Exhibit R-2, RDT&E Budget Item Justification: PB 2023 Air Force											Date: April 2022	
Appropriation/Budget Activity 3600: *Research, Development, Test & Evaluation, Air Force* / BA 7: *Operational Systems Development*					R-1 Program Element (Number/Name) PE 0101328F / *ICBM Reentry Vehicles*							
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	77.231	108.625	96.313	118.616	0.000	118.616	368.449	640.795	835.562	854.140	Continuing	Continuing
674920: *W87-1/Mk21A*	77.231	108.625	96.313	118.616	0.000	118.616	368.449	640.795	698.244	595.010	248.117	2,951.400
675920: *Next Generation Reentry Vehicle**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	137.318	259.130	Continuing	Continuing
Program MDAP/MAIS Code: 576												

*This project's R-2a exhibit has been suppressed due to funding not beginning until after FY 2023

A. Mission Description and Budget Item Justification

The Intercontinental Ballistic Missile (ICBM) Reentry Vehicles (RVs) program will design, develop, produce, and deploy an integrated RV capable of delivering the W87-1 Warhead and future warheads when released from the Ground Based Strategic Deterrent (GBSD) ICBM.

The Mk21A program will meet the requirements laid out in the GBSD Capability Development Document (CDD) as directed by Air Force Global Strike Command, and will provide needed performance and security enhancements over the Mk21 RV to meet the upgraded requirements for the Department of Energy W87-1 Warhead. The Mk21A RV includes: high velocity nose tip; high impulse transducer; arming and fuzing assembly; aeroshell forward section, body section, and rear cover; radio frequency subsystem with antennas; RV spin-up system; in-flight disconnect cable; and other electrical cables.

The major activities in the Mk21A RV Technology Maturation and Risk Reduction (TMRR) phase include: (1) Trade Studies, (2) Prototype designs, (3) government systems engineering, analytics, and test capability development, (4) RV risk reduction, and (5) Weapon System (WS) integration risk reduction.

During the Engineering and Manufacturing Development (EMD) phase, the Mk21A program will include prime contractor development of a critical RV design, applicable support equipment, data, flight test hardware, infrastructure, and training materials while examining and mitigating weapon system integration risks, nuclear surety, hardness and certification, and system vulnerability assessments. Additionally, the program, in conjunction with the National Nuclear Security Administration, will develop test assets to ensure the integration and qualification of the Mk21A and W87-1 on GBSD.

The Next Generation Reentry Vehicle (NGRV) will meet requirements for future RVs in alignment with the Air Force's RV strategy to maintain continued effectiveness as technology matures. Future RV programs will be able to integrate with current and/or future warheads.

This program element may include necessary civilian pay expenses required to manage, execute, and deliver weapon system capability. The use of such programs funds would be in addition to the civilian pay expenses budgeted in program elements 0605831F and 0605833F. In FY2021 $2.681M was expended for civilian pay expenses in this program element, and in FY2022 $2.838M is forecasted for civilian pay expenses in this program element.

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This program is in Budget Activity 7, Operational System Development because this budget activity includes development efforts to upgrade systems that have been fielded or have received approval for full rate production and anticipate production funding in the current or subsequent fiscal year.

B. Program Change Summary ($ in Millions)	FY 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total
Previous President's Budget	112.547	96.313	0.000	0.000	0.000
Current President's Budget	108.625	96.313	118.616	0.000	118.616
Total Adjustments	-3.922	0.000	118.616	0.000	118.616
• Congressional General Reductions	0.000	0.000			
• Congressional Directed Reductions	0.000	0.000			
• Congressional Rescissions	0.000	0.000			
• Congressional Adds	0.000	0.000			
• Congressional Directed Transfers	0.000	0.000			
• Reprogrammings	0.000	0.000			
• SBIR/STTR Transfer	-3.922	0.000			
• Other Adjustments	0.000	0.000	118.616	0.000	118.616

Change Summary Explanation

FY2021 funding reflects a Small Business Innovation Research (SBIR) adjustment of $3.922 million.

The FY2022 President's Budget submittal did not reflect FY2023 through FY2026 funding. Therefore, an explanation of the change between the two budget positions for FY2023 cannot be made in a relevant manner.

