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

Appropriation/Budget Activity 3600: <i>Research, Development, Test & Evaluation, Air Force I BA 5: System Development & Demonstration (SDD)</i>	R-1 Program Element (Number/Name) PE 0604735F / <i>Combat Training Ranges</i>
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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	-	42.383	52.365	8.898	0.000	8.898	23.959	24.384	171.178	315.767	Continuing	Continuing
652286: <i>Combat Training Range Equipment</i>	-	42.383	52.365	8.898	0.000	8.898	23.959	24.384	171.178	315.767	Continuing	Continuing
Quantity of RDT&E Articles	-	-	-	-	-	-	-	-	-	-		

A. Mission Description and Budget Item Justification

The Combat Training Ranges (CTR) program provides equipment and support to Air Force units and combat training ranges for electronic warfare (EW) mission testing, training, and evaluation of aircrews, as well as operational testing of weapon systems and tactics under simulated combat conditions. This program provides funding for the development and integration of EW training capabilities to include: Air Combat Training Systems (ACTS); threat emitters; advanced radar threat systems; communication jammers; command and control and debrief capability; and instrumentation equipment/systems. These systems and capabilities support integrated training operations for all aircraft (including 5th Generation) and for Joint, Coalition, and Live, Virtual, Constructive (LVC) training events.

The Advanced Radar Threat System (ARTS) programs design, develop, build, and test threat systems based on advanced foreign fielded surface-to-air missile (SAM) radar threat systems. The ARTS variants will be used at Department of Defense (DoD) training ranges for 4th and 5th Generation aircrew training and tactics development to increase combat effectiveness and aircrew survivability by training aircrews to engage or defend against an advanced SAM threat before encountering it in actual combat to stress their tactics, techniques and procedures. The ARTS programs support early research, studies, technology development, and planning for next-generation threat systems. The ARTS programs also fund development of high-fidelity surrogate targets matching simulated threat systems to stress 5th Generation sensor fusion capabilities.

The Modernization Range Threats Systems (RTS) efforts fund development of modifications for range threat systems to provide continued combat training relevancy and enhanced systems capabilities. RTS efforts include Multiple Threat Emitter System (MUTES), Miniature Multiple Threat Emitter System (Mini-MUTES), Modular Threat Emitter (MTE) system, Tactical Radar Threat Generator (TRTG) system, Band Simulator, Unmanned Modular Threat Emitter (UMTE) system, and legacy Joint Threat Emitter (JTE) systems. Enhancements focus on upgrading threat systems to match fielded modifications for foreign threat systems faced by combat aircrews. The Common Electronic Attack Receiver (CEAR) provides reactive training and enhanced debriefs using legacy threats. The Modernization Systems effort upgrades Band Simulator and other legacy emitters with modern electronics to improve threat relevance and sustainability. The Double Digit Threat Emitter (DDTE) effort leverages JTE to provide greater on-range threat density of advanced SAM radars. The B-Pedestal modification will provide double-digit threat capability to Mini-MUTES B-Pedestals.

The P5 Combat Training System (P5 CTS) program addresses new capability requirements for the fielded P5 system, to include continued operations in a global positioning system (GPS)-contested environment. This will enable ongoing analyses, studies, risk reduction efforts, and/or technology development to enhance Operational Training Infrastructure (OTI), such as combat training range equipment integration into a blended training architecture, communication and GPS jammers,

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weapon drop scoring systems, and infrastructure networks. These enhancements will add a critical dimension to exercises and optimize warfighter training throughout the program's lifecycle.

The Live Mission Operations Capability (LMOC) will regionalize and standardize training airspace, threat systems, and control centers to better challenge 5th Generation aircraft and aircrew and provide comprehensive training support for warfighters. It will provide a node-based enterprise that integrates all range system capabilities, including pre/post mission coordination, in a multi-level secure environment to enable blended training for combat and combat support units, including F-35. It will address three combat training capability requirements: build and display an integrated surface and air picture; manage training; and enable LVC training operations.

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

This program is in Budget Activity 5, System Development and Demonstration (SDD) because it has passed Milestone B approval and is conducting engineering and manufacturing development tasks aimed at meeting validated requirements prior to full rate production.

