Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Air Force											Date: February 2019	
Appropriation/Budget Activity 3600: *Research, Development, Test & Evaluation, Air Force* / BA 4: *Advanced Component Development & Prototypes (ACD&P)*					R-1 Program Element (Number/Name) PE 1206422F / *Weather System Follow-on*							
COST ($ in Millions)	**Prior Years**	**FY 2018**	**FY 2019**	**FY 2020 Base**	**FY 2020 OCO**	**FY 2020 Total**	**FY 2021**	**FY 2022**	**FY 2023**	**FY 2024**	**Cost To Complete**	**Total Cost**
Total Program Element	276.283	98.396	138.052	225.660	0.000	225.660	54.748	34.809	36.660	38.759	297.300	1,200.667
644289: *Weather System Follow-On*	276.283	98.396	138.052	225.660	0.000	225.660	54.748	34.809	36.660	38.759	297.300	1,200.667
Program MDAP/MAIS Code: 488												

A. Mission Description and Budget Item Justification

Based on completion of the Space-Based Environmental Monitoring (SBEM) JROC Memo 092-14, capabilities will be developed to satisfy weather gaps for which no known mitigation exists. Weather System Follow-on (WSF) is a component of SBEM efforts to develop capabilities to satisfy weather Gap 3 Ocean Surface Vector Winds (OSVW), Gap 8 Tropical Cyclone Intensity (TCI), and Gap 11 Low Earth Orbit (LEO) Energetic Charged Particles (LEO ECP). Gap 3 OSVW and Gap 8 TCI require a space-based microwave sensor to provide polarimetric ocean surface wind direction and speed required for naval sea operations, as well as fighter sortie generations and marine amphibious operations. Gap 11 LEO ECP requires in situ ECP sensor for space situational awareness. The earliest possible launch options are being integrated in the design for critical gaps.

DoD established WSF as a Pre-Major Defense Acquisition Program (MDAP) with the Air force as the lead component. Based on the SBEM AoA results, the WSF initial thrusts will be to enable:
1) DoD use of data collected by civil, international and other DoD space systems;
2) Timely weather collection over broad oceans in support of maneuvering forces;
3) Space weather capabilities to characterize operational orbits, space situational awareness, and the ionosphere.

Secondary investments may be supported to address weather gaps identified in the SBEM AoA and validated by the JROC.

The Military Application of the Space Environment (MASE) is a program to demonstrate mature space environment technology to improve combat operations. MASE will enhance regional ionospheric specification (nowcasts) and predictions (forecasts) affecting signal propagation paths. MASE uses traditional and non-traditional ionospheric measurements in advanced space environment models to forecast and predict impacts to weapon systems. Contributes to satisfying Gaps 4 and 7 of the SBEM AoA results as supplemented by the AFRDM 02-17-02 (SBEM JDCR).

Space acquisition must respond with speed and agility to emerging adversary threats. Space & Missile Systems Center (SMC) is transforming the organization and implementation of space acquisition to an enterprise approach, maximizing innovation and resiliency, leveraging international, commercial, and mission partnerships, and managing program/project priorities according to an integrated unclassified/classified enterprise space architecture. Expanding the appropriate acquisition authorities and contract mechanisms to deliver capability sooner, SMC will strategically execute experimentation, prototyping, risk reduction, and other efforts to develop new or repurpose capabilities.

Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Air Force	Date: February 2019
Appropriation/Budget Activity 3600: *Research, Development, Test & Evaluation, Air Force* / BA 4: *Advanced Component Development & Prototypes (ACD&P)*	**R-1 Program Element (Number/Name)** PE 1206422F / *Weather System Follow-on*

This program element may include necessary civilian pay expenses required to manage, execute, and deliver WSF weapon system capability. The use of such program funds would be in addition to the civilian pay expenses budgeted in program elements 1206392F and 1206398F.

As directed in the FY 2018 NDAA, Sec 825, amendment to PL 114-92 FY 2016 NDAA, Sec 828 Penalty for Cost Overruns, the FY 2018 Air Force penalty total is $14.373M. The calculated percentage reduction to each research, development, test and evaluation and procurement account will be allocated proportionally from all programs, projects, or activities under such account.

