; and develops increased power while reducing size and weight, and complexity of all HEL components			
FY 2022 Plans: Will further explore the potential of fiber laser power scaling based on crystalline core/crystalline cladding (C4) fiber designs, as it pertains to power scaling to a 5 kW power level, continuous wave (CW); design and develop new high power pump couplers with reduced insertion loss and advanced heat management; investigate advanced fiber end-capping techniques, enabling power scaling out of a single fiber aperture well beyond the current state-of-the-art; model and analyze wide band gap semiconductor performance in the power switching system with the goal of providing higher efficiency.			
FY 2021 to FY 2022 Increase/Decrease Statement: This effort has been realigned from PE0602150A Project AD2 in FY 2022.			
Accomplishments/Planned Programs Subtotals	-	-	7.547

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602141A / *Lethality Technology*	**Project (Number/Name)** CF7 / *Solid-state Laser Concepts and Architectures*

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army			Date: May 2021
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602141A / *Lethality Technology*	**Project (Number/Name)** CF8 / *Terminal Effects Against Critical Targets Tech*	

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
CF8: *Terminal Effects Against Critical Targets Tech*	-	-	-	4.040	-	4.040	-	-	-	-	-	-

Note

In Fiscal Year (FY) 2022, this Project is realigned from: PE 0602141A Lethality Technology, *Project AI1 Advanced Terrain Shaping Technology

A. Mission Description and Budget Item Justification

This Project designs and develops engineering tools and high-fidelity modeling and simulation capabilities for materials and structural response to predict and enhance weapons performance to ensure lethality against structures and critical assets. Through dynamic impact experiments for a broad range of velocities against conventional and advanced structural materials, this project develops engineering tools and technologies to rapidly evaluate and predict weapon performance.

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

Work in this Project is performed by the United States (U.S.) Engineer Research and Development Center (ERDC) in coordination with U.S. Army Futures Command (AFC).

Work in this Project complements PE 0603116A (Lethality Advanced Technology) / Project CH5 (Terminal Effects Against Critical Targets Adv Tech).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
Title: Advanced Terminal Weapons Effects Technology	-	-	4.040
Description: This effort develops and validates terminal weapons effects prediction capabilities for Long Range Precision Fires (LRPF) weapons against geomaterials, structures, and other critical assets. ***FY 2022 Plans:*** Will conduct lab and scaled field experiments of blast/fragmentation munitions against critical protective materials; will design and begin development of fast running engineering tools to support LRPF weapon design and performance evaluation; and will investigate Battle Damage Assessment (BDA) using Non-Line-of-Sight (NLOS) imagery. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Funding change in FY22 reflects planned lifecycle of this effort; beginning in FY22, this effort continues research conducted previously under PE 0602141A Project AI1 (Advanced Terrain Shaping Technology) for enhanced battle damage assessment and effectiveness using current and new long range Army weapon systems.			
Accomplishments/Planned Programs Subtotals	-	-	4.040

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602141A / *Lethality Technology*	**Project (Number/Name)** CF8 / *Terminal Effects Against Critical Targets Tech*

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army			Date: May 2021
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602141A / *Lethality Technology*	**Project (Number/Name)** CG4 / *Advanced Radar Concepts and Technologies*	

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
CG4: *Advanced Radar Concepts and Technologies*	-	-	-	4.687	-	4.687	-	-	-	-	-	-

Note

This effort has been realigned from PE0602150A Project AD5 in FY 2022.

A. Mission Description and Budget Item Justification

This Project conducts experiments on single crystal diamond and diamond hetero-structure semiconductor materials, layered structures, and novel devices for Diamond Electronics for Radar, Communications, and improved Size, Weight, and Power (SWaP) Department of Defense systems. Efforts include multiscale modeling, material and structure growth and characterization, and novel device design and fabrication. This research has application to radars, communication systems, electronic warfare, directed energy, electronics for hypersonic systems, radiation hard systems, quantum sensing, and others. This Project directly supports Air and Missile Defense modernization priority capabilities by investigating essential component technologies for insertion into Multi-Mission Army Radar systems. This Project addresses the challenges of integrating new materials into Silicon Complementary Metal Oxide Semiconductor (CMOS) processing flows, and electronics reliability including protection against unintended adversarial use of state-of-the-art semiconductor materials, devices, and systems for Air and Missile Defense in contested environments.

Work in this Project complements PE 0603466A (Air and Missile Defense Advanced Technology) Project AD6 (Next Generation Fires Radar Advanced Technology).

