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Exhibit R-2, RDT&E Budget Item Justification: PB 2024 Defense Advanced Research Projects Agency **Date:** March 2023

Appropriation/Budget Activity 0400: <i>Research, Development, Test & Evaluation, Defense-Wide / BA 3: Advanced Technology Development (ATD)</i>	R-1 Program Element (Number/Name) PE 0603286E / <i>ADVANCED AEROSPACE SYSTEMS</i>
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COST (\$ in Millions)	Prior Years	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total	FY 2025	FY 2026	FY 2027	FY 2028	Cost To Complete	Total Cost
Total Program Element	-	184.206	241.015	331.753	-	331.753	361.051	352.546	325.500	251.468	-	-
AIR-01: <i>ADVANCED AEROSPACE SYSTEMS</i>	-	184.206	241.015	331.753	-	331.753	361.051	352.546	325.500	251.468	-	-
Quantity of RDT&E Articles	-	-	-	-	-	-	-	-	-	-		

A. Mission Description and Budget Item Justification

The efforts described in this Program Element (PE) address the Advanced Technology Development associated with the Advanced Aerospace Systems Program that 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)

	<u>FY 2022</u>	<u>FY 2023</u>	<u>FY 2024 Base</u>	<u>FY 2024 OCO</u>	<u>FY 2024 Total</u>
Previous President's Budget	194.043	253.135	200.933	-	200.933
Current President's Budget	184.206	241.015	331.753	-	331.753
Total Adjustments	-9.837	-12.120	130.820	-	130.820
• Congressional General Reductions	0.000	-12.120			
• 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	-2.910	0.000			
• SBIR/STTR Transfer	-6.927	0.000			
• TotalOtherAdjustments	-	-	130.820	-	130.820

Congressional Add Details (\$ in Millions, and Includes General Reductions)

Project: AIR-01: *ADVANCED AEROSPACE SYSTEMS*

Congressional Add: *Hypersonic Risk Reduction (Hypersonic Air breathing Weapon Concept) - Congressional Add*

Congressional Add: *Hypersonic Risk Reduction (Tactical Boost Glide) - Congressional Add*

	FY 2022	FY 2023
	15.000	-
	5.000	-

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Congressional Add Details (\$ in Millions, and Includes General Reductions)	FY 2022	FY 2023
Congressional Add Subtotals for Project: AIR-01	20.000	-
Congressional Add Totals for all Projects	20.000	-

Change Summary Explanation

FY 2022: Decrease reflects SBIR/STTR transfer and reprogrammings.

FY 2023: Decrease reflects a Congressional reduction to Reduce Growth.

FY 2024: Increase reflects initiation of the SPeed and Runway INdependent Technologies (SPRINT) X-Plane Demonstration Project, Artificial Intelligence (AI) Reinforcements (AIR) and AdvaNced airCRAFT Infrastructure-Less Launch And RecoverY (ANCILLARY) programs, the development of an updated guidance electronic unit (GEU) for Tactical Boost Glide, and the shift from design to demonstration and testing activities for Glide Breaker and LongShot.

C. Accomplishments/Planned Programs (\$ in Millions)	FY 2022	FY 2023	FY 2024
<p>Title: LongShot</p> <p>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.</p> <p>FY 2023 Plans:</p> <ul style="list-style-type: none"> - 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. <p>FY 2024 Plans:</p> <ul style="list-style-type: none"> - Complete fabrication of flight test vehicles and integrate onto host aircraft. - Conduct captive carry testing of the flight test vehicle. - Conduct initial series of flight demonstrations validating separation of air-to-air missile from host flight test vehicle. <p>FY 2023 to FY 2024 Increase/Decrease Statement: The FY 2024 increase reflects the shift from design to the fabrication, testing, and demonstration of the flight test vehicle.</p>	36.000	36.000	44.038
<p>Title: Glide Breaker</p>			