This effort is in Budget Activity 4, Advanced Component Development and Prototypes (ACD&P), because efforts are necessary to evaluate integrated technologies, representative modes or prototype systems in a high fidelity and realistic operating environment.

B. Program Change Summary ($ in Millions)	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
Previous President's Budget	112.088	138.052	122.897	0.000	122.897
Current President's Budget	98.396	138.052	225.660	0.000	225.660
Total Adjustments	-13.692	0.000	102.763	0.000	102.763
• Congressional General Reductions	0.000	0.000			
• Congressional Directed Reductions	-10.000	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	-3.692	0.000			
• Other Adjustments	0.000	0.000	102.763	0.000	102.763

Change Summary Explanation

FY 2018: -$10.00M congressional reduction - excess to need
FY 2018: WSF received a Congressional rescission of -$5.388M. The correct total for FY 2018 is $93.008M.

FY 2020: $105.000M increase for SV-1 development; -$2.237M transfer to dedicated Space Situational Awareness Environmental Monitoring (SSAEM) Project (PE 1206422F/BA05/Project 65A038)

Exhibit R-2A, RDT&E Project Justification: PB 2020 Air Force			Date: February 2019
Appropriation/Budget Activity 3600 / 4	R-1 Program Element (Number/Name) PE 1206422F / *Weather System Follow-on*	Project (Number/Name) 644289 / *Weather System Follow-On*	

COST ($ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
644289: *Weather System Follow-On*	276.283	98.396	138.052	225.660	0.000	225.660	54.748	34.809	36.660	38.759	297.300	1,200.667
Quantity of RDT&E Articles	-	-	-	-	-	-	-	-	-	-		

A. Mission Description and Budget Item Justification

Based on completion of the Space-Based Environmental Monitoring (SBEM) JROC Memo 092-14, capabilities will be developed to satisfy weather gaps for which no known mitigation exists. Weather System Follow-on (WSF) is a component of SBEM efforts to develop capabilities to satisfy weather Gap 3 Ocean Surface Vector Winds (OSVW), Gap 8 Tropical Cyclone Intensity (TCI), and Gap 11 Low Earth Orbit (LEO) Energetic Charged Particles (LEO ECP). Gap 3 OSVW and Gap 8 TCI require a space-based microwave sensor to provide polarimetric ocean surface wind direction and speed required for naval sea operations, as well as fighter sortie generations and marine amphibious operations. Gap 11 LEO ECP requires in situ ECP sensor for space situational awareness. The earliest possible launch options are being integrated in the design for critical gaps.

DoD established WSF as a Pre-Major Defense Acquisition Program (MDAP) with the Air force as the lead component. Based on the SBEM AoA results, the WSF initial thrusts will be to enable:
1) DoD use of data collected by civil, international and other DoD space systems;
2) Timely weather collection over broad oceans in support of maneuvering forces;
3) Space weather capabilities to characterize operational orbits, space situational awareness, and the ionosphere.

Secondary investments may be supported to address weather gaps identified in the SBEM AoA and validated by the JROC.

The Military Application of the Space Environment (MASE) is a program to demonstrate mature space environment technology to improve combat operations. MASE will enhance regional ionospheric specification (nowcasts) and predictions (forecasts) affecting signal propagation paths. MASE uses traditional and non-traditional ionospheric measurements in advanced space environment models to forecast and predict impacts to weapon systems. Contributes to satisfying Gaps 4 and 7 of the SBEM AoA results as supplemented by the AFRDM 02-17-02 (SBEM JDCR). MASE was a new start in FY 2019.

Space acquisition must respond with speed and agility to emerging adversary threats. Space & Missile Systems Center (SMC) is transforming the organization and implementation of space acquisition to an enterprise approach, maximizing innovation and resiliency, leveraging international, commercial, and mission partnerships, and managing program/project priorities according to an integrated unclassified/classified enterprise space architecture. Expanding the appropriate acquisition authorities and contract mechanisms to deliver capability sooner, SMC will strategically execute experimentation, prototyping, risk reduction, and other efforts to develop new or repurpose capabilities.

