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**Exhibit R-2, RDT&E Budget Item Justification:** PB 2021 Air Force **Date:** February 2020

<b>Appropriation/Budget Activity</b> 3600: <i>Research, Development, Test &amp; Evaluation, Air Force I BA 7: Operational Systems Development</i>	<b>R-1 Program Element (Number/Name)</b> PE 0101328F / ICBM Reentry Vehicles
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COST (\$ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
Total Program Element	0.000	13.747	65.671	112.753	0.000	112.753	74.755	81.756	225.602	252.142	2,193.374	3,019.800
674920: W87-1/Mk21A	0.000	13.747	65.671	112.753	0.000	112.753	74.755	81.756	225.602	252.142	2,193.374	3,019.800
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 reentry vehicle 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, and nuclear surety, hardness and certification and system vulnerability assessments.

This program element may include necessary civilian pay expenses required to manage, execute, and deliver Mk21A RV weapon system capability. The use of such program funds would be in addition to the civilian pay expenses budgeted in program element 0605831F or 0605833F.

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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<b>B. Program Change Summary (\$ in Millions)</b>	<b>FY 2019</b>	<b>FY 2020</b>	<b>FY 2021 Base</b>	<b>FY 2021 OCO</b>	<b>FY 2021 Total</b>
Previous President's Budget	14.167	75.571	112.959	0.000	112.959
Current President's Budget	13.747	65.671	112.753	0.000	112.753
Total Adjustments	-0.420	-9.900	-0.206	0.000	-0.206
• Congressional General Reductions	0.000	0.000			
• Congressional Directed Reductions	0.000	-9.900			
• 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	-0.420	0.000			
• Other Adjustments	0.000	0.000	-0.206	0.000	-0.206

**Change Summary Explanation**

FY2019 funding reflects a Small Business Innovation Research (SBIR) adjustment of \$0.420 million.

FY2020 funding reflects a Congressional directed reduction of \$9.900 million for "Program delay."

<b>C. Accomplishments/Planned Programs (\$ in Millions)</b>	<b>FY 2019</b>	<b>FY 2020</b>	<b>FY 2021</b>
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<b>Title:</b> Mk21A Technology Maturation Risk Reduction	13.747	65.671	112.753
<b>Description:</b> 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 2 prototype RVs in ICBM-like environment			
<b>FY 2020 Plans:</b>			
<ul style="list-style-type: none"> <li>• Award one TMRR contract</li> <li>• Modify, modernize, and expand the analytic environment and labs to support TMRR activities to enable full execution of the program's capability to own the technical baseline throughout the program life cycle. This involves establishing a digital engineering system including a supporting environment/infrastructure to perform digital activities, collaborate with, and communicate across stakeholders.</li> <li>• Initiate RV preliminary design in order to reduce integration risk by conducting trade studies, system engineering, test activities, and system modeling and simulation.</li> </ul>			

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<b>C. Accomplishments/Planned Programs (\$ in Millions)</b>	<b>FY 2019</b>	<b>FY 2020</b>	<b>FY 2021</b>
<ul style="list-style-type: none"> <li>• Develop ground and flight test plans for prototypes</li> <li>• Further develop analytical, information technology, and data management capabilities to ensure weapon system design information dissemination.</li> <li>• Initiate development of demonstration flight reentry vehicle</li> <li>• Develop and execute a unified certification strategy which meets nuclear surety, cyber security, and nuclear safety requirements.</li> <li>• 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.</li> </ul> <p><b>FY 2021 Plans:</b></p> <ul style="list-style-type: none"> <li>• Continue TMRR contract efforts</li> <li>• 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.</li> <li>• 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.</li> <li>• Continue development of demonstration flight reentry vehicle</li> <li>• Continue to develop and execute a unified certification strategy which meets nuclear surety, cyber security, and nuclear safety requirements.</li> <li>• Initiate prototype reentry vehicle flight tests</li> <li>• 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.</li> <li>• Plan, prepare for, and successfully complete Preliminary Design Review.</li> </ul> <p><b>FY 2020 to FY 2021 Increase/Decrease Statement:</b> Funding increased due to continued aeroshell, nose-tip, and fuze design efforts; preparation for Preliminary Design Review; and preparation for initial flight tests of two prototype reentry vehicles.</p>			
<b>Accomplishments/Planned Programs Subtotals</b>	13.747	65.671	112.753