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C. Accomplishments/Planned Programs (\$ in Millions)	FY 2022	FY 2023	FY 2024
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<p>Description: Glide Breaker is developing and demonstrating a propulsion technology to support a lightweight vehicle designed for hit-to-kill engagement of hypersonic threats at very long range. Glide Breaker will first demonstrate a divert and attitude control system (DACS) to enable a kill vehicle capable of intercepting hypersonic threats during glide phase. The program will then quantify jet interaction effects between the DACS plumes and the hypersonic cross flow by conducting wind tunnel and flight tests. Results of these tests will culminate into a divert propelled flight test of a vehicle at conditions relevant to glide-phase intercept of a hypersonic threat.</p> <p>FY 2023 Plans:</p> <ul style="list-style-type: none"> - Conduct ground demonstrations of integrated divert and attitude control system (DACS) designs. - Initiate preliminary design of sounding rocket test article for flight test of propulsion technology. <p>FY 2024 Plans:</p> <ul style="list-style-type: none"> - Conduct cold-gas wind tunnel testing of aero bodies with divert jets to develop performance database in relevant aerodynamic environment. - Conduct hot-gas wind tunnel testing of aero bodies with divert jets to develop performance database in relevant aerothermal environment. - Complete detailed design of flight test article. - Initiate procurement of long lead items leading to a demonstration vehicle. <p>FY 2023 to FY 2024 Increase/Decrease Statement: The FY 2024 increase reflects the shift from design of the test article to long lead procurement and wind tunnel testing.</p>			
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<p>Title: Tactical Boost Glide</p> <p>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.</p> <p>FY 2023 Plans:</p>	50.043	30.000	81.500
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C. Accomplishments/Planned Programs (\$ in Millions)		FY 2022	FY 2023	FY 2024
<ul style="list-style-type: none"> - Continue assembly, integration, and test (AI&T) of additional test vehicles. - Conduct test readiness reviews (TRR), conduct flight tests, and complete post-test analyses. - Conduct Navy variant subsystem lab verification testing. - Conduct additional development and system-level testing of Navy variant guidance electronic unit (GEU) and complete post-test analysis. - Complete second TBG performer's materials arc-jet testing. - Complete second TBG performer's engineering component and system-level 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. - Complete second TBG performer's final reporting and program close-out activities. <p>FY 2024 Plans:</p> <ul style="list-style-type: none"> - Complete first TBG performer's phase 2 analysis. - Complete Navy variant subsystem lab verification test. - Initiate update to glider design to accommodate GEU and additional subsystem. - Initiate operational flight program (OFP) and six degree-of-freedom (6DoF) simulations. - Initiate GEU design update. - Begin procurement of long lead hardware for GEU. - Initiate additional subsystem design update. - Begin procurement of long lead hardware for additional subsystem. <p>FY 2023 to FY 2024 Increase/Decrease Statement: The FY 2024 increase is for an updated GEU and additional subsystem integration and test.</p>				
<p>Title: Advanced Aerospace System Concepts</p> <p>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.</p> <p>FY 2023 Plans:</p>		3.000	3.200	3.360