This program element may include necessary civilian pay expenses required to manage, execute, and deliver WSF weapon system capability. The use of such program funds would be in addition to the civilian pay expenses budgeted in program elements 1206392F and 1206398F.

Exhibit R-2A, RDT&E Project Justification: PB 2020 Air Force		Date: February 2019
Appropriation/Budget Activity 3600 / 4	**R-1 Program Element (Number/Name)** PE 1206422F / *Weather System Follow-on*	**Project (Number/Name)** 644289 / *Weather System Follow-On*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
Title: WSF Microwave Satellite (SV1-2)	94.046	115.195	209.954
Description: WSF Microwave Satellite (SV1-2): The Air Force awarded a contract to Ball Aerospace and Technologies Corp. to develop the WSF - Microwave (WSF-M) Space Vehicle (SV) to meet all three capability gaps. WSF-M SV-2 will be an option to exercise, should AF wish to replenish WSF constellation post-SV-1. SV-2 will be functionally equivalent to SV-1. The WSF-M SV-1 projected Initial Launch Capability (ILC) is FY 2024. Secondary investments may be supported to address weather gaps identified in the SBEM AoA and validated by the JROC. ***FY 2019 Plans:*** Will complete WSF-M System PDR, WSF-M Milestone B required acquisition documentation, Microwave Imager (MWI) Critical Design Review (CDR), and Spacecraft CDR. Will initiate work on WSF-M System CDR. Continue program office support and other related support activities that may include, but are not limited to studies, technical analysis, prototyping, etc. ***FY 2020 Plans:*** Will complete WSF-M System CDR and continue SV-1 development to include purchase of long lead items and spares. Plan for robust spares purchase for SV-1 could potentially support future SV-2 fabrication, should the option be exercised. Rapidly respond to implement system resiliency and situational awareness necessary to operate in the contested space domain. Activities may include, but are not limited to program office support, studies, technical analysis, prototyping, technology maturation, etc. ***FY 2019 to FY 2020 Increase/Decrease Statement:*** FY 2020 increase compared to FY 2019 by $94.759M. Justification for this increase is described in the plans above.			
Title: COWVR Tech Demo	3.158	5.230	14.376
Description: The Compact Ocean Surface Wind Vector Radiometer (COWVR) launch objective supports Category A Weather Requirements, as codified in JROC Memo 092-014, providing on-orbit technology demonstration of the new COWVR technology to deliver Weather Gap #3, Ocean Surface Vector Winds (OSVW) and Gap #8, Tropical Cyclone Intensity (TCI). This will be a cooperative mission with NASA for integrating the sensor onto the International Space Station (ISS) as a weather technology demonstration project. The new mission designation for the COWVR launch will be Space Test Program Houston Mission #8 (STP-H8). Demonstrating COWVR technology in the space environment remains an important milestone for the microwave data weather mission in lieu of the ORS-6 cancellation. Unlike ORS-6, COVWR will fly on the International Space Station and there will be no residual operational capability. Due to this restructure, the projected COWVR launch will be delayed from FY 2019 to FY 2021. ***FY 2019 Plans:***			

