Exhibit R-2, RDT&E Budget Item Justification: PB 2022 Air Force												Date: May 2021
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 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	13.747	63.484	112.547	96.313	0.000	96.313	-	-	-	-	-	-
674920: *W87-1/Mk21A*	13.747	63.484	112.547	96.313	0.000	96.313	-	-	-	-	-	-
Quantity of RDT&E Articles	-	-	-	-	-	-	-	-	-	-		
Program MDAP/MAIS Code: 576												

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 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 will also meet the requirements laid out in the Ground Based Strategic Deterrent (GBSD) Capability Development Document (CDD) as directed by Air Force Global Strike Command.

The major activities in the Technology Maturation and Risk Reduction (TMRR) phase of the Mk21A RV program 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. Reentry vehicle components include: high velocity nose tip, high impulse transducer, fuze, aeroshell forward section, body section and rear cover, radio frequency subsystem with antennas, RV spin-up system, inflight disconnect cable, and other electrical cables. The Mk21A program will include prime contractor development of 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.

The FY2022 funding request was reduced by $1.206 million to account for the availability of prior year execution balances.

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 element 0605831F. In FY 2020 $1.199M and in FY2021 $2.959M was expended for civilian pay expenses in this program element.

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.

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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*

B. Program Change Summary ($ in Millions)	FY 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total
Previous President's Budget	65.671	112.753	74.755	0.000	74.755
Current President's Budget	63.484	112.547	96.313	0.000	96.313
Total Adjustments	-2.187	-0.206	21.558	0.000	21.558
• Congressional General Reductions	0.000	-0.206			
• 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	-2.187	0.000			
• Other Adjustments	0.000	0.000	21.558	0.000	21.558

Change Summary Explanation

FY2020 funding reflects a Small Business Innovation Research (SBIR) adjustment of 2.187 million.
FY2022 funding reflects an increase in accordance with the current service cost position.

C. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
Title: Mk21A Technology Maturation Risk Reduction	63.484	112.547	96.313

Description: The objectives of TMRR for Mk21A are as follows:
(1) Deliver one preliminary design and two 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 (OTTB)
(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 2021 Plans:
• Continue TMRR contract efforts
• Continue to modify, modernize, and expand the analytic environment and labs in ongoing TMRR support and the anticipated transition to Engineering and Manufacturing Development (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 conducting system engineering, test activities, and system modeling and simulation
• Continue development of demonstration flight reentry vehicle

Exhibit R-2, RDT&E Budget Item Justification: PB 2022 Air Force	Date: May 2021
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*

C. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
• Continue to develop and execute a unified certification strategy which meets nuclear surety, cyber security, and nuclear safety requirements • Initiate prototype reentry vehicle flight test(s) • 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 • Plan, prepare for, and successfully complete Preliminary Design Review ***FY 2022 Plans:*** • Continue TMRR contract efforts • Continue to modify, modernize, and expand the analytic environment and labs in ongoing TMRR support and the anticipated transition to Engineering and Manufacturing Development (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 reentry vehicle • Continue to develop and execute a unified certification strategy which meets nuclear surety, cyber security, and nuclear safety requirements • Conduct/complete prototype reentry vehicle flight test(s) • 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 • Initiate preparation for TMRR Option year or entrance into Engineering and Manufacturing Development (EMD) ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Funding decreased due to the completion of TMRR trade studies and Preliminary Design Review (PDR) in FY21.			
Accomplishments/Planned Programs Subtotals	63.484	112.547	96.313

D. Other Program Funding Summary ($ in Millions)

Line Item	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
• RDTE 04 0605230F/641025: *Ground Based Strategic Deterrent*	538.643	1,447.113	2,553.541	-	2,553.541	-	-	-	-	-	-
• MPAF 01 MGBSD0: *GBSD*	0.000	0.000	10.895	-	10.895	-	-	-	-	-	-
• RDTE 05 0604933F/655082: *Fuze Modernization*	155.476	156.693	129.709	-	129.709	-	-	-	-	-	-

Exhibit R-2, RDT&E Budget Item Justification: PB 2022 Air Force	Date: May 2021
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*

D. Other Program Funding Summary ($ in Millions)

Line Item	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
• RDTE 04 060351F/641022: *Dem/Val - RVAP*	17.060	22.337	18.166	-	18.166	-	-	-	-	-	-

Remarks

E. Acquisition Strategy

The Mk21A RV program acquisition strategy is to deliver 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.

The objectives of TMRR for Mk21A are as follows: (1) deliver one preliminary design and two prototypes; (2) incorporate a modular, open systems architecture; (3) implement Model Based System Engineering 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 ICBM-like environment.

The TMRR phase will include a System Requirements Review, System Functional Review, Preliminary Design Review, and prototype RV flight test(s). The contractor may elect to perform additional risk reduction testing on select components to further evolve the design during TMRR, to lower component integration risk during the EMD phase. The reference design for the Mk21A includes use of Mk21 Mod 6 aeroshells and is open to similar new aeroshell design due to the recent increase in quantities in the Nuclear Weapons Council's Requirements and Planning Document (RPD). Because Mk21 aeroshells were originally developed as test vehicles for the legacy Peacekeeper ICBM, they must be modified for use as war reserve. All RV subsystems must also be procured, including the high impulse transducer, radio frequency subsystem, antennas, spin generators, and cables.

