Annual Progress Report: Year 1
for the
Next Generation Wyoming King Air
Atmospheric Research Aircraft Project
(UWKA-2)

MSRI-1 Award # 1935930

at the

University of Wyoming

Division of Atmospheric and Geospace Sciences
Directorate for Geoscience

National Science Foundation

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Reporting Period: Year 1
(October 2019 – September 2020)

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1 Summary

The next-generation UW King Air Project had a successful first year. Year 1 laid the groundwork for the start of major development efforts and creative work across projects scheduled for Year 2. Throughout Year 1, all five Projects that compose this grant remained on track, notwithstanding the COVID-19 pandemic. So far, the pandemic has only caused some minor delays in Year 1.

The highlight of Year 1's progress was the 24 July acquisition of the baseline aircraft, a 2013 King Air 350 (s/n FL-862), by the University of Wyoming (UW). The aircraft avionics upgrade (also a UW expense) is nearly complete, as can be read below (Section 3.2, summary of Project 1) the heavyweight gear and -67 engines are in-hand at Avcon, the vendor selected for all aircraft modifications and certifications. With this major milestone completed, each of the four other Projects can move forward with design elements and component choices, which were dependent on the airframe selection and acquisition.

The radar project (Project 2) has gone very smoothly and is on track for both WCR4 and KPR2. The lidar project (Project 3) is progressing well with data system and optical milestones being achieved for the Raman and Doppler lidars. The air chemistry project (Project 4) is still scheduled to start in Quarter 8, although some efforts have been spent investigating current sensing technology. Project 5, enhanced communications and education, has progressed well and is awaiting antenna placement discussions with Avcon, so the project can move forward.

The scheduling and project management efforts at UW are being adjusted as needed to match with Avcon's internal schedule. There is enough slack in the UW baseline schedule to accommodate Avcon's proposed workflow. UW is refining our communications with the finance department at the Subawardee (Univ. of Colorado) to ensure a timely flow of financial information for Project 3, so the Earned Value Management reporting is current. Internally, expenditures are being tracked by UW's financial software, which has resulted in some delay of Quarter-end and Year-end financial data. This deficiency is being handled with expenditure tracking in the Department. Blosser engineering is serving as UW's "owner's representative" and is interfacing with Avcon to ensure that Project 1 is progressing according to schedule and that information is available when necessary to facilitate the design and installation process.

2 Major goals of the project

The University of Wyoming King Air (UWKA) aircraft is part of the NSF Lower Atmospheric Observing Facilities (LAOF) Program, and is approaching the end of its useful life. Through this grant, we will build the next generation research King Air (UWKA-2), a facility that will not only meet the needs of the NSF-supported community within this same niche in the LAOF fleet, but will include new instruments and capabilities that are not currently available on any of the three LAOF aircraft. Specifically, we will convert a relatively new, slightly larger King Air aircraft, owned by the University of Wyoming, into an atmospheric research platform more capable than the current aircraft, equip it with instruments that allow new research perspectives, and bring these new capabilities to a technical readiness level and a data accessibility level where they can be requested and used by the NSF-funded community. Project 1 will modify a King Air 350 and certify the various modifications. The new instruments will enhance the UWKA's already strong tropospheric profiling capabilities, in particular clear-air measurements of humidity, temperature, aerosol, and 3D winds (Raman lidar and Doppler lidar) and improved measurements of cloud and precipitation properties (dual-frequency mm-wave radar system). Project 2

will develop or upgrade W-band and Ka-band profiling radars. Project 3 will develop a Doppler Wind Lidar and a Raman lidar for temperature and humidity profiling. These remote sensors, deployed in synergy, together with a series of atmospheric chemistry probes (Project 4), will make the UWKA-2 a supreme yet cost-effective airborne lab. An advanced air-to-ground communication technology (Project 5) will give scientists and students an immersive and highly-informed flight experience from the ground, thus enabling remote flight decisions.

3 Accomplishments

3.1 Project management

Matt Burkhart was appointed Project Manager of the Next-Generation UWKA Aircraft MSRI-1 grant.

The Quarter 1 report was made to NSF by the requisite deadline; after which, NSF requested clarification of items in the original Project Execution Plan (PEP), focused on the Work Breakdown Structure (WBS) dictionary and schedule. The existing PEP (rev. 2) was modified to address NSF's request and submitted to NSF on 5/29/2020 as the *baseline* Project Execution Plan (PEP.rev3). NSF commented on this on 6/22/2020, and we provided a brief response a week later, finalizing the baseline PEP.