Exhibit R-2A, RDT&E Project Justification: PB 2023 Air Force			Date: April 2022
Appropriation/Budget Activity 3600 / 7	R-1 Program Element (Number/Name) PE 0101328F / *ICBM Reentry Vehicles*	Project (Number/Name) 674920 / *W87-1/Mk21A*	

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
674920: *W87-1/Mk21A*	77.231	108.625	96.313	118.616	0.000	118.616	368.449	640.795	698.244	595.010	248.117	2,951.400
Quantity of RDT&E Articles	-	-	-	-	-	-	-	-	-	-		

A. Mission Description and Budget Item Justification

The Mk21A Reentry Vehicle (RV) program will design, develop, produce, and deploy an integrated RV capable of delivering the W87-1 Warhead when released from the Ground Based Strategic Deterrent (GBSD) Intercontinental Ballistic Missile (ICBM). The Mk21A program will provide needed performance and security enhancements over the Mk21 RV to meet the upgraded requirements for the Department of Energy W87-1 Warhead, while ensuring the time certain delivery of both the W87-1 and Mk21A programs. The Mk21A will also meet the requirements laid out in the GBSD Capability Development Document (CDD) as directed by Air Force Global Strike Command. The Mk21A RV includes: high velocity nose tip; high impulse transducer; arming and fuzing assembly; aeroshell forward section, body section, and rear cover; radio frequency subsystem with antennas; RV spin-up system; in-flight disconnect cable; and other electrical cables.

The major activities in the Mk21A RV Technology Maturation and Risk Reduction (TMRR) phase include: (1) Trade Studies, (2) Prototype designs, (3) government systems engineering, analytics, and test capability development, (4) RV risk reduction, and (5) Weapon System (WS) integration risk reduction.

During the Engineering and Manufacturing Development (EMD) phase, the Mk21A program will include prime contractor development of a critical RV design, applicable support equipment, data, flight test hardware, infrastructure, and training materials while examining and mitigating weapon system integration risks, nuclear surety, hardness and certification, and system vulnerability assessments. Additionally, the program, in conjunction with the National Nuclear Security Administration, will develop test assets to ensure the integration and qualification of the Mk21A and W87-1 on GBSD.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023
Title: Mk21A Technology Maturation Risk Reduction	108.625	96.313	84.045
Description: The objectives of TMRR for Mk21A are as follows: (1) Deliver one preliminary design and three prototypes for flight testing to inform National Nuclear Security Administration/ Department of Energy designs and further technology maturation (2) Incorporate a modular, open systems architecture (3) Implement Model Based System Engineering (MBSE) enabling the government to own the technical baseline (4) Demonstrate performance of weapon system capabilities through prototyping, modeling, simulation, and testing (5) Conduct flight test of prototype RVs in an ICBM-like environment			
FY 2022 Plans: • Continue TMRR contract efforts			

Exhibit R-2A, RDT&E Project Justification: PB 2023 Air Force		Date: April 2022
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023
• Continue to modify, modernize, and expand the analytic environment and labs in ongoing TMRR support and the anticipated transition to EMD activities to enable full execution of the program's capability to own the technical baseline throughout the program life cycle • Continue to mature the weapon system RV preliminary design and reduce integration risk by initiating/conducting trade studies, system engineering, test activities, and system modeling and simulation • Continue/complete development of demonstration flight RV • Continue to develop and execute a unified certification strategy which meets nuclear surety, cyber security, and nuclear safety requirements • Conduct prototype RV flight test • Conduct activities to mitigate RV development risks • Continue to expand and develop analytical, information technology, test, and data management capabilities to ensure access to weapon system design information is properly controlled and securely transmitted between government and contractors ***FY 2023 Plans:*** • Conclude TMRR contract efforts • Modify, modernize, and expand the analytic environment and labs in ongoing TMRR support and the anticipated transition to EMD activities to enable full execution of the program's capability to own the technical baseline throughout the program life cycle • Finalize weapon system RV preliminary design and reduce integration risk by concluding trade studies, system engineering, test activities, and system modeling and simulation • Continue to develop, mature, and execute a unified certification strategy which meets nuclear surety, cyber security, and nuclear safety requirements • Conduct prototype RV flight test • Continue activities to mitigate RV development risks • Continue to expand and develop analytical, information technology, test, and data management capabilities to ensure access to weapon system design information is properly controlled and securely transmitted between government and contractors • Conduct planning and test activities in preparation to integrate the Mk21A onto GBSD ***FY 2022 to FY 2023 Increase/Decrease Statement:*** Funding decreased due to the completion of TMRR efforts and transition to EMD.			
Title: Mk21A Engineering & Manufacturing Development ***Description:*** The objectives of EMD for Mk21A are as follows: (1) Develop and build a Mk21A RV capable of delivering National Nuclear Security Administration/Department of Energy W87-1 (2) Incorporate a modular, open systems architecture (3) Implement MBSE enabling the government to own the technical baseline (4) Demonstrate performance of weapon system capabilities through modeling, simulation, and testing of the EMD design	-	-	34.571