The TMRR contract is a three year based contract plus a one year option potentially extending TMRR and test related activities through 4QFY23. After Milestone B approval, the EMD contract will be awarded no later than 1QFY24.

Exhibit R-3, RDT&E Project Cost Analysis: PB 2022 Air Force		Date: May 2021
Appropriation/Budget Activity 3600 / 7	**R-1 Program Element (Number/Name)** PE 0101328F / *ICBM Reentry Vehicles*	**Project (Number/Name)** 674920 / *W87-1/Mk21A*

Product Development ($ in Millions)

Cost Category Item	Contract Method & Type	Performing Activity & Location	Prior Years	FY 2020 Cost	FY 2020 Award Date	FY 2021 Cost	FY 2021 Award Date	FY 2022 Base Cost	FY 2022 Base Award Date	FY 2022 OCO Cost	FY 2022 OCO Award Date	FY 2022 Total Cost	Cost To Complete	Total Cost	Target Value of Contract
Mk21A TMRR Contractor	C/CPFF	Lockheed Martin : King of Prussia, PA	8.028	42.293	Jan 2020	56.906	Nov 2020	23.422	Nov 2021	-		23.422	-	-	201.933
Mk21A EMD Contract(s)	TBD	TBD : TBD	0.000	-		-		0.000		-		0.000	-	-	-
		Subtotal	8.028	42.293		56.906		23.422		-		23.422	-	-	N/A

Support ($ in Millions)

Cost Category Item	Contract Method & Type	Performing Activity & Location	Prior Years	FY 2020 Cost	FY 2020 Award Date	FY 2021 Cost	FY 2021 Award Date	FY 2022 Base Cost	FY 2022 Base Award Date	FY 2022 OCO Cost	FY 2022 OCO Award Date	FY 2022 Total Cost	Cost To Complete	Total Cost	Target Value of Contract
Mk21A Fuze Trade Study (TMRR)	MIPR	Sandia National Lab : Albuquerque, NM	0.618	1.295	Nov 2019	-		-		-		-	-	-	-
Mk21A Fuze Effort (TMRR)	Various	Various : Various	0.000	-		12.536	Jan 2021	18.500	Nov 2021	-		18.500	-	-	-
Mk21A TMRR Support: PMA (TMRR)	Various	Various : Various	0.019	0.328	Nov 2019	0.565	Nov 2020	0.550	Nov 2021	-		0.550	-	-	-
Mk21A Integration Support: BAE (TMRR)	C/FP	BAE : Hill AFB, UT	1.828	2.576	Oct 2019	2.778	Oct 2020	3.766	Oct 2021	-		3.766	-	-	-
Mk21A Integration Support: FFRDC/UARC (TMRR)	MIPR	Various : Various	0.987	-		-		2.304	Nov 2021	-		2.304	-	-	-
Mk21A EMD Support	Various	TBD : TBD	0.000	-		-		-		-		-	-	-	-
Mk21A Civilian Manpower	Various	US Gov Civilians : Hill AFB, UT	0.397	1.199	Oct 2019	3.211	Oct 2020	2.838	Oct 2021	-		2.838	-	-	-
		Subtotal	3.849	5.398		19.090		27.958		-		27.958	-	-	N/A

Remarks

• Mk21A Fuze Effort (TMRR): added as a result of trade studies highlighting it as an area of emphasis for the remainder of TMRR for critical risk reduction activities

• 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.

Exhibit R-3, RDT&E Project Cost Analysis: PB 2022 Air Force		Date: May 2021
Appropriation/Budget Activity 3600 / 7	**R-1 Program Element (Number/Name)** PE 0101328F / *ICBM Reentry Vehicles*	**Project (Number/Name)** 674920 / *W87-1/Mk21A*

Test and Evaluation ($ in Millions)

Cost Category Item	Contract Method & Type	Performing Activity & Location	Prior Years	FY 2020 Cost	FY 2020 Award Date	FY 2021 Cost	FY 2021 Award Date	FY 2022 Base Cost	FY 2022 Base Award Date	FY 2022 OCO Cost	FY 2022 OCO Award Date	FY 2022 Total Cost	Cost To Complete	Total Cost	Target Value of Contract
Mk21A Test & Evaluation (TMRR)	Various	Various : Various	0.000	7.523	Dec 2019	26.819	Nov 2020	37.120	Nov 2021	-		37.120	-	-	-
Mk21A Test & Evaluation: Air Force and NNSA Demonstrator Initiative (ANDI) (TMRR)	MIPR	Various : Various	0.000	8.111		4.875	Oct 2020	4.200	Oct 2021	-		4.200	-	-	-
Mk21A EMD Test Support	Various	TBD : TBD	0.000	-		-		-		-		-	-	-	-
		Subtotal	0.000	15.634		31.694		41.320		-		41.320	-	-	N/A

Remarks

• TMRR flight test(s) require incremental funding up to two years prior to flight test(s). Funds allow contracts to be established for support and the build-up of flight test vehicles in order to meet the scheduled test(s).
• FY22 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 the Mk21A development and risk reduction and NNSA of the W87-1 development. The ANDI effort is expected to span over FY20, FY21, and FY22 and will provide critical information for EMD.
• Mk21 Test & Evaluation: Air Force and NNSA Demonstrator Initiative (ANDI) is a former ICBM Demonstration/Validation study that was transitioned to the Mk21A program office beginning in FY20.