Exhibit R-2A, RDT&E Project Justification: PB 2020 Air Force		Date: February 2019
Appropriation/Budget Activity 3600 / 4	**R-1 Program Element (Number/Name)** PE 1206422F / *Weather System Follow-on*	**Project (Number/Name)** 644289 / *Weather System Follow-On*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
Contract awards to NASA STP mission contractors, signed JPL task plan for supporting STP-H8 mission, and completed System Preliminary Design Review (PDR) and Critical Design Review (CDR). ***FY 2020 Plans:*** Integration & Test (I&T) for COWVR/ISS; Environmental Tests; Phase 3 NASA Safety review; continued development of COWVR ground processing software; Turnover to NASA. This funding includes but is not limited to payload interface unit, associated electronics, integration, system and environmental testing, launch, and ground operations establishment. ***FY 2019 to FY 2020 Increase/Decrease Statement:*** FY 2020 increased compared to FY 2019 by $9.146M. Justification for this increase is described in plans above.			
Title: ECP ***Description:*** Energetic Charged Particles (ECP) will fulfill the Space-based Environmental Monitoring (SBEM) Weather Gap 11 and address the Secretary of the Air Force (SECAF) policy which directs each USAF Satellite Office to plan for and integrate ECP sensors on all pre-Milestone B new satellite acquisitions. To accomplish this requirement, the ECP sensor will be integrated on the WSF-M satellite. Energetic Charged Particle (ECP) Hazard Assessment System (HAS) will be a component of space attack assessment. A commercial sources for Aerospace's ECP-Lite sensor will be established. The ECP sensors will be hosted on international and commercial missions to gain additional flight opportunities, orbital regimes, relationships, and constellation architectures to augment the ECP HAS system with supplemental data. ***FY 2019 Plans:*** Complete ECP sensor and put in storage. ***FY 2020 Plans:*** Continue testing and storage of the ECP sensor for WSF before delivery to prime contractor. ***FY 2019 to FY 2020 Increase/Decrease Statement:*** FY 2020 increase compared to FY 2019 by $0.032M. Justification for the increase is described in plans above.	1.192	1.298	1.330
Title: Military Application of the Space Environment (MASE) ***Description:*** MASE demonstrates a sensor-to-shooter solution to improve mission effectiveness by providing commanders an operational risk assessment tool. MASE will deliver a capability comprised of weapon system tailored visualizations/decision aids to allow warfighter integration into operational plans and tactics, techniques, and procedures. MASE products and services will be evaluated using quantitative standard measures of performance, effectiveness, and outcome against theater operational requirements.	-	16.329	0.000

Exhibit R-2A, RDT&E Project Justification: PB 2020 Air Force		Date: February 2019
Appropriation/Budget Activity 3600 / 4	**R-1 Program Element (Number/Name)** PE 1206422F / *Weather System Follow-on*	**Project (Number/Name)** 644289 / *Weather System Follow-On*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
FY 2019 Plans: Transitioned prototype capability into operations and will continue the R&D effort for future phases. ***FY 2020 Plans:*** N/A ***FY 2019 to FY 2020 Increase/Decrease Statement:*** FY 2020 decreased compared to FY 2019 by $18.4M. Justification for the decrease is described in plans above.			
Accomplishments/Planned Programs Subtotals	98.396	138.052	225.660

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

DoD established WSF as a pre-MDAP. The acquisition strategy for WSF is based on validated SBEM AoA results from FY2014 and subsequent acquisition strategy development activities that were conducted in FY 2015. The WSF acquisition strategy focuses on streamlined acquisition process for providing materiel solutions to OSVW, TCI & LEO ECP, as validated by the JROC; deliver microwave sensing solution to address DoD needs for OSVW and TCI capabilities and deliver space environment sensing solution to address LEO ECP capabilities for on-orbit attributions and anomaly resolutions.

The Air Force intends to conduct a technology demonstration of the Compact Ocean Surface Wind Vector Radiometer (COWVR) sensor in partnership with NASA Space Test Program (STP) to launch and integrate with International Space Station (ISS), utilizing their unique technology demonstration capabilities for on-orbit demonstration of COWVR technology. SMC's STP-Houston detachment will be leading AF organization spearheading NASA partnership, with RS for funding and programmatic support to enable sensor to ISS integration/technology demonstration by 1Q FY21.

The program awarded a contract for WSF satellite, capable of meeting all three weather capability gaps, in a full and open competition environment, in order to reduce overall program cost. The Air Force is procuring one WSF-M satellite with an option for a second satellite. WSF-M first satellite (SV-1) ILC is FY 2024 to mitigate any potential weather coverage gaps. WSF-M SV-2 ILC is currently projected for FY 2028. The WSF SV-2 will be functionally equivalent to SV-1.