Exhibit R-2A, RDT&E Project Justification: PB 2023 Air Force		Date: April 2022
Appropriation/Budget Activity 3600 / 7	**R-1 Program Element (Number/Name)** PE 0101328F / *ICBM Reentry Vehicles*	**Project (Number/Name)** 674920 / *W87-1/Mk21A*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023
(5) Integrate Mk21A/W87-1 into the GBSD weapon system ***FY 2023 Plans:*** • Award EMD contract • Execute the EMD contract to advance Mk21A major activities to include systems engineering activities, information technology, data management, analytical capabilities and delivery of mature, low risk reentry vehicle design • Develop test assets supporting the qualification of the Mk21A and W87-1 on GBSD • Begin GBSD integration activities to support delivery of the Mk21A and W87-1 • Continue activities to mitigate RV development risks • Continue to develop, mature, and execute a unified certification strategy which meets nuclear surety, cyber security, and nuclear safety requirements ***FY 2022 to FY 2023 Increase/Decrease Statement:*** Funding increased due to the completion of TMRR and transition to EMD.			
Accomplishments/Planned Programs Subtotals	108.625	96.313	118.616

C. Other Program Funding Summary ($ in Millions)

Line Item	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
• RDTE 04 PE 0605230F: *Ground Based Strategic Deterrent*	1,397.485	2,553.541	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	3,951.026
• RDTE 05 PE 0605238F: *Ground Based Strategic Deterrent EMD*	0.000	0.000	3,614.290	-	3,614.290	3,614.629	3,255.759	3,190.113	2,628.739	4,439.300	20,742.830
• MPAF 01 MGBSD0: *GBSD*	0.000	10.895	0.000	-	0.000	610.586	502.720	5,689.931	6,410.554	48,355.610	61,580.296
• RDTE 05 0604933F/655082: *Fuze Modernization*	151.158	129.709	98.376	-	98.376	72.756	14.329	0.000	0.000	0.000	466.328
• RDTE 04 060351F/641022: *Dem/Val - RVAP*	10.456	18.166	13.042	-	13.042	0.000	0.000	0.000	0.000	Continuing	Continuing
• RDTE 04 0603851F: *Intercontinental Ballistic Missile - Dem/Val*	0.162	23.433	29.253	-	29.253	16.717	28.424	7.821	7.995	Continuing	Continuing

Remarks

Prototype RV Flight Test #2 costs are shared between the Mk21A and ICBM Demonstration/Validation program elements to meet combined interests.

Exhibit R-2A, RDT&E Project Justification: PB 2023 Air Force		Date: April 2022
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D. Acquisition Strategy

The Mk21A RV program acquisition strategy delivers an integrated RV capable of delivering the W87-1 Warhead to target beginning in FY30. For the TMRR phase, the Program Office competitively awarded one cost plus fixed fee contract in October 2019. The Air Force is responsible for developing, producing, and maintaining the RV. The NNSA develops/modifies the nuclear weapon inside the RV, including the Weapon Electrical System, which is the firing set that interfaces with the DoD fuze. Mk21A includes the use of Mk21 Mod 6 aeroshells which were originally developed as test vehicles for the legacy Peacekeeper ICBM and must be modified for use as war reserve aeroshells. Mk21A subsystems include the nose tip, high impulse transducer, arming and fuzing assembly, aeroshell forward section/body section and rear cover, radio frequency subsystem, antennas, spin generators, and cables.

The objectives of TMRR for Mk21A are as follows: (1) deliver one preliminary design and three prototypes; (2) incorporate a modular, open systems architecture; (3) implement MBSE enabling the government to own the technical baseline; (4) demonstrate performance of weapon system capabilities through prototyping, modeling, simulation, and testing; (5) conduct test flight of prototype RVs in an ICBM-like environment.