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C. Accomplishments/Planned Programs (\$ in Millions)	FY 2022	FY 2023	FY 2024
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<ul style="list-style-type: none"> - 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. <p>FY 2024 Plans:</p> <ul style="list-style-type: none"> - Examine and refine rocket, airbreathing, and combined air vehicle architectures, concepts of operations, and propulsion and vehicle technology. - Demonstrate integrated cross-domain air dominance solutions. - Develop deeper understanding of hybrid aerodynamics and propulsion concepts to enable future technology demonstrations. <p>FY 2023 to FY 2024 Increase/Decrease Statement: FY 2024 increase reflects minor program repricing.</p>			
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<p>Title: Control of Revolutionary Aircraft with Novel Effectors (CRANE)</p> <p>Description: The Control of Revolutionary Aircraft with Novel Effectors (CRANE) program will develop and demonstrate 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.</p> <p>FY 2023 Plans:</p> <ul style="list-style-type: none"> - Complete detailed design, flight software, and control law development. - Conduct subsystem and component level risk reduction testing. - Begin subsystems integration and fabrication of a demonstration aircraft. - Initiate airworthiness and ground/flight test approvals supporting testing of the demonstration aircraft. <p>FY 2024 Plans:</p> <ul style="list-style-type: none"> - Complete system critical design review. - Complete fabrication and subsystem integration of a demonstration aircraft. - Complete airworthiness and ground/flight test approvals. 	-	40.565	44.500
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C. Accomplishments/Planned Programs (\$ in Millions)		FY 2022	FY 2023	FY 2024
- Initiate ground test of the demonstration aircraft.				
FY 2023 to FY 2024 Increase/Decrease Statement: The FY 2024 increase reflects demonstration aircraft development, integration and demonstration.				
Title: Liberty Lifter		-	31.000	42.310
Description: The Liberty Lifter program will design and demonstrate 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 will build upon technologies developed in the Advanced Aeronautics and Space Technologies program budgeted in PE 0602702E, Project TT-07.				
FY 2023 Plans:				
- Conduct design and analysis activities leading to Conceptual Design Review (CoDR) for multiple concepts.				
- Initiate preliminary design and analysis activities.				
- Conduct risk reduction activities.				
FY 2024 Plans:				
- Complete system preliminary design review.				
- Initiate critical design and analysis activities.				
- Conduct manufacturing plan review detailing overall approach to vehicle fabrication, integration, and assembly.				
- Conduct test planning review detailing test plan approach through completion of the flight test campaign.				
FY 2023 to FY 2024 Increase/Decrease Statement: The FY 2024 increase reflects detailed design activities and subsystem testing as the program moves from conceptual design to a detailed system.				
Title: SPeed and Runway INdependent Technologies (SPRINT) X-Plane Demonstration Project		-	-	22.663
Description: The SPeed and Runway INdependent Technologies (SPRINT) X-Plane Demonstration Project will develop and demonstrate the fundamental technologies needed for combined high speed and vertical take-off and landing (VTOL) capabilities in a single aircraft. This program culminates in the fabrication and flight test of a scaled demonstrator that validates the critical technologies in a representative environment and reduces technical, schedule and cost risk for a follow-on operational system.				

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C. Accomplishments/Planned Programs (\$ in Millions)		FY 2022	FY 2023	FY 2024
<p>High speed VTOL aircraft are highly desired in a variety of military missions such as infiltration/exfiltration, contested personnel recovery, troop transport and armed escort, however, the thresholds for speed and range have evolved with military strategy and mission needs. The SPRINT Demonstrator is envisioned to transition to military service members for further risk reduction flight testing.</p> <p>FY 2024 Plans:</p> <ul style="list-style-type: none"> - Conduct design and analysis activities leading to Conceptual Design Review (CoDR) for multiple concepts. - Initiate preliminary design and analysis activities. - Initiate simulations, component testing, subsystem testing, manufacturing planning and flight test planning. <p>FY 2023 to FY 2024 Increase/Decrease Statement: The FY 2024 increase reflects program initiation.</p>				
<p>Title: Artificial Intelligence (AI) Reinforcements (AIR)</p> <p>Description: AI Reinforcements (AIR) will develop and demonstrate dominant tactical autonomy for multi-ship, beyond visual range, real-world air combat missions. This program is focused on developing highly accurate models that are orders of magnitude faster than present state-of-the-art and then using those models to unlock novel and robust AI-driven autonomy approaches. An operations-centric development approach will be enabled through usage of human-on-the-loop F-16 testbeds. On piloted platforms, AIR's algorithms will automate tactical control tasks transforming junior pilots from low-level tacticians into high-level mission commanders. For unpiloted platforms, AIR will enable vehicles to perform missions with minimal human oversight. The outcome of this program will be an AI air combat capability that works in dynamic, operationally representative environments. The transition partner is the U.S. Air Force.</p> <p>FY 2024 Plans:</p> <ul style="list-style-type: none"> - Evaluate current sensor and aircraft models and the ability to use them in high-speed simulation. - Establish pipelines to incorporate feedback from flight test data into underlying Modeling and Simulation (M&S) tools. - Develop AI algorithms that work on testbed aircraft. - Establish framework for M&S and interfaces with testbed aircraft. - Incorporate F-16 testbeds into the AIR integration and testing pipeline and iterate development through live flight testing. <p>FY 2023 to FY 2024 Increase/Decrease Statement: The FY2024 increase reflects program initiation.</p>		-	-	21.082
<p>Title: AdvanCed airCRAFT Infrastructure-Less Launch And RecoverY (ANCILLARY)</p> <p>Description: The AdvanCed airCRAFT Infrastructure-Less Launch And RecoverY (ANCILLARY) program will develop and flight demonstrate an X-plane with the critical technologies required for a leap-ahead in long endurance, vertical takeoff and</p>		-	-	13.200