B. Program Change Summary (\$ in Millions)	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
Previous President's Budget	43.895	37.365	8.915	0.000	8.915
Current President's Budget	42.383	52.365	8.898	0.000	8.898
Total Adjustments	-1.512	15.000	-0.017	0.000	-0.017
• Congressional General Reductions	0.000	0.000			
• Congressional Directed Reductions	0.000	0.000			
• Congressional Rescissions	0.000	0.000			
• Congressional Adds	0.000	15.000			
• Congressional Directed Transfers	0.000	0.000			
• Reprogrammings	0.000	0.000			
• SBIR/STTR Transfer	-1.460	0.000			
• Other Adjustments	-0.052	0.000	-0.017	0.000	-0.017

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

Project: 652286: *Combat Training Range Equipment*

Congressional Add: *F-35 Advanced Threat Simulator*

	FY 2019	FY 2020
	8.000	15.000
Congressional Add Subtotals for Project: 652286	8.000	15.000
Congressional Add Totals for all Projects	8.000	15.000

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Change Summary Explanation FY19 \$1.46M reduction for Small Business Innovation Research (SBIR) FY20 Congressional add for \$15M F-35 advanced threat simulator				
C. Accomplishments/Planned Programs (\$ in Millions)		FY 2019	FY 2020	FY 2021
Title: P5 Combat Training System (CTS)		0.175	0.200	0.500
Description: P5 CTS funding supports ACTS capabilities and includes the development, integration and testing of future software/hardware upgrades, aircraft/pod integration, upgrades for range applications, and associated studies. Additionally, funding supports efforts to enable initial training interoperability with 5th Generation aircraft via Ground Subsystem (GS) decryption of secure (encrypted) Time, Space, Position Information (TSPI), weapon simulation, and other training data.				
FY 2020 Plans: Funding supports the study, development and test of a Production Representative Article (PRA) for global positioning system (GPS)-contested training upgrade for P5 CTS. Funding is also being used to study optimization of message format and priority in support of Proficiency-Based Training (PBT) objectives.				
FY 2021 Plans: Funding will continue to support the study, development and test of a PRA for GPS-contested training upgrade for P5 CTS. Funding is also being used to study optimization of message format and priority in support of PBT objectives.				
FY 2020 to FY 2021 Increase/Decrease Statement: Funding increased due to procurement of prototype hardware required for system qualification.				
Title: Modernization Range Threat Systems (RTS)		0.000	0.150	0.000
Description: Modernization Systems efforts fund development of modifications for range threat systems to provide continued combat training relevancy and enhanced systems capabilities. Range threat systems include MUTES, Mini-MUTES, MTE system, TRTG system, Band Sim, UMTE system, legacy JTE system, and other radar systems fielded throughout the combat training range enterprise. Enhancements focus on upgrading threat systems to match fielded modifications for foreign threat systems faced by combat aircrews. The CEAR provides reactive training and enhanced debriefs using legacy threats. The Modernization Systems effort upgrades the Band Sim and other legacy emitters with modern electronics to improve threat relevance and sustainability. The DDTE effort leverages JTE to provide greater on-range threat density of advanced SAM radars.				
FY 2020 Plans: Funding supports preparation for Mini-MUTES modification for improved threat relevance and required relevancy upgrades to support Joint Pacific Alaska Range Complex (JPARC) legacy systems.				
FY 2021 Plans:				

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C. Accomplishments/Planned Programs (\$ in Millions)		FY 2019	FY 2020	FY 2021
N/A				
FY 2020 to FY 2021 Increase/Decrease Statement: Funding decreased due to realignment of priorities to other projects within Combat Training Ranges.				
Title: Advanced Radar Threat System (ARTS-V1) Description: ARTS-V1 program will design, develop, build and test radar threat systems based on advanced strategic, long-range, re-locatable foreign fielded Surface-to-Air Missile (SAM) radar threat systems. ARTS-V1 will leverage an existing DoD test resource development program to reduce non-recurring development cost, minimize schedule risk, and promote range interoperability between test and training. While various aircraft platforms will train against ARTS-V1, the focus of the program is to develop realistic radar threat systems meant to stress 5th Generation aircraft capabilities. Additionally, development of a high-fidelity surrogate target, ongoing analyses, studies, and risk reduction efforts will focus on integrating ARTS and other systems into regional range and LVC architectures. FY 2020 Plans: Funding supports the development of a PRA and integration and testing, along with Technical Data Package (TDP) development. Additionally, funding is supporting ongoing analyses and studies focused on integrating ARTS into regional range and LVC architectures. FY 2021 Plans: Funding will support further development (technical design reviews, integration, fabrication and testing) of a Production Representative Article (PRA) along with finalization of the TDP. Additionally, funding will support ongoing analyses and studies focused on integrating Advanced Radar Threat System (ARTS) into regional range and Live, Virtual, Constructive (LVC) architectures. FY 2020 to FY 2021 Increase/Decrease Statement: Funding decreased due to finalization of PRA activities.		3.788	13.100	6.457
Title: Advanced Radar Threat System (ARTS-V2) Description: ARTS-V2 program will design, develop, build and test radar threat systems based on an advanced tactical, mobile, short/medium range foreign fielded SAM radar threat system. Additionally, development of a high-fidelity surrogate target, ongoing analyses, studies, and risk reduction efforts will focus on integrating ARTS-V2 and other systems into LVC architectures. FY 2020 Plans:		29.670	10.200	1.741