Starting with PEP r3., Oracle Primavera P6 software is being used to develop the schedule and spending plan. It was used to support the EVM reporting in Q3, and will continue to be for future reports.

NSF recommended adjusting our contingency planning to consider both scope and cost contingency. A comprehensive contingency plan was submitted to NSF on 7/24/2020. The basic principle is that for any of the five Projects, we will request, as cost contingency, either up to 10% of the scheduled remaining budget, or the amount identified in the PEP for descoping, whichever is higher. This plan was approved by NSF on 8/3/'20, and is now included in the PEP, as a first modification to the baseline PEP.

The Fall 2019 King Air Advisory Panel (KAAP) meeting was held on 10/18/2019. The highlight of the meeting was the MSRI project and all five projects gave an extensive presentation of objectives and schedules. There was a good dialog between UW and KAAP members and constructive comments on the projects and MSRI were received. The Spring 2020 King Air Advisory Panel (KAAP) meeting was held on 4/22/2020. All five Project leads provided an update on their projects. The KAAP has provided NSF and the PIs with a report including some recommendations.

Project progress reporting, both quarterly and annually, follows a new format, first used for the Q3 report. We plan to keep this format for the remainder of the grant, through Q20. Project management software (Primavera) is used for Earned Value Management (EVM) reporting (Section 5) and PEP progress tracking. The Traffic Light Report (TLR) has been updated to reflect the WBS in the PEP (Section 4).

Note that this Year 1 annual report is being issued early (8 September) at the request of NSF. Fiscal data is only available through August 2020. Efforts have been made to account for progress that will be finished in the remaining one month of Year1 – which ends September 2020. Final Year 1 budget numbers will not be available until early October, at which time we will consider amending the annual report.

3.2 Project 1: Research Aircraft

Two significant efforts outline the bulk of the major accomplishments for Project 1 (and the MSRI in general): (1) the acquisition of the 'baseline' aircraft and its delivery to Avcon for research modifications and certification and (2) the finalization of the research modifications contract and *Statement of Work* (SOW, Rev D) that detail the 50+ modifications and certifications required to transform the baseline aircraft into one suitable for conducting atmospheric research.

The acquisition of the baseline aircraft included major items throughout Year 1, note all of these items are funded through UW, but their completion is critical to the MSRI Project 1:

• Securing a loan from the Wyoming State Land and Investment Board for the purchase of an aircraft suitable for this project (completed in December 2019);

• Approval from the UW Board of Trustees to proceed with the project, to utilize up to $4.7 M for the acquisition of a late-model King Air 350i aircraft with suitable avionics (completed April 2020);

• Selection of an aircraft and a Letter of Intent to purchase FL-862 (2013 King Air 350i; N576FA) by UW (completed June 2020);

• Signed contract with Avcon to complete the installation of Avionics upgrade for FL-862 (completed July 2020);

• Completion of aircraft purchase and delivery of aircraft to Avcon (completed July 2020); and

• Installation of Garmin G1000 Avionics system (currently underway, expected completion September 2020).

Many of the structural and electrical modifications and certifications that will be required to transform the baseline aircraft into one suitable for atmospheric research will be accomplish through a contract to Avcon Industries. Work during the first year of this award has focused on negotiating a contract between UW and Avcon for this work and developing the detailed SOW that captures the work to be completed. During the first two quarters of this year, UW was reviewing bids for the work from several vendors and awaiting final approval to proceed with the project. In April 2020, the UW Board of Trustees granted that approval and UW began negotiating a contract with Avcon. Through this process, Revisions C and D of the UW SOW were released. The current version, Rev. D, released in May 2020, is the one upon which the contract is based. Following the release of this revision, UW and Avcon negotiated a final price and schedule for the contract. The contract was presented to and approved by the Board of Trustees later in that month.

Work towards the development of the modifications commenced in June, even prior to the acquisition of the aircraft. UW hosted a Kick-off meeting between UW and Avcon personnel at the University Flight Center on June 29. During this meeting, both parties agreed to protocols that would be used for communication, sharing of data, points of contact, etc. More recently, in August, UW and Avcon have begun holding teleconferences every two weeks to discuss progress on the project. Information is being shared through a Google Drive. Action items are tracked through a RAIL system that is updated every two weeks and reviewed during the teleconference. A project schedule is also updated and reviewed

during the teleconferences every two weeks to review progress on specific items and to identify items that may fall behind schedule.

