Exhibit R-2, RDT&E Budget Item Justification: PB 2023 Defense Advanced Research Projects Agency	Date: April 2022
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide I* BA 3: *Advanced Technology Development (ATD)*	**R-1 Program Element (Number/Name)** PE 0603286E *I ADVANCED AEROSPACE SYSTEMS*

COST ($ in Millions)	Prior Years	FY 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total	FY 2024	FY 2025	FY 2026	FY 2027	Cost To Complete	Total Cost
Total Program Element	-	216.283	194.043	253.135	-	253.135	200.933	200.546	225.320	238.057	-	-
AIR-01: *ADVANCED AEROSPACE SYSTEMS*	-	216.283	194.043	253.135	-	253.135	200.933	200.546	225.320	238.057	-	-
Quantity of RDT&E Articles	-	-	-	-	-	-	-	-	-	-		

A. Mission Description and Budget Item Justification

The Advanced Aerospace Systems program element, budgeted in the Advanced Technology Development Budget Activity, is focused on exploiting high pay-off opportunities to provide revolutionary new system capabilities, as opposed to incremental or evolutionary advancements, in order to achieve undeterrable air presence at dramatically reduced costs. Rapid prototyping and experimentation of integrated system concepts, as well as enabling vehicle subsystems will be conducted. Programs will explore new architectural concepts that employ a mix of weapon technologies that achieve lethality through a combination of overwhelming performance and overwhelming numbers rather than through the use of singular and costly high value assets. Studies conducted under this program element include examination and evaluation of emerging aerospace threats, technologies, concepts, use of autonomy to minimize risk, and applications for missiles, munitions, and vehicle systems.

B. Program Change Summary ($ in Millions)	FY 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total
Previous President's Budget	223.478	174.043	0.000	-	0.000
Current President's Budget	216.283	194.043	253.135	-	253.135
Total Adjustments	-7.195	20.000	253.135	-	253.135
• Congressional General Reductions	0.000	0.000			
• Congressional Directed Reductions	0.000	0.000			
• Congressional Rescissions	0.000	0.000			
• Congressional Adds	0.000	20.000			
• Congressional Directed Transfers	0.000	0.000			
• Reprogrammings	0.000	0.000			
• SBIR/STTR Transfer	-7.195	0.000			
• Adjustments to Budget Year	-	-	253.135	-	253.135

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2021	FY 2022
Project: AIR-01: *ADVANCED AEROSPACE SYSTEMS*		
Congressional Add: *Advanced Full Range Engine (AFRE) Congressional Add*	2.500	-
Congressional Add: *Hypersonic Risk Reduction (Hypersonic Air breathing Weapon Concept) - Congressional Add*	-	15.000
Congressional Add: *Hypersonic Risk Reduction (Tactical Boost Glide) - Congressional Add*	-	5.000

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Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2021	FY 2022
Congressional Add Subtotals for Project: AIR-01	2.500	20.000
Congressional Add Totals for all Projects	2.500	20.000

Change Summary Explanation

FY 2021: Decrease reflects SBIR/STTR transfer.
FY 2022: Increase reflects a Congressional add for Hypersonic risk reduction.
FY 2023: FY 2023 funding increase reflects the fact that the FY 2022 President's Budget request did not include out-year funding.

C. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023
Title: LongShot	24.000	36.000	36.000
Description: The LongShot program is developing and flight demonstrating an air-launched Unmanned Aerial Vehicle (UAV) capable of engaging multiple adversary targets from standoff ranges using existing air-to-air missiles. LongShot will be deployed either externally from existing fighters or internally from existing bombers. This system will capitalize on a slower speed, fuel-efficient air vehicle for ingress, while retaining highly energetic air-to-air missiles for end-game target engagements, which provides several key benefits that increase weapon effectiveness. This program will address the stability and control challenges of launching air-to-air missiles from a relatively small UAV in an operational environment. Potential transition partners include the Navy and Air Force. ***FY 2022 Plans:*** - Complete preliminary design of the Demonstration System and conduct preliminary design review. - Complete Wind Tunnel Testing of the Demonstration Air Vehicle. - Conduct missile separation test. - Initiate System Integration Laboratory setup and testing. ***FY 2023 Plans:*** - Conduct risk reduction testing and requirements verification and validation events to mature the demonstration system design. - Complete critical design of the demonstration system and conduct critical design review. - Initiate demonstration system fabrication, integration, assembly, and test.			
Title: Series Hybrid Electric Propulsion AircRaft Demonstrator (SHEPARD)	16.770	23.000	22.000
Description: The Series Hybrid Electric Propulsion AircRaft Demonstrator (SHEPARD) program is designing and developing an efficient Hybrid Electric Propulsion (HEP) system and integrating it into a unique military aircraft application. The innovative aircraft design will include essential operational considerations and mission system components. The program employs a rapid development framework that capitalizes on maturing mission-enabling technologies to quickly meet emergent mission needs while			