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C. Accomplishments/Planned Programs (\$ in Millions)		FY 2019	FY 2020	FY 2021
<p>Funding supports the development (technical design reviews, integration, fabrication and testing) of a PRA under the Engineering Manufacturing and Development (EMD) contract. Additionally, funding is supporting ongoing analyses and studies focused on integrating ARTS into regional range and LVC architectures.</p> <p>FY 2021 Plans: Funding will support completion of the development (technical design reviews, integration, fabrication and testing) of a PRA under the EMD contract. Additionally, funding will support ongoing analyses and studies focused on integrating ARTS into regional range and LVC architectures.</p> <p>FY 2020 to FY 2021 Increase/Decrease Statement: Funding decreased due to conclusion of PRA activities.</p>				
<p>Title: Advanced Radar Threat System (ARTS-V3)</p> <p>Description: ARTS-V3 program will design, develop, build and test advanced surface-to-air threat systems replicating strategic/tactical threat(s) at the fidelity necessary to stress current EW systems, 5th Generation and beyond air platform engagements and be integrated into a future Combat Air Forces (CAF) LVC system. ARTS-V3 will provide an anti-access/area denial (A2/AD) environment for CAF test and training with highly reactive threat systems that provide immediate feedback to aircrews. The ARTS-V3 system will create a relevant combat training threat system that is dynamic and represents a modern and dynamic adversary force.</p> <p>FY 2020 Plans: Funding supports intelligence, early research, studies, risk reduction, and technology maturation to reduce program risk. Funds are supporting intelligence data to ensure emulation of the real world system is relevant and realistic.</p> <p>FY 2021 Plans: Funding will continue intelligence and requirements support, early research, studies, risk reduction, support technology maturation, prototyping, and reduce program risk. Funds will also support intelligence data to ensure emulation of the real world system is relevant and realistic.</p> <p>FY 2020 to FY 2021 Increase/Decrease Statement: Funding decreased due to realignment of priorities to other projects within Combat Training Ranges.</p>		0.000	5.183	0.100
<p>Title: Advanced Radar Threat System (ARTS-V4)</p> <p>Description: ARTS-V4 program will design, develop, build, and test modern surface-to-air threat systems replicating tactical highly mobile threats at the fidelity necessary to stress current EW systems, 5th Generation and beyond air platform engagements, and be integrated into a future CAF LVC system. The ARTS-V4 system will create a relevant combat training threat</p>		0.000	1.540	0.100

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C. Accomplishments/Planned Programs (\$ in Millions)		FY 2019	FY 2020	FY 2021
system that is dynamic and represents adversary forces. Additionally funding will support ongoing analyses and studies focused on integrating ARTS into regional range and LVC architectures.				
FY 2020 Plans: Funding supports finalizing program foundation to include intelligence and requirements support, early research, studies, support technology maturation and demonstration, and planning to support a Milestone B decision. Funding acquires intelligence data to ensure emulation of the real world system is relevant and realistic.				
FY 2021 Plans: Funding will continue intelligence and requirement support, early research, studies, risk reduction, support technology maturation, prototyping and reduce program risk. Funding will also support intelligence data to ensure emulation of the real work system is relevant and realistic.				
FY 2020 to FY 2021 Increase/Decrease Statement: Funding decreased due to realignment of priorities to other projects within Combat Training Ranges.				
Title: Modular Threat Emitter (MTE)		0.400	0.000	0.000
Description: MTE will conduct RDT&E to modernize the Range Threat family of systems, focusing on the MTE System. Foreign fielded SAM threat systems have undergone major modernization programs to replace aging analog technology with modern digital electronics. This program requires the development of digital electronics upgrades to provide realistic electronic warfare training to combat aircrews. This effort will improve threat fidelity (ensuring threat-representative Radio Frequency (RF) emissions), increase reliability, maintainability, supportability, system mobility, and support remote operations with Digital Integrated Air Defense Systems (DIADS). This effort supports warfighter development of new tactics, techniques, and procedures in a relevant, realistic combat environment.				
FY 2020 Plans: N/A				
FY 2021 Plans: N/A				
FY 2020 to FY 2021 Increase/Decrease Statement: N/A				
Title: Live Mission Operations Capability (LMOC)		0.350	6.992	0.000
Description: LMOC will regionalize and standardize training airspace, threat systems, and control centers to better challenge 5th Generation aircraft and aircrew and provide comprehensive training support for all warfighters. It will provide a node-				