<b>D. Other Program Funding Summary (\$ in Millions)</b>											
<u>Line Item</u>	<u>FY 2019</u>	<u>FY 2020</u>	<u>FY 2021</u>	<u>FY 2021</u>	<u>FY 2021</u>	<u>FY 2022</u>	<u>FY 2023</u>	<u>FY 2024</u>	<u>FY 2025</u>	<u>Cost To</u>	<u>Total Cost</u>
			<u>Base</u>	<u>OCO</u>	<u>Total</u>					<u>Complete</u>	
• RDTE 04 0605230F/641025: <i>Ground Based Strategic Deterrent</i>	401.244	557.495	1,524.759	-	1,524.759	2,536.450	3,034.370	3,072.837	3,031.610	7,327.795	21,486.560

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

<u>Line Item</u>	<u>FY 2019</u>	<u>FY 2020</u>	<u>FY 2021</u> <u>Base</u>	<u>FY 2021</u> <u>OCO</u>	<u>FY 2021</u> <u>Total</u>	<u>FY 2022</u>	<u>FY 2023</u>	<u>FY 2024</u>	<u>FY 2025</u>	<u>Cost To</u> <u>Complete</u>	<u>Total Cost</u>
• RDTE 05 0604933F/655082: <i>Fuze Modernization</i>	124.457	161.199	167.099	-	167.099	104.657	20.503	2.067	2.105	0.000	582.087
• RDTE 04 060351F/641022: <i>Dem/Val - RVAP</i>	16.052	18.148	22.397	-	22.397	40.126	40.481	0.000	0.000	Continuing	Continuing

**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 two 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 tests. 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. 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 as early as 1QFY24.

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**Exhibit R-3, RDT&E Project Cost Analysis: PB 2021 Air Force** **Date:** February 2020

<b>Appropriation/Budget Activity</b> 3600 / 7	<b>R-1 Program Element (Number/Name)</b> PE 0101328F / ICBM Reentry Vehicles	<b>Project (Number/Name)</b> 674920 / W87-1/Mk21A
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<b>Product Development (\$ in Millions)</b>				FY 2019		FY 2020		FY 2021 Base		FY 2021 OCO		FY 2021 Total	Cost To Complete	Total Cost	Target Value of Contract
Cost Category Item	Contract Method & Type	Performing Activity & Location	Prior Years	Cost	Award Date	Cost	Award Date	Cost	Award Date	Cost	Award Date	Cost			
Mk21A TMRR Contractor	C/CPFF	Lockheed Martin : King of Prussia, PA	0.000	8.034	Oct 2019	29.970	Jan 2020	35.806	Nov 2020	-		35.806	108.322	182.132	-
Mk21A EMD Contracts	Various	TBD : TBD	0.000	-		-		-		-		-	1,043.018	1,043.018	-
<b>Subtotal</b>			0.000	8.034		29.970		35.806		-		35.806	1,151.340	1,225.150	N/A

<b>Support (\$ in Millions)</b>				FY 2019		FY 2020		FY 2021 Base		FY 2021 OCO		FY 2021 Total	Cost To Complete	Total Cost	Target Value of Contract
Cost Category Item	Contract Method & Type	Performing Activity & Location	Prior Years	Cost	Award Date	Cost	Award Date	Cost	Award Date	Cost	Award Date	Cost			
Mk21A Fuze Trade Study (TMRR)	MIPR	Sandia National Lab : Albuquerque, NM	0.000	0.618	Jul 2019	2.500	Nov 2019	6.400	Nov 2020	-		6.400	2.840	12.358	-
Mk21A TMRR Support: PMA (TMRR)	Various	Various : Various	0.000	0.013	Jan 2019	0.497	Nov 2019	0.565	Nov 2020	-		0.565	27.630	28.705	-
Mk21A Integration Support: BAE (TMRR)	C/FP	BAE : Hill AFB, UT	0.000	1.828	Jan 2019	3.380	Oct 2019	2.778	Oct 2020	-		2.778	21.243	29.229	-
Mk21A Integration Support: Aerospace (TMRR)	MIPR	Aerospace : Hill AFB, UT	0.000	0.987	Feb 2019	-		2.070	Nov 2020	-		2.070	16.429	19.486	-
Mk21A EMD Support	Various	TBD : TBD	0.000	-		-		-		-		-	662.567	662.567	-
Mk21A Civilian Manpower	Various	US Gov Civilians : Hill AFB	0.000	0.397	Jan 2019	5.040	Oct 2019	3.699	Oct 2020	-		3.699	35.936	45.072	-
<b>Subtotal</b>			0.000	3.843		11.417		15.512		-		15.512	766.645	797.417	N/A