The WSF ECP sensor development will leverage current AFRL sensor and hazard assessment technology to accelerate availability of ECP sensor for integration on WSF-M and other planned AF satellite acquisitions. The AF intends to transition AFRL's technology to industry for production via competitive award. Two Tech Demo ECP sensors are projected to be delivered and ready for satellite integration by FY 2021. Post-Tech Demo ECP phase, each respective program offices will be responsible for the procurement/integration and sustainment of the sensors required to meet the SecAF's Space Situational Awareness (SSA) policy.

Exhibit R-2A, RDT&E Project Justification: PB 2020 Air Force		Date: February 2019
Appropriation/Budget Activity 3600 / 4	**R-1 Program Element (Number/Name)** PE 1206422F / *Weather System Follow-on*	**Project (Number/Name)** 644289 / *Weather System Follow-On*

The program intends to continue research and development at AFRL to support the MASE baseline. Features to enhance and improve MASE related prototypes/models will be added through capability drops while maintaining Risk Management Framework compliance. Award contracts to conduct studies and perform technical analysis for external data sources and optimal sensor laydown, system development and external system integration. Conduct field campaigns to validate scientific algorithms. Provision cloud services, deploy ionospheric ground sensors and provide program office support.

E. Performance Metrics

Please refer to the Performance Base Budget Overview Book for information on how Air Force resources are applied and how those resources are contributing to Air Force performance goals and most importantly, how they contribute to our mission.

Exhibit R-3, RDT&E Project Cost Analysis: PB 2020 Air Force			Date: February 2019
Appropriation/Budget Activity 3600 / 4	R-1 Program Element (Number/Name) PE 1206422F / *Weather System Follow-on*	Project (Number/Name) 644289 / *Weather System Follow-On*	

Product Development ($ in Millions)

Cost Category Item	Contract Method & Type	Performing Activity & Location	Prior Years	FY 2018 Cost	FY 2018 Award Date	FY 2019 Cost	FY 2019 Award Date	FY 2020 Base Cost	FY 2020 Base Award Date	FY 2020 OCO Cost	FY 2020 OCO Award Date	FY 2020 Total Cost	Cost To Complete	Total Cost	Target Value of Contract
COWVR Technology Demonstration	Various	Various : Various	50.745	3.157	Oct 2018	5.230	Apr 2019	14.376	Apr 2020	-		14.376	0.000	73.508	-
WSF Microwave System (SV1-2)	C/FFP	Ball Aerospace : Boulder, CO	48.044	71.832	Nov 2018	64.065	Nov 2018	182.674	Nov 2019	-		182.674	Continuing	Continuing	-
ECP	Various	Various : Various, NM	4.339	1.192	Aug 2018	11.298	Aug 2019	1.330	Aug 2020	-		1.330	Continuing	Continuing	-
ECP Prototyping	TBD	TBD : TBD	0.000	-		10.000		-		-		-	0.000	10.000	-
MASE	Various	Various : Various, CO	0.000	-		16.329	Dec 2018	-		-		-	Continuing	Continuing	-
Enterprise Systems Engineering & Integration	C/CPIF	Engility Corp. : Andover, MA	1.605	2.735	Dec 2017	4.794	Nov 2018	3.506	Nov 2019	-		3.506	Continuing	Continuing	-
Technical Mission Analysis	RO	Aerospace Corp : El Segundo, CA	6.574	4.260	Oct 2017	5.649	Oct 2018	5.789	Oct 2019	-		5.789	Continuing	Continuing	-
Weather Studies (Formerly BAA)	Various	Various : Various, CA	1.960	4.529	Mar 2018	0.500		-		-		-	0.000	6.989	-
Ground	TBD	TBD : TBD	0.000	1.670	Dec 2017	6.911	Dec 2018	5.734	Dec 2019	-		5.734	0.000	14.315	-
Pre-Acquisition Activities	Various	Various : Various	121.704	-		-		-		-		-	0.000	121.704	-
		Subtotal	234.971	89.375		124.776		213.409		-		213.409	Continuing	Continuing	N/A

Support ($ in Millions)