The TMRR phase includes a System Requirements Review, System Functional Review, Preliminary Design Review, and prototype RV flight test(s). The contractor performs risk reduction and testing on select components to further evolve the design during TMRR, to lower component integration risk during the EMD phase. The TMRR contract is a three year based contract plus a one year option with test related activities through 4QFY23.

The objectives of EMD for Mk21A are as follows: (1) develop and build a Mk21A RV capable of delivering the W87-1 Warhead; (2) incorporate a modular, open systems architecture; (3) implement MBSE enabling the government to own the technical baseline; (4) demonstrate performance of weapon system capabilities through prototyping, modeling, simulation, and testing of the EMD design; (5) integrate Mk21A/W87-1 into the GBSD weapon system.

The EMD phase includes an EMD contractor update to the Preliminary Design Review, Critical Design Review, and a Production Readiness Review. Testing includes ground and flight test vehicles which support the integration on GBSD. The contractor will convert Mod 6 (Mk21) to Mod 3 (War Reserve) RVs and perform integration of the W87-1 with the Mk21A and the GBSD weapon system. The EMD/Production & Deployment contract is a thirteen year based contract with EMD efforts through 2QFY27. After Milestone B approval, the EMD contract is planned to be awarded in 4QFY23.

Exhibit R-3, RDT&E Project Cost Analysis: PB 2023 Air Force			Date: April 2022
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Product Development ($ in Millions)

Cost Category Item	Contract Method & Type	Performing Activity & Location	Prior Years	FY 2021 Cost	FY 2021 Award Date	FY 2022 Cost	FY 2022 Award Date	FY 2023 Base Cost	FY 2023 Base Award Date	FY 2023 OCO Cost	FY 2023 OCO Award Date	FY 2023 Total Cost	Cost To Complete	Total Cost	Target Value of Contract
Mk21A TMRR Contractor	C/CPFF	Lockheed Martin : King of Prussia, PA	50.321	68.501	Nov 2020	41.922	Nov 2021	49.474	Nov 2022	-		49.474	0.000	210.218	240.947
GBSD Integration Contract	C/CPIF	Northrop Grumman Sys Corp : El Segundo, CA	0.000	-		-		2.863	Nov 2022	-		2.863	2.770	5.633	-
W87-1 Integration	MIPR	NNSA : Various	0.000	-		-		14.700	Nov 2022	-		14.700	2.819	17.519	-
Mk21A EMD Contract	TBD	TBD : TBD	0.000	-		-		21.804	Aug 2023	-		21.804	1,114.296	1,136.100	-
		Subtotal	50.321	68.501		41.922		88.841		-		88.841	1,119.885	1,369.470	N/A

Remarks

• Unless specifically noted, the efforts within this cost category cover both TMRR and EMD phases of the program.

Support ($ in Millions)

Cost Category Item	Contract Method & Type	Performing Activity & Location	Prior Years	FY 2021 Cost	FY 2021 Award Date	FY 2022 Cost	FY 2022 Award Date	FY 2023 Base Cost	FY 2023 Base Award Date	FY 2023 OCO Cost	FY 2023 OCO Award Date	FY 2023 Total Cost	Cost To Complete	Total Cost	Target Value of Contract
Mk21A Fuze Trade Study (TMRR)	MIPR	Sandia National Lab : Albuquerque, NM	1.913	-		-		-		-		-	0.000	1.913	-
Mk21A TMRR Support: PMA (TMRR)	Various	Various : Various	0.347	0.238	Nov 2020	0.550	Nov 2021	0.348	Nov 2022	-		0.348	9.554	11.037	-
Mk21A Integration Support: BAE (TMRR)	C/FP	BAE : Hill AFB, UT	4.404	3.047	Oct 2020	3.766	Oct 2021	-		-		-	0.000	11.217	-
Mk21A Integration Support: ISC	C/TBD	TBD : TBD	0.000	-		-		3.700	Oct 2022	-		3.700	39.734	43.434	-
Mk21A Integration Support: FFRDC/UARC (TMRR)	MIPR	Various : Various	0.987	-		2.304	Nov 2021	1.261	Nov 2022	-		1.261	8.750	13.302	-
Mk21A Direct Cite Civilian Pay	Various	US Gov Civilians : Hill AFB, UT	1.596	2.681	Oct 2020	2.838	Oct 2021	3.055	Oct 2022	-		3.055	32.253	42.423	-
Digital and Model Based System Engineering Support	TBD	TBD : TBD	0.000	-		-		1.035	Oct 2022	-		1.035	7.235	8.270	-