**Remarks**

- Aerospace costs in FY20 were included in Mk21A PMA costs, but has been broken out separately beginning in FY21 due to program growth. This was initially thought to be part of PMA but based on the nature of the work it has been determined as support costs.
- Civilian manpower increase supports ramp up of Program Office. Thirteen additional personnel were added in FY20 (all 13 positions were allocated to the program office). The cost decrease from FY20 to FY21 can be attributed to last year's estimate; the program estimated 25 additional personnel but requirements dictated that only 13 were necessary.

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<b>Test and Evaluation (\$ in Millions)</b>				FY 2019		FY 2020		FY 2021 Base		FY 2021 OCO		FY 2021 Total	Cost To Complete	Total Cost	Target Value of Contract
Cost Category Item	Contract Method & Type	Performing Activity & Location	Prior Years	Cost	Award Date	Cost	Award Date	Cost	Award Date	Cost	Award Date	Cost			
Mk21A Test & Evaluation (TMRR)	Various	Various : Various	0.000	-		22.170	Dec 2019	54.078	Nov 2020	-		54.078	31.498	107.746	-
Mk21A Test & Evaluation: Air Force and NNSA Demonstrator Initiative (ANDI) (TMRR)	MIPR	Various : SNL & LLNL, CA	0.000	-		-		2.500	Oct 2020	-		2.500	2.926	5.426	-
Mk21A EMD Test Support	Various	TBD : TBD	0.000	-		-		-		-		-	835.402	835.402	-
<b>Subtotal</b>			0.000	-		22.170		56.578		-		56.578	869.826	948.574	N/A

**Remarks**

- TMRR flight tests require incremental funding up to two years prior to flight tests. Funds allow contracts to be established for support and the build-up of flight test vehicles in order to meet the scheduled tests.
- FY21 Test & Evaluation support includes developing ground test plans and flight test plans to support development of prototype test vehicles. These tests 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 FY21.

<b>Management Services (\$ in Millions)</b>				FY 2019		FY 2020		FY 2021 Base		FY 2021 OCO		FY 2021 Total	Cost To Complete	Total Cost	Target Value of Contract
Cost Category Item	Contract Method & Type	Performing Activity & Location	Prior Years	Cost	Award Date	Cost	Award Date	Cost	Award Date	Cost	Award Date	Cost			
Mk21A PMA	C/Various	Various : Various	0.000	1.870	Jan 2019	2.114	Nov 2019	4.857	Nov 2020	-		4.857	39.818	48.659	-
<b>Subtotal</b>			0.000	1.870		2.114		4.857		-		4.857	39.818	48.659	N/A

**Remarks**

- Civilian Manpower allocation moved to Support Category. DCA positions were determined to be support costs rather than management services.
- Mk21A PMA increase required to support program growth as TMRR ramps up.

	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	Cost To Complete	Total Cost	Target Value of Contract
<b>Project Cost Totals</b>	0.000	13.747	65.671	112.753	-	112.753	2,827.629	3,019.800	N/A

**Remarks**



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<b>Exhibit R-4A, RDT&amp;E Schedule Details:</b> PB 2021 Air Force		<b>Date:</b> February 2020
<b>Appropriation/Budget Activity</b> 3600 / 7	<b>R-1 Program Element (Number/Name)</b> PE 0101328F / <i>ICBM Reentry Vehicles</i>	<b>Project (Number/Name)</b> 674920 / <i>W87-1/Mk21A</i>

Schedule Details

Events by Sub Project	Start		End	
	Quarter	Year	Quarter	Year
<b><i>Mk21A Reentry Vehicle (RV)</i></b>				
Milestone A (Sept 2019)	4	2019	4	2019
TMRR Phase	1	2020	4	2023
Preliminary Design Review (Mar 2021)	2	2021	2	2021
Prototype RV flight tests	4	2021	2	2022
Milestone B (Oct 2023)	1	2024	1	2024
EMD Phase	1	2024	4	2025

**Note**  
 • EMD Phase continues beyond FY2025 to FY2027