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C. Accomplishments/Planned Programs (\$ in Millions)		FY 2022	FY 2023	FY 2024
<p>landing (VTOL) unmanned air system (UAS) performance. The UAS should be able to launch and recover from small ship flight decks and austere land locations in adverse weather without additional infrastructure equipment, thus enabling expeditionary deployments.</p> <p>FY 2024 Plans:</p> <ul style="list-style-type: none"> - Conduct design and analysis activities leading to Conceptual Design Review (CoDR) for multiple concepts. - Complete Preliminary Design Reviews (PDRs) for multiple performer X-Plane designs. - Conduct risk reduction activities. <p>FY 2023 to FY 2024 Increase/Decrease Statement: The FY 2024 increase reflects program initiation.</p>				
<p>Title: Series Hybrid Electric Propulsion AirCraft Demonstrator (SHEPARD)</p> <p>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 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.</p> <p>FY 2023 Plans:</p> <ul style="list-style-type: none"> - Complete aircraft fabrication. - Conduct vehicle integration and taxi tests. - Complete flight test series. - Conduct a mission demonstration. <p>FY 2023 to FY 2024 Increase/Decrease Statement: The FY 2024 decrease reflects program completion.</p>		23.000	22.000	-
<p>Title: Operational Fires</p> <p>Description: The Operational Fires (OpFires) program developed and demonstrated 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 developed an advanced booster capable of delivering a variety of payloads at a variety of ranges. Additional considerations included 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 conducted an engineering flight test to demonstrate the critical technologies in a relevant environment. Those lessons were</p>		25.000	-	-

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C. Accomplishments/Planned Programs (\$ in Millions)		FY 2022	FY 2023	FY 2024
captured in an integrated weapon system critical design review for a potential follow-on effort developing a full prototype. OpFires leveraged and integrated ongoing investments in hypersonics to achieve these objectives.				
Title: Hypersonic Air-breathing Weapon Concept (HAWC) Description: The Hypersonic Air-breathing Weapon Concept (HAWC) program was a Joint DARPA / Air Force effort developing and demonstrating technologies for an effective and affordable air-launched hypersonic cruise missile. These technologies included 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 was a joint program with the Air Force.		14.163	-	-
Title: MoHAWC Description: 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. This program builds off the demonstrator system design, technology advances and lessons learned under the Hypersonic Airbreathing Weapon Concept (HAWC) and supporting technology maturation programs. FY 2023 Plans: - Initiate procurement of long lead components for multiple flight test systems. - Complete subsystem technology risk reduction efforts. - Begin demonstrator assembly, integration, and ground testing. FY 2024 Plans: - Complete demonstrator assembly, integration, and ground testing. - Complete multiple flight tests. - Complete flight test data analysis and final program review. FY 2023 to FY 2024 Increase/Decrease Statement: The FY 2024 decrease reflects the shift from procurement and building of test units to flight testing and transition.		-	60.000	30.000
Accomplishments/Planned Programs Subtotals		164.206	241.015	331.753

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	FY 2022	FY 2023
Congressional Add: Hypersonic Risk Reduction (Hypersonic Air breathing Weapon Concept) - Congressional Add FY 2022 Accomplishments: - Conducted flight tests and data analysis. - Completed second and third flight tests. - Completed flight test data analysis and final program review. - Transitioned demonstrator system design, technology advances and lessons learned to MoHAWC.	15.000	-
Congressional Add: Hypersonic Risk Reduction (Tactical Boost Glide) - Congressional Add FY 2022 Accomplishments: - Completed test range support for flight testing. - Continued glider build up and initial system integration for subsequent flight test.	5.000	-
Congressional Adds Subtotals	20.000	-

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

N/A

Remarks

E. Acquisition Strategy

N/A