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C. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023
overcoming significant system-level technical challenges. The result will be a flight-demonstrated system with a minimal viable mission capability that is developed quickly and at relatively low cost. ***FY 2022 Plans:*** - Conduct propulsion component testing. - Begin aircraft fabrication. - Conduct system integration lab testing. - Develop test plans and range coordination. ***FY 2023 Plans:*** - Complete aircraft fabrication. - Conduct a flight test series. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** The FY 2023 decrease reflects completion of aircraft fabrication.			
Title: Glide Breaker ***Description:*** Glide Breaker is developing and demonstrating a critical component technology to support a lightweight vehicle designed for precise engagement of hypersonic threats at very long range. Glide Breaker focuses on a single, critical, long-lead technology with applicability to a variety of interceptor concepts and designs. The development of the component technology will initiate with ground testing, followed by testing in a wind tunnel to develop a performance database to inform future designs and execution of a sounding rocket flight test to demonstrate the technology in a relevant hypersonic free flight environment. ***FY 2022 Plans:*** - Conduct ground demonstration of component technologies. - Initiate design of sounding rocket test article design for flight test of component technology. ***FY 2023 Plans:*** - Conduct wind tunnel testing of component to develop performance database in relevant aerothermal environment. - Complete preliminary design of flight test article. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** The FY 2023 increase reflects transition from demonstration of a component to prepare for integrated flight demonstration in a relevant aero-thermal environment.	7.000	7.000	18.250
Title: Advanced Aerospace System Concepts	3.000	3.000	3.200

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C. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023
Description: Studies conducted under this program examine and evaluate emerging aerospace technologies and system concepts for applicability to military use. This includes the degree and scope of potential impact and improvements to military operations, mission utility, and warfighter capability. Studies are also conducted to analyze emerging aerospace threats along with possible methods and technologies to counter them. The feasibility of achieving potential improvements, in terms of resources, schedule, and technological risk, is also evaluated. The results from these studies are used, in part, to formulate future prototype development programs or refocus ongoing work. Topics include: methods of defeating enemy anti-aircraft attacks; munition technologies to increase precision, range, endurance, and lethality of weapons for a variety of mission sets; novel launch systems; air vehicle control, power, propulsion, materials, and architectures; and payload and cargo handling systems. ***FY 2022 Plans:*** - Examine operational utility of novel aerospace system concepts. - Assess feasibility and practicality of developmental aerospace subsystems. - Perform modeling and simulation that support future concepts and novel architectures. ***FY 2023 Plans:*** - Assess ability of novel aerospace propulsion concepts to be integrated into feasible and practical weapons. - Refine concepts for integration of cross-domain air dominance solutions. - Integrate advanced aerospace systems concepts and technologies into realistic capability demonstrations. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** The FY 2023 increase reflects emphasis on studies related to advanced propulsion concepts leading to critical technologies enabling novel weapons delivery.			
Title: Liberty Lifter	-	-	31.000
Description: The Liberty Lifter program is designing and demonstrating a runway independent, large payload, survivable aircraft capable of extended on-water operations and flight both in and out of ground effect. Critical to an effective aircraft of this type is a robust sea plane capability to operate in high sea states as well as an innovative manufacturing approach that dramatically reduces vehicle acquisition costs. The vehicle is anticipated to be survivable against peer threats due to the combination of extremely low altitude operations and speeds significantly higher than ships. The ability to deploy amphibious cargo while on the water will minimize exposure time and enable a wide variety of mission capabilities in the maritime and air domains. The Liberty Lifter program is envisioned to transition a full-scale technology demonstrator to military service partners for continued testing and development activities. The Liberty Lifter program is building upon technologies developed in the Advanced Aeronautics and Space Technologies program budgeted in PE 0602702E, Project TT-07. ***FY 2023 Plans:***			