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.
Work in this Project is performed by the United States Army Futures Command (AFC).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
Title: Antennas and RF Device Components for Advanced Electronic Systems	-	-	4.687
Description: Conduct experiments into novel diamond material and device structures operable in the Radio Frequency (RF) electromagnetic spectrum with high radiated power density for increased radar range and better target detection, improved efficiency of communications systems, smaller Size, Weight, and Power (SWaP) for electronics/cooling of autonomous systems, high temperature electronics for hypersonics, and radiation hardened electronics.			
FY 2022 Plans: Will investigate the growth and properties of single crystal diamond and diamond/boron nitride heterostructures, including different carbon-boron-nitrogen compositions, n-type and p-type doping of the alloys, and the generation of defects associated with growth techniques and fundamental studies on chip-scale.			
FY 2021 to FY 2022 Increase/Decrease Statement:			

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602141A / *Lethality Technology*	**Project (Number/Name)** CG4 / *Advanced Radar Concepts and Technologies*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
This effort has been realigned from PE0602150A Project AD6 in FY 2022.			
Accomplishments/Planned Programs Subtotals	-	-	4.687

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army			Date: May 2021
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602141A / *Lethality Technology*	**Project (Number/Name)** CJ1 / *Lethality Enabling University Applied Research*	

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
CJ1: *Lethality Enabling University Applied Research*	-	-	-	5.794	-	5.794	-	-	-	-	-	-

Note

This is a new start in FY 2022.

This project is a FY22 new start. This project was created to demonstrate increased investment in our university partners.

A. Mission Description and Budget Item Justification

The Project leverages research and technological innovations from academia, of lethal directed energy, laser diagnostics and accelerated design of future hypersonics, deep learning (DL) and novel materials of importance to the Army, by accelerating research and conducting experiments focused on getting technology to the warfighter more quickly. This Project performs discovery research efforts to focus more on mid to far-term Army modernization priorities while also maintaining delivery of near-term technologies critical to the Long Range Precision Fires and Air and Missile Defense. This Project focuses on employment of research technologies originating from extramural applied research in academia pertaining to lethal directed energy, laser diagnostics, future hypersonic glide body design, deep learning (DL), novel materials, and expansion of the Ballistic, Aero-Optics and Materials (B.A.M.) range applied to lethality. This effort conducts applied research and development leading to potential emerging technologies in areas of strategic importance to the Army in directed energy, future hypersonic glide body design, deep learning (DL) and novel materials, etc., by bringing competitively selected Universities with research and development teams into Technical Alliances.

Work in this Project supports the Army Modernization Priority Long Range Precision Fires and Air and Missile Defense.

The cited work is consistent with Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

Work in this Project is performed by the United States (US) Army Futures Command.

This work is done in coordination with PE 0602147A (Long Range Precision Fires), PE 0602150A (Air and Missile Defense Technologies)

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
Title: Laser Diagnostics for Hypersonics and Directed Energy	-	-	1.978
Description: This effort researched systematic expansion in laser diagnostics technologies to assess hypersonic turbulence and boundary layer transition. Work is conducted in collaboration with university partners to advance the effects of atmospheric turbulence on laser propagation and gain applied knowledge in directed energy systems effectiveness and range.			
FY 2022 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602141A / *Lethality Technology*	**Project (Number/Name)** CJ1 / *Lethality Enabling University Applied Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
Will investigate methods to expand laser diagnostics and the flight envelope of the existing glide body, accelerate design of block upgrades and future hypersonic glide bodies; reduce flight test risks. Will investigate new backward lasing guidestar methods to improve correction for atmospheric distortion. Will conduct experiments to inform the development of the Ballistic, Aero-Optics and Materials (B.A.M.) range for testing and evaluation of hypersonic and directed energy systems. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** This effort is a new start.			
Title: Turbulence and Transition Modeling and Validation for Hypersonic Vehicles ***Description:*** This effort is conducted in collaboration with university partners to develop modeling tools to help inform the flight envelope of existing hypersonic vehicles to accelerate design of future hypersonic glide bodies. ***FY 2022 Plans:*** Will design and develop modeling techniques to expand the flight envelop and control of the existing glide body. Funds applied research to inform the development of the Ballistic, Aero-Optics and Materials (B.A.M.) range for testing and evaluation of aerothermodynamic performance at hypersonic speeds. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** This effort is a new start.	-	-	1.852
Title: Novel Materials for Extreme Environments ***Description:*** This effort produces a test environment for thermal and ablation evaluation of novel materials relevant to hypersonic vehicles. Work is conducted in collaboration with university partners to assess material characteristics and develop computational models of high strain rate materials to mitigate the effects of high kinetic energy impacts. ***FY 2022 Plans:*** Will develop critical high temperature materials and characterize for the design of thermal protection systems to overmatch from high temperatures and high kinetic energy impacts. Will investigate material ablation models and the effect of material layering on ballistics and hypervelocity impact energy absorption, damage mitigation, and penetration resistance. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** This effort is a new start.	-	-	1.100
Title: Intelligent Hypersonics and Other Vehicle Systems ***Description:*** This effort develops and designs geometrically relevant testing hardware required to study aerothermodynamic performance. Work is conducted in collaboration with university partners to collect experimental data and insights required to	-	-	0.864