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C. Accomplishments/Planned Programs (\$ in Millions)	FY 2019	FY 2020	FY 2021
based enterprise that integrates all range system capabilities, including pre/post mission coordination, in a multi-level secure environment to enable blended live-synthetic training for combat and combat support units including F-35. It will address three combat training capability requirements: build and display an integrated surface and air picture; manage training; and enable LVC training operations. FY 2020 Plans: Funding supports initial stand-up of a system integration laboratory, further risk reduction activities and requirement documentation to ensure quick and incremental fielding of capability. FY 2021 Plans: N/A FY 2020 to FY 2021 Increase/Decrease Statement: Funding decreased due to realignment of priorities to other projects within Combat Training Ranges.			
Accomplishments/Planned Programs Subtotals	34.383	37.365	8.898

	FY 2019	FY 2020
Congressional Add: F-35 Advanced Threat Simulator FY 2019 Accomplishments: FY19 funding is being used to study enhancements to legacy systems capable of providing advanced Surface-to-Air Missile (SAM) threats through integration of commercial off-the-shelf or previously developed technology into existing systems at JPARC. FY 2020 Plans: FY20 funding will be used to design, develop, and install digital upgrades to improve the fidelity and Electronic Warfare (EW) scenarios for F-35 and other aircrews during Live, Virtual and Constructive test and training events, increasing warfighter interoperability and survivability.	8.000	15.000
Congressional Adds Subtotals	8.000	15.000

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>
• OPAF 03 Line Item 834190: <i>Combat Training Ranges</i>	227.598	282.893	195.185	-	195.185	237.288	177.931	178.051	170.354	Continuing	Continuing
• OPAF 05 Line Item 861900: <i>Spares and Repair Parts</i>	14.035	2.322	8.241	-	8.241	19.082	11.413	0.737	0.750	Continuing	Continuing

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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>
• APAF 07 Line Item 000075: <i>Other Production Charges</i>	13.842	0.300	3.495	-	3.495	0.300	0.300	0.300	0.305	Continuing	Continuing

Remarks

E. Acquisition Strategy

The acquisition strategy varies by effort. Overall strategy is competition focused, with both cost plus and fixed price contracts.

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

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Product Development (\$ in Millions)				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			
Advanced Radar Threat System-Variant 1 (ARTS-V1) Development	Various	Various : Pax River, MD	-	3.788	Jun 2019	9.000	Dec 2019	6.732	Oct 2020	-		6.732	Continuing	Continuing	-
Advanced Radar Threat System-Variant 2 (ARTS-V2) Development	C/FPIF	Lockheed Martin : Grand Prairie, TX	-	26.488	Jan 2019	8.600	Nov 2019	0.246	Sep 2021	-		0.246	Continuing	Continuing	-
Advanced Radar Threat System-Variant 4 (ARTS-V4) Development	Various	Various : Hill AFB, UT	-	-		0.840	Nov 2019	-		-		-	Continuing	Continuing	-
P5 CTS GPS Contested	Various	Various : Hill AFB, UT	-	0.175	Sep 2019	0.200	Feb 2020	0.500	Apr 2021	-		0.500	Continuing	Continuing	-
Live Mission Operation Capability (LMOC)	Various	Various : Hill AFB, UT	-	0.350	Sep 2019	6.192	Mar 2020	-		-		-	Continuing	Continuing	-
Subtotal			-	30.801		24.832		7.478		-		7.478	Continuing	Continuing	N/A

Support (\$ in Millions)				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			
Advanced Radar Threat Systems (Direct Msn Spt)	Various	Various : Various, NV	-	-		5.183	Dec 2019	-		-		-	Continuing	Continuing	-
Subtotal			-	-		5.183		-		-		-	Continuing	Continuing	N/A