Exhibit R-3, RDT&E Project Cost Analysis: PB 2023 Air Force		Date: April 2022
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Support ($ in Millions)

Cost Category Item	Contract Method & Type	Performing Activity & Location	Prior Years	FY 2021 Cost	FY 2021 Award Date	FY 2022 Cost	FY 2022 Award Date	FY 2023 Base Cost	FY 2023 Base Award Date	FY 2023 OCO Cost	FY 2023 OCO Award Date	FY 2023 Total Cost	Cost To Complete	Total Cost	Target Value of Contract
Mk21A EMD Support	Various	TBD : TBD	0.000	-		-		2.806	Aug 2023	-		2.806	669.105	671.911	-
		Subtotal	9.247	5.966		9.458		12.205		-		12.205	766.631	803.507	N/A

Remarks

• Mk21A Fuze Effort incorporated into the Mk21A TMRR Contract starting in FY21.
• FFRDC/UARC costs began to be included as a separate line item under support costs beginning in FY21. Costs were previously included under Mk21A Test and Evaluation line item.
• Unless specifically noted, the efforts within this cost category cover both TMRR and EMD phases of the program.

Test and Evaluation ($ in Millions)

Cost Category Item	Contract Method & Type	Performing Activity & Location	Prior Years	FY 2021 Cost	FY 2021 Award Date	FY 2022 Cost	FY 2022 Award Date	FY 2023 Base Cost	FY 2023 Base Award Date	FY 2023 OCO Cost	FY 2023 OCO Award Date	FY 2023 Total Cost	Cost To Complete	Total Cost	Target Value of Contract
Mk21A Test & Evaluation	Various	Various : Various	7.523	27.549	Nov 2020	37.120	Nov 2021	12.516	Nov 2022	-		12.516	0.000	84.708	-
Mk21A Test & Evaluation: Air Force and NNSA Demonstrator Initiative (ANDI) (TMRR)	MIPR	Various : Various	8.111	5.835	Oct 2020	4.200	Oct 2021	-		-		-	0.000	18.146	-
Mk21A EMD Test Support	Various	TBD : TBD	0.000	-		-		1.298	Aug 2023	-		1.298	656.230	657.528	-
		Subtotal	15.634	33.384		41.320		13.814		-		13.814	656.230	760.382	N/A

Remarks

• FY22 and FY23 Test & Evaluation support includes developing ground test plans and flight test plans to support development of prototype test vehicles and conduct flight test(s). These test(s) will provide detailed, reliable data to inform EMD and to inform Mk21A development and risk reduction, and NNSA for the W87-1 development.
• The Mk21A Test & Evaluation line includes incremental funding to launch RV prototypes on Rocket Systems Launch Program (RSLP) missiles. Funding for the FY22 flight began in FY20, and funding for the FY23 flight began in FY21. The incremental funding allows contracts to be established for support and the build-up of the flight test vehicles and missiles in order to meet the scheduled tests.
• Mk21A Test & Evaluation: Air Force and NNSA Demonstrator Initiative (ANDI) is a former ICBM Demonstration/Validation study that was transitioned to the Mk21A program office. The ANDI effort is expected to span over FY20, FY21, and FY22 and will provide critical information for EMD.
• Unless specifically noted, the efforts within this cost category cover both TMRR and EMD phases of the program.

Exhibit R-3, RDT&E Project Cost Analysis: PB 2023 Air Force			Date: April 2022
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Management Services ($ in Millions)

Cost Category Item	Contract Method & Type	Performing Activity & Location	Prior Years	FY 2021 Cost	FY 2021 Award Date	FY 2022 Cost	FY 2022 Award Date	FY 2023 Base Cost	FY 2023 Base Award Date	FY 2023 OCO Cost	FY 2023 OCO Award Date	FY 2023 Total Cost	Cost To Complete	Total Cost	Target Value of Contract
Mk21A PMA	C/Various	Various : Various	2.029	0.774	Nov 2020	3.613	Nov 2021	3.756	Nov 2022	-		3.756	7.869	18.041	-
		Subtotal	2.029	0.774		3.613		3.756		-		3.756	7.869	18.041	N/A

Remarks

• The efforts within this cost category cover both TMRR and EMD phases of the program.