Management Services ($ in Millions)

Cost Category Item	Contract Method & Type	Performing Activity & Location	Prior Years	FY 2020 Cost	FY 2020 Award Date	FY 2021 Cost	FY 2021 Award Date	FY 2022 Base Cost	FY 2022 Base Award Date	FY 2022 OCO Cost	FY 2022 OCO Award Date	FY 2022 Total Cost	Cost To Complete	Total Cost	Target Value of Contract
Mk21A PMA	C/Various	Various : Various	1.870	0.159	Nov 2019	4.857	Nov 2020	3.613	Nov 2021	-		3.613	-	-	-
		Subtotal	1.870	0.159		4.857		3.613		-		3.613	-	-	N/A

	Prior Years	FY 2020		FY 2021		FY 2022 Base		FY 2022 OCO		FY 2022 Total	Cost To Complete	Total Cost	Target Value of Contract
Project Cost Totals	13.747	63.484		112.547		96.313		-		96.313	-	-	N/A

Remarks

Exhibit R-4, RDT&E Schedule Profile: PB 2022 Air Force		Date: May 2021
Appropriation/Budget Activity 3600 / 7	**R-1 Program Element (Number/Name)** PE 0101328F / *ICBM Reentry Vehicles*	**Project (Number/Name)** 674920 / *W87-1/Mk21A*

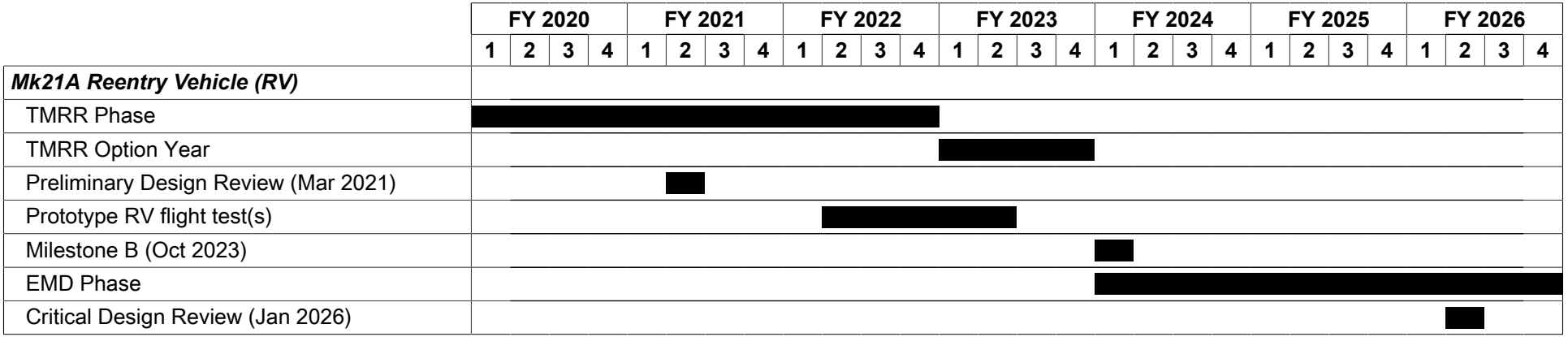

Exhibit R-4A, RDT&E Schedule Details: PB 2022 Air Force		Date: May 2021
Appropriation/Budget Activity 3600 / 7	**R-1 Program Element (Number/Name)** PE 0101328F / *ICBM Reentry Vehicles*	**Project (Number/Name)** 674920 / *W87-1/Mk21A*

Schedule Details

	Start		End	
Events by Sub Project	**Quarter**	**Year**	**Quarter**	**Year**
Mk21A Reentry Vehicle (RV)				
TMRR Phase	1	2020	4	2022
TMRR Option Year	1	2023	4	2023
Preliminary Design Review (Mar 2021)	2	2021	2	2021
Prototype RV flight test(s)	2	2022	2	2023
Milestone B (Oct 2023)	1	2024	1	2024
EMD Phase	1	2024	4	2026
Critical Design Review (Jan 2026)	2	2026	2	2026

Note

- Prototype RV flight test(s) window expanded for aeroshell heatshield testing
- EMD Phase continues beyond FY2026 to FY2027
- MS B and EMD Phase could be as early as FY23 if TMRR Option Year not executed