Test and Evaluation (\$ in Millions)				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			
Advanced Radar Threat Systems (Direct Msn Spt)	C/Various	Not specified. : TBD	-	-		2.600	Jun 2020	1.420	Oct 2020	-		1.420	Continuing	Continuing	-
Subtotal			-	-		2.600		1.420		-		1.420	Continuing	Continuing	N/A

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

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Management Services (\$ in Millions)				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			
Advanced Radar Threat Systems (PMA/A&AS)	Various	Various : Hill AFB, UT	-	3.182	Jun 2019	3.800	May 2020	-		-		-	Continuing	Continuing	-
Live Mission Operations Capability (LMOC) (PMA/A&AS)	Various	AFLCMC/AZS : Hill AFB, UT	-	-		0.800	Feb 2020	-		-		-	Continuing	Continuing	-
Modernization Systems (PMA/A&AS)	Various	AFLCMC/AZS : Hill AFB, UT	-	8.400	Jun 2019	15.000	Jun 2020	-		-		-	Continuing	Continuing	-
Modernization Systems (RTS) (PMA/A&AS)	Various	AFLCMC/AZS : Hill AFB	-	-		0.150	Apr 2020	-		-		-	Continuing	Continuing	-
Subtotal			-	11.582		19.750		-		-		-	Continuing	Continuing	N/A
Project Cost Totals			-	42.383		52.365		8.898		-		8.898	Continuing	Continuing	N/A

Remarks
 FINANCIAL PERFORMANCE: Combat Training Ranges is evaluated against traditional Research and Development (R&D) program expenditure benchmarks. Unlike many traditional R&D programs, however, the ARTS-V2 development contract is an FPIF contract with progress payments. 20 percent of incurred costs are withheld until the end of the contract, when they are liquidated. Mandatory funding obligations and progress payment withholds will cause the program to lag traditional expenditure benchmarks, painting an inaccurate portrait of overall program health.

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Exhibit R-4, RDT&E Schedule Profile: PB 2021 Air Force **Date:** February 2020

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	FY 2019				FY 2020				FY 2021				FY 2022				FY 2023				FY 2024				FY 2025			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4

Modernization Systems																												
Live Mission Operations Capability (LMOC)																												

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Exhibit R-4A, RDT&E Schedule Details: PB 2021 Air Force		Date: February 2020
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Schedule Details

Events by Sub Project	Start		End	
	Quarter	Year	Quarter	Year
Combat Training Range Equipment				
P5CTS Development	4	2019	4	2022
-- P5 CTS GPS-Contested Training Operation Capability	4	2019	4	2022
Advanced Radar Threat System-Variant 1(ARTS-V1) EMD Phase	1	2019	3	2022
-- ARTS-V1 Develop First Article (PRA)	1	2019	2	2021
-- ARTS-V1 Factory Acceptance Test	2	2021	2	2021
-- ARTS-V1 DT-E AND OT-E	3	2021	2	2022
-- ARTS-V1 Milestone C	3	2022	3	2022
Advanced Radar Threat System-Variant 2 (ARTS-V2) EMD Phase	1	2019	4	2021
-- ARTS-V2 PRA Contract	1	2019	4	2021
-- ARTS-V2 CDR	1	2019	1	2019
-- ARTS-V2 DT-E and OT-E	3	2020	3	2021
-- ARTS-V2 Milestone C	4	2021	4	2021
Advanced Radar Threat System-Variant 3 (ARTS-V3) System Spec Definition	1	2019	2	2022
-- ARTS-V3 First Intel Assessment	1	2019	4	2019
-- ARTS-V3 Second Intel Assessment	2	2020	1	2021
-- ARTS-V3 Third Intel Assessment	2	2022	1	2024
Advanced Radar Threat System-Variant 4 (ARTS-V4) Pre-milestone B	1	2019	1	2021
-- ARTS-V4 Milestone B	2	2023	2	2023
-- ARTS-V4 Development	2	2023	4	2025
-- ARTS-V4 Milestone C	4	2025	4	2025
Modernization Systems	3	2019	2	2020

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Exhibit R-4A, RDT&E Schedule Details: PB 2021 Air Force		Date: February 2020
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Events by Sub Project	Start		End	
	Quarter	Year	Quarter	Year
Live Mission Operations Capability (LMOC)	2	2019	4	2021