	Prior Years	FY 2021		FY 2022		FY 2023 Base		FY 2023 OCO		FY 2023 Total	Cost To Complete	Total Cost	Target Value of Contract
Project Cost Totals	77.231	108.625		96.313		118.616		-		118.616	2,550.615	2,951.400	N/A

Remarks

Exhibit R-4, RDT&E Schedule Profile: PB 2023 Air Force		Date: April 2022
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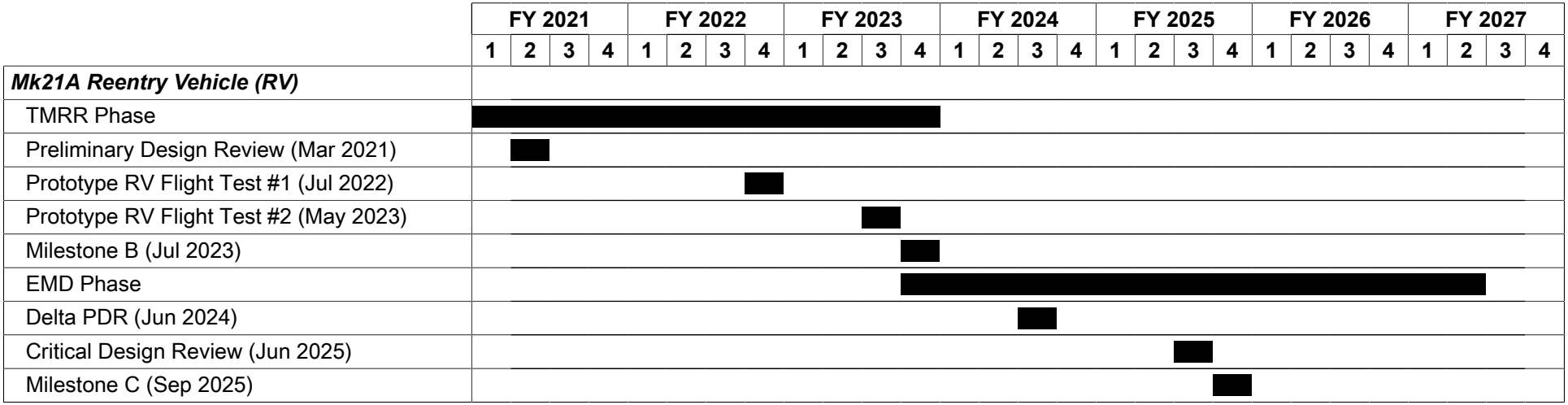

Exhibit R-4A, RDT&E Schedule Details: PB 2023 Air Force		Date: April 2022
Appropriation/Budget Activity 3600 / 7	**R-1 Program Element (Number/Name)** PE 0101328F / *ICBM Reentry Vehicles*	**Project (Number/Name)** 674920 / *W87-1/Mk21A*

Schedule Details

	Start		End	
Events by Sub Project	**Quarter**	**Year**	**Quarter**	**Year**
Mk21A Reentry Vehicle (RV)				
TMRR Phase	1	2021	4	2023
Preliminary Design Review (Mar 2021)	2	2021	2	2021
Prototype RV Flight Test #1 (Jul 2022)	4	2022	4	2022
Prototype RV Flight Test #2 (May 2023)	3	2023	3	2023
Milestone B (Jul 2023)	4	2023	4	2023
EMD Phase	4	2023	2	2027
Delta PDR (Jun 2024)	3	2024	3	2024
Critical Design Review (Jun 2025)	3	2025	3	2025
Milestone C (Sep 2025)	4	2025	4	2025

Note

• TMRR Phase began in 1QFY20

• Flight Tests: flight tests delayed to 4QFY22 (flight test #1) and 3QFY23 (flight test #2) due to range availability; no impact to program

• Due to differing level of complexity of the RV components, the program anticipates aeroshells will start production sooner, while subcomponents like the fuze may remain in development resulting in overlap of EMD and P&D. P&D phase continues beyond FY2027.