Cost Category Item	Contract Method & Type	Performing Activity & Location	Prior Years	FY 2018 Cost	FY 2018 Award Date	FY 2019 Cost	FY 2019 Award Date	FY 2020 Base Cost	FY 2020 Base Award Date	FY 2020 OCO Cost	FY 2020 OCO Award Date	FY 2020 Total Cost	Cost To Complete	Total Cost	Target Value of Contract
Requirements/Engineering Analysis Support	RO	Defense Information Technical Center : El Segundo, CA	1.543	-		-		-		-		-	0.000	1.543	-
Engineering Risk Reduction Studies	Various	Various : Various	1.711	-		-		-		-		-	0.000	1.711	-
		Subtotal	3.254	-		-		-		-		-	0.000	3.254	N/A

Exhibit R-3, RDT&E Project Cost Analysis: PB 2020 Air Force			Date: February 2019
Appropriation/Budget Activity 3600 / 4	R-1 Program Element (Number/Name) PE 1206422F / *Weather System Follow-on*	Project (Number/Name) 644289 / *Weather System Follow-On*	

Management Services ($ in Millions)

Cost Category Item	Contract Method & Type	Performing Activity & Location	Prior Years	FY 2018 Cost	FY 2018 Award Date	FY 2019 Cost	FY 2019 Award Date	FY 2020 Base Cost	FY 2020 Base Award Date	FY 2020 OCO Cost	FY 2020 OCO Award Date	FY 2020 Total Cost	Cost To Complete	Total Cost	Target Value of Contract
FFRDC	RO	Aerospace Corp : El Segundo, CA	21.312	4.260	Oct 2017	4.189	Oct 2018	4.293	Nov 2019	-		4.293	Continuing	Continuing	-
Other Support	Various	Various : Various	4.819	2.734	Nov 2017	3.001	Nov 2018	2.625	Nov 2019	-		2.625	Continuing	Continuing	-
A&AS	Various	Various : Various	11.927	2.027	Nov 2017	6.086	Nov 2018	5.333	Nov 2019	-		5.333	Continuing	Continuing	-
		Subtotal	38.058	9.021		13.276		12.251		-		12.251	Continuing	Continuing	N/A

	Prior Years	FY 2018		FY 2019		FY 2020 Base		FY 2020 OCO		FY 2020 Total	Cost To Complete	Total Cost	Target Value of Contract
Project Cost Totals	276.283	98.396		138.052		225.660		-		225.660	Continuing	Continuing	N/A

Remarks

Exhibit R-4, RDT&E Schedule Profile: PB 2020 Air Force		Date: February 2019
Appropriation/Budget Activity 3600 / 4	**R-1 Program Element (Number/Name)** PE 1206422F / *Weather System Follow-on*	**Project (Number/Name)** 644289 / *Weather System Follow-On*