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C. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023
- Conduct design and analysis activities leading to a conceptual design. - Initiate preliminary design and analysis activities. - Conduct risk reduction activities. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** The FY 2023 increase reflects program initiation.			
Title: Tactical Boost Glide	74.663	50.043	30.000
Description: The Tactical Boost Glide (TBG) program is a Joint DARPA / Air Force effort developing and demonstrating technologies to enable air-launched tactical range hypersonic boost glide systems, including flight demonstration of a vehicle that is traceable to an operationally relevant weapon that can be launched from current platforms. The program will also consider traceability, compatibility, and integration with the Navy Vertical Launch System (VLS). The metrics associated with this objective include total range, time of flight, payload, accuracy, and impact velocity. The program will address the system and technology issues required to enable development of a hypersonic boost glide system considering (1) vehicle concepts possessing the required aerodynamic and aero-thermal performance, controllability and robustness for a wide operational envelope, (2) the system attributes and subsystems required to be effective in relevant operational environments, and (3) approaches to reducing cost and improving affordability for both the demonstration system and future operational systems. TBG capabilities are planned for transition to the Air Force and the Navy. ***FY 2022 Plans:*** - Complete Engineering Review Board (ERB) activities for flight test 1 investigation. - Complete corrective-action design verification and qualification testing for return to flight. - Complete Assembly, Integration, and Test (AI&T) of second and third flight-test vehicle. - Conduct test readiness review (TRR) for second and third flights, conduct second flight test, and complete post-flight analysis. - Complete Navy variant weapon datalink (WDL) critical design. - Conduct Navy variant weapon datalink (WDL) lab verification test. - Complete Navy variant guidance electronic unit (GEU) critical design. - Conduct four Navy variant GEU captive flight tests and complete post-test analysis. - Complete materials arc-jet testing. - Complete second TBG performer's engineering component and system-level testing and design verification testing. - Complete second TBG performer's material and thermo-structural risk reduction testing, including structural model validation test, and full-scale hot structure test. ***FY 2023 Plans:***			

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C. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023
- Conduct third flight test and complete post-test analysis. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** The FY 2023 decrease reflects move to final assembly integration and third test flight.			
Title: Control of Revolutionary Aircraft with Novel Effectors (CRANE) ***Description:*** The Control of Revolutionary Aircraft with Novel Effectors (CRANE) program is demonstrating revolutionary improvements in aircraft controls technology. The program will design, build, and flight test an aircraft able to fly and maneuver at altitude relying on state-of-the-art Active Flow Control (AFC) technology. AFC is a broad term that encompasses a range of technology approaches; it includes a number of control mechanisms which alter the aerodynamic flow field thru ejection or suction of fluid via an orifice on a lifting body. An emphasis of the program is on assessing AFC component technologies, risk reduction and experimentation, integrated testing, fabrication and demonstration of a relevant scale novel and innovative aircraft. Technologies, design tools and models developed and demonstrated under this program will be made available to all Services as well as the civilian aerospace sector for application to future air systems development. Prior to FY 2023, this program was funded in PE 0602702E, Project TT-07. ***FY 2023 Plans:*** - Complete detailed design, flight software, and control law development. - Conduct system critical design review. - Begin subsystems integration and begin fabrication of a demonstration aircraft. - Initiate airworthiness and ground/flight test approvals supporting testing of the X-Plane. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** The FY 2023 increase reflects maturation of program from PE 0602702E, Project TT-07, into detailed design and fabrication of the demonstration aircraft.	-	-	52.685
Title: Operational Fires ***Description:*** The Operational Fires (OpFires) program is developing and demonstrating a novel ground-launched system enabling advanced tactical weapons to penetrate modern enemy air defenses, and rapidly and precisely engage critical time-sensitive targets. This program will develop an advanced booster capable of delivering a variety of payloads at a variety of ranges. Additional considerations include the need for compatible mobile ground launch platforms enabling integration with existing ground forces and infrastructure, and specific system attributes required for rapid deployment and redeployment. The program will conduct an engineering flight test to demonstrate the critical technologies in a relevant environment. Those lessons will be captured in an integrated weapon system critical design review for a potential follow-on effort developing a full prototype. OpFires will leverage and integrate ongoing investments in hypersonics to achieve these objectives.	47.575	45.000	-