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602141A / *Lethality Technology*	**Project (Number/Name)** CJ1 / *Lethality Enabling University Applied Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
train deep learning neural networks used for the development of hypersonic vehicle flight systems with adaptability and increased lethality. ***FY 2022 Plans:*** Will investigate characterization of hardware ablation (or structural deformation) using Mach 5 or above wind tunnel. Will design and develop testing hardware for data collection and training of deep neural network using wind tunnel data and synthetic flight control system of a geometrically relevant vehicle. Will develop intelligent defense vehicle systems using deep learning (DL) algorithms for improved surveillance, detection, and tracking and overcoming line-of-sight constraints. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** This effort is a new start.			
Accomplishments/Planned Programs Subtotals	-	-	5.794

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army			Date: May 2021
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602141A / *Lethality Technology*	**Project (Number/Name)** CJ6 / *Advanced Energetics for Missile Technologies*	

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
CJ6: *Advanced Energetics for Missile Technologies*	-	-	-	1.185	-	1.185	-	-	-	-	-	-

Note

In Fiscal Year (FY) 2022 this Project was realigned from Program Element (PE) 0602141A/AH9 Advanced Warheads Technology.

A. Mission Description and Budget Item Justification

This Project directly supports Army Modernization Priorities through funding research and developing energetic (propellant) technologies and processes for increased performance, expanded operation temperature bounds, and improved safety and environmental compliance of missile systems.

Work in this Project complements PE 0602147A (Long Range Precision Fires Technology), PE 0602150 (Air and Missile Defense Technology); and 0602141A/AH9 Advanced Energetics Technology.

The cited work is consistent with the Assistant Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy. Work in this Project is performed by the United States (US) Army Futures Command (AFC).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
Title: Advanced Energetics Technology (Missiles) ***Description:*** This effort investigates new and emerging energetic ingredients and processes for propellant formulations to enable enhanced performance and mission flexibility by extending the reach and effects of tactical and strategic missile systems. ***FY 2022 Plans:*** Will investigate current and future substances that provide higher delivered specific impulse density in rocket propellants; novel binders (both energetic and inert); will mature processing techniques to improve mass fraction; and will investigate explore concepts for improved combustion properties to improve efficiency. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Fiscal Year (FY) 2022 this Project was realigned from Program Element (PE) 0602141A/AH9 Advanced Warheads Technology	-	-	1.185
Accomplishments/Planned Programs Subtotals	-	-	1.185

C. Other Program Funding Summary ($ in Millions)

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602141A / *Lethality Technology*	**Project (Number/Name)** CJ6 / *Advanced Energetics for Missile Technologies*

C. Other Program Funding Summary ($ in Millions)

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army			Date: May 2021
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602141A / *Lethality Technology*	**Project (Number/Name)** CJ7 / *Future Air Defense Missile Enabling Tech*	

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
CJ7: *Future Air Defense Missile Enabling Tech*	-	-	-	1.498	-	1.498	-	-	-	-	-	-

Note

In Fiscal Year (FY) 2022 this Project was realigned from Program Element (PE) 0602150A/AD3 Manuever Air Defense Technology, Task Future Air Defense Missile Enabling Technology.

A. Mission Description and Budget Item Justification

This project investigates, develops, and evaluates critical missile technologies and components necessary for advanced lethal capability in support of future/mid to far term affordable short range air defense interceptor capability to defeat Cruise Missile (CM), Rotary Wing (RW), Tactical / Lethal Unmanned Aerial System (UAS), and Fixed Wing (FW) threats. This effort designs and develops technologies to provide advanced materials for reduced size weight and power and cost for Maneuver Short Range Air Defense (MSHORAD), Short Range Air Defense (SHORAD), and Lower Tier essential to maintain overmatch against mid-/far-term threats. This project supports Air and Missile Defense Modernization priority efforts.

This research is coordinated with Project PE 602141A Lethality Technology /CJ6 (Advanced Energetics for Missile Technologies); PE 0602147A Long Range Precision Fires Technology /AF3 (Extended Range Propulsion) and AF8 (Affordable Extended Range Precision). The research complements PE 602150A Air and Missile Defense Technology /AD3 (Manuever Air Defense Technology) and PE 0603466A Air and Missile Defense Advanced Technology / AD4 (Maneuver Air Defense Advanced Technology).

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

Work in this Project is performed by the United States Army Futures Command (AFC).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
Title: Future Air Defense Missile Enabling Technology	-	-	1.498
Description: Designs and develops reduced cost advanced Air Defense missile critical components essential to maintain overmatch against mid/far term Maneuver-Short Range Air Defense (M-SHORAD), SHORAD, and Lower Tier threats.			
FY 2022 Plans: Will conduct component level trade studies and will investigate reduced space, weight, power and cost designs for improved future Air Defense missile seeker, guidance and control, aerostructures, and propulsion technologies.			
FY 2021 to FY 2022 Increase/Decrease Statement:			

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602141A / *Lethality Technology*	**Project (Number/Name)** CJ7 / *Future Air Defense Missile Enabling Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
Realigned from Program Element (PE) 0602150A/AD3 Manuever Air Defense Technology, Task Future Air Defense Missile Enabling Technology;			
Accomplishments/Planned Programs Subtotals	-	-	1.498

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A