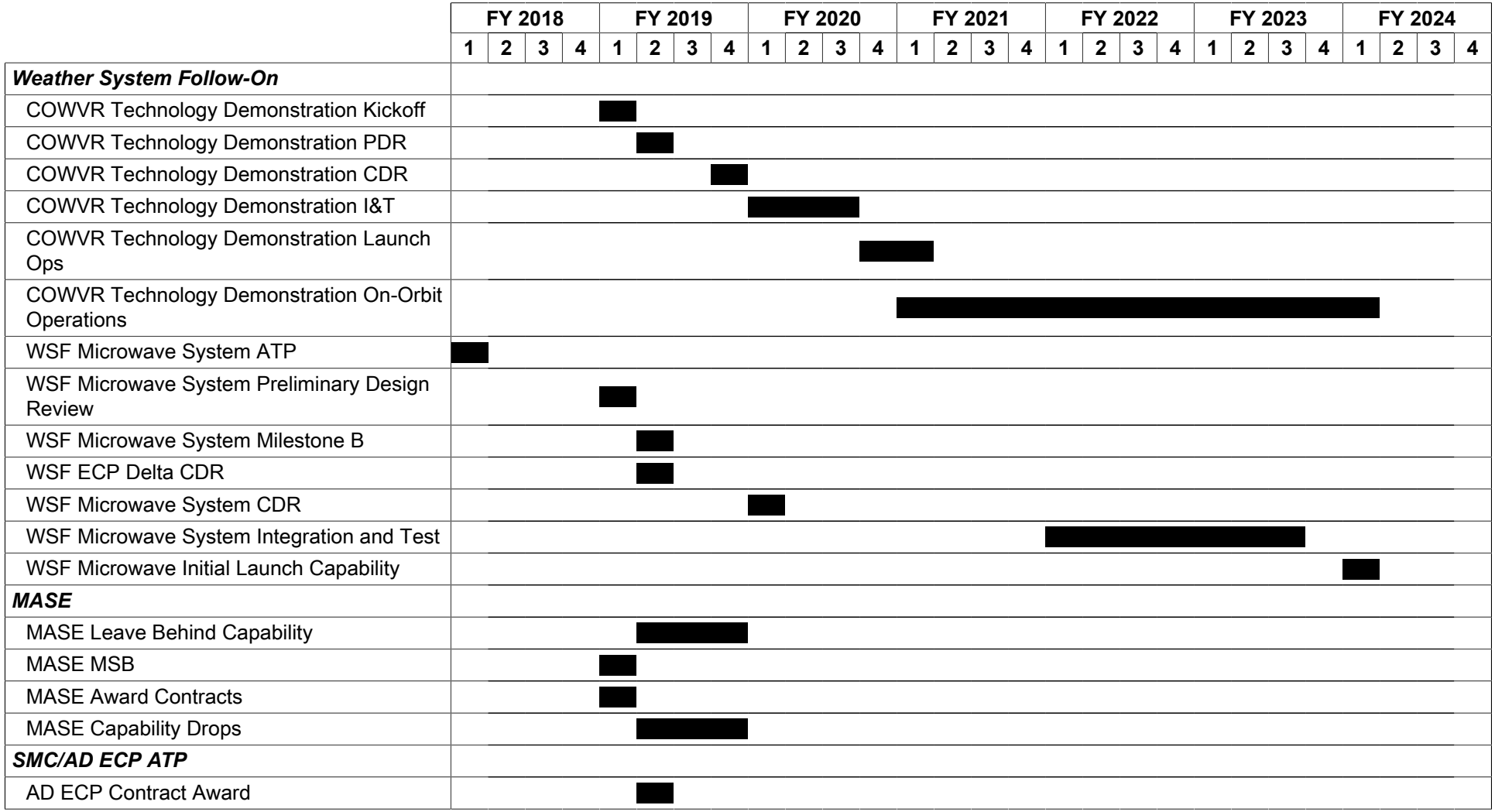

Exhibit R-4A, RDT&E Schedule Details: PB 2020 Air Force		Date: February 2019
Appropriation/Budget Activity 3600 / 4	**R-1 Program Element (Number/Name)** PE 1206422F / *Weather System Follow-on*	**Project (Number/Name)** 644289 / *Weather System Follow-On*

Schedule Details

	Start		End	
Events by Sub Project	**Quarter**	**Year**	**Quarter**	**Year**
Weather System Follow-On				
COWVR Technology Demonstration Kickoff	1	2019	1	2019
COWVR Technology Demonstration PDR	2	2019	2	2019
COWVR Technology Demonstration CDR	4	2019	4	2019
COWVR Technology Demonstration I&T	1	2020	3	2020
COWVR Technology Demonstration Launch Ops	4	2020	1	2021
COWVR Technology Demonstration On-Orbit Operations	1	2021	1	2024
WSF Microwave System ATP	1	2018	1	2018
WSF Microwave System Preliminary Design Review	1	2019	1	2019
WSF Microwave System Milestone B	2	2019	2	2019
WSF ECP Delta CDR	2	2019	2	2019
WSF Microwave System CDR	1	2020	1	2020
WSF Microwave System Integration and Test	1	2022	3	2023
WSF Microwave Initial Launch Capability	1	2024	1	2024
MASE				
MASE Leave Behind Capability	2	2019	4	2019
MASE MSB	1	2019	1	2019
MASE Award Contracts	1	2019	1	2019
MASE Capability Drops	2	2019	4	2019
SMC/AD ECP ATP				
AD ECP Contract Award	2	2019	2	2019