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C. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023
FY 2022 Plans: - Complete booster separation, missile control system, and design verification testing. - Complete flight test configuration assembly, integration, test plans and readiness review. - Complete flight test demonstrating canister egress engineering test. - Complete integrated weapon system Critical Design Review (CDR). ***FY 2022 to FY 2023 Increase/Decrease Statement:*** The FY 2023 decrease reflects program completion.			
Title: Hypersonic Air-breathing Weapon Concept (HAWC) ***Description:*** The Hypersonic Air-breathing Weapon Concept (HAWC) program is a Joint DARPA / Air Force effort developing and demonstrating technologies for an effective and affordable air-launched hypersonic cruise missile. These technologies include advanced air vehicle configurations capable of efficient hypersonic flight, hydrocarbon scramjet-powered propulsion to enable sustained hypersonic cruise, thermal management approaches designed for high-temperature cruise, and affordable system designs and manufacturing approaches. Investments may lead into developments in aerodynamics, propulsion, and payload capacity, and algorithms that support maneuvering and target recognition. This is a joint program with the Air Force, and HAWC technologies are planned for transition to the Air Force after flight-testing is complete. ***FY 2022 Plans:*** - Complete flight tests. - Complete flight test data analysis and final program review. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** The FY 2023 decrease reflects completion of flight tests and program completion.	30.880	10.000	-
Title: MoHAWC ***Description:*** The MoHAWC program builds off the demonstrator system design, technology advances and lessons learned under the Hypersonic Airbreathing Weapon Concept (HAWC) and supporting technology maturation programs. MoHAWC will develop, integrate, and demonstrate technologies to increase effectiveness and producibility of an air-launched hypersonic cruise missile. These technologies include advancing hydrocarbon scramjet-powered propulsion operation, shrinking navigation components, upgrading aircraft integration algorithms, and improving manufacturing approaches. Flight tests will expand the operational envelope. This program will collaborate with Navy and Air Force science and technologies efforts to meet future technology insertion dates for service programs of record ***FY 2023 Plans:***	-	-	60.000

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C. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023
- Incorporate HAWC lessons learned into the cruiser design. - Initiate procurement of long lead components for four flight test systems. - Complete subsystem technology risk reduction efforts. - Begin assembly, integration, and ground testing of cruisers. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** The FY 2023 increase reflects need to initiate a program to leverage, integrate, and demonstrate DARPA technologies into a hypersonic weapon.			
Title: Advanced Full Range Engine (AFRE) ***Description:*** The Advanced Full Range Engine (AFRE) program demonstrated turbine-based combined cycle (TBCC) technologies to establish the feasibility of a hypersonic reusable propulsion system. Specifically, AFRE demonstrated key components of the TBCC propulsion system at low speed where turbine propulsion is used, at high speed where a dual-mode ramjet (DMRJ) is used, and at turbine-to-DMRJ transition conditions. Large-scale components of this complex propulsion system were developed and demonstrated independently and experimentation focused on regimes where the propulsion system smoothly transitions from low-speed turbine only operation to high-speed DMRJ-only operation. AFRE will enable future airfield-based hypersonic systems to operate without special logistics considerations, resulting in transformational changes in long-range strike, high-speed Intelligence, Surveillance and Reconnaissance (ISR) and Two-Stage-To-Orbit (TSTO) operations. The anticipated transition partner for this effort is the Air Force.	9.895	-	-
Accomplishments/Planned Programs Subtotals	213.783	174.043	253.135

	FY 2021	FY 2022
Congressional Add: Advanced Full Range Engine (AFRE) Congressional Add ***FY 2021 Accomplishments:*** - Completed facility preparation, hardware installation, and ground test of full-scale combustor (DMRJ) at mode-transition conditions. - Initiated facility preparations and hardware installation for ground test of full-scale combustor (DMRJ) at mode-transition and high-Mach conditions.	2.500	-
Congressional Add: Hypersonic Risk Reduction (Hypersonic Air breathing Weapon Concept) - Congressional Add ***FY 2022 Plans:*** - Complete second and third flight tests. - Complete flight test data analysis and final program review.	-	15.000
Congressional Add: Hypersonic Risk Reduction (Tactical Boost Glide) - Congressional Add	-	5.000

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	FY 2021	FY 2022
FY 2022 Plans: - Test range support for flight test 2. - Glider build up and initial system integration for flight test 3.		
Congressional Adds Subtotals	2.500	20.000

D. Other Program Funding Summary ($ in Millions)

N/A

Remarks

E. Acquisition Strategy

N/A