Major progress on through the Avcon work during the first year focuses principally on the Special Mission Enhancements. In particular, the larger (PT6a-67) engines were ordered and have been delivered to Avcon and are awaiting installation following the completion of the Avionics upgrade. The heavy-weight kit (landing gear and associated STC) have also been purchased and delivered to Avcon. The 400 Amp generators and development of associated STC are awaiting installation, testing, and final approval from the FAA.

Initial Conceptual design reviews have been completed for the underwing pylons and the nose extension. Preliminary design reviews for these and other major structural and electrical items are expected prior to or just following the end of Year 1.

3.3 Project 2: Radars

ProSensing has worked throughout Year 1 on the design and fabrication of KPR2 hardware, which is scheduled to be finished and delivered by 12/31/2020. KPR2 design reviews in Year 1 were productive and addressed potential issues with King Air installations.

The WCR4 contract with ProSensing, Inc. is to be signed in the beginning of Q5 with the first payment occurring in October 2020. This is a necessary deviation from the baseline schedule due to a possible deployment of WCR3 on the C-130 in early 2022 (the CAESAR project). In addition, this change will allow better synchronization between Prosensing's work with the new modulator and the start/end of work by CPI to match the new modulator to the Klystron. Initial work to gather preliminary information on the UWKA-2 Zenith ports is underway and a brief discussion of the capability was had with Avcon during the 23 June 2020 on-site kickoff meeting. The zenith port design specifications are anticipated by the end of Q5 with design reviews happening shortly thereafter. The WCR4 RF component schematic is finalized and the W-band switch logic has been optimized for non-polarimetric antennas.

The decision when to take WCR3 out of service will have to be postponed, until NSF has made a decision on CAESAR. If CAESAR is approved, we will delay taking WCR3 out of service from 30 September 2021 to 1 May 2022. This is a delay of 7 months that will move the operational readiness of WCR4 from the end of 2022 to mid-2023. The operational readiness includes testing WCR4 on the ground, installing it on the new King Air (UWKA-2), and test flying it. With this delay, we expect that ProSensing will deliver WCR4 by the end of 2022 and therefore we should be able to do ground tests as well as start working on the 4th generation of quality control, L1 and L2 processing software. Currently, we are not changing the milestone date for finishing the software work and hope to be able to still make WCR4 ready for field deployment in the 4th quarter of 2023.

3.4 Project 3: Lidars

Work on the Raman Lidar (MARLi2) for Year 1 was centered on the specification and purchase of equipment to enhance the airborne capabilities and broaden the platforms on which MARLi2 can be deployed. The laser and data system were purchased along with the 32-channel PMT array. The laser required some specific design requirements and the manufacturer was able to customize the laser to meet requirements. These items are being lab-tested and prepared for integration into MARLi2 in Year 2. Major activities for the data system upgrade and optical design were delayed due to the ongoing COVID-19 pandemic, affecting Colorado and research at CU.

Work on the Airborne Doppler lidar (ADL) was focused on the flight data system, the specification of the laser and optical sections and firmware development. The baseline data system development is progressing well and the FPGA system meets initial design specifications. The FPGA system is being refined to increase performance and test systems have been ordered to continue proof-of-concept for the single-beam ADL. The main design consideration is to have flexibilities in setting up vertical and temporal resolutions according to the application, with various FPGA devices being tested. Specifications for the laser and optical system are nearly finished and those components will be ordered and integrated starting in Quarter 5. Lab testing for the single-beam ADL components and data system may continue to be impacted by COVID-19 early in Year 2.

3.5 Project 4: Trace Gas Chemistry

No milestones or tasks for Project 4 were completed in Year 1, which is in line with our PEP. Project 4 is schedule to start in Quarter 8 at the end of Year 2. The Project 4 team has taken time in Year 1 to investigate developing trace gas analyzer technology to stay apprised of the most recent advancements. In addition, communications with the Project 1 team are ongoing to ensure that the schedule for the eventual acquisition of the trace gas instruments stays up to date. The integration of the aerosol inlet has been discussed during UW/Avcon project meetings to ensure the statement of work for the aircraft captures the inlet mounting requirements and those requirements are supported by the Avcon designs.

3.6 Project 5: Enhanced Communications and Educational Opportunities

Project 5 progress in Year 1 focused on the schematic and preliminary design of the communications systems for the new aircraft and capturing the requirements for the remote instrument control, in-flight PI display and interactive systems that will build on the aircraft communications systems. With the purchase of the aircraft, the [preferred] communications systems vendor could finalize equipment and pricing. ICDs for the antenna placements are in progress and UW is working with Avcon to secure locations for the antenna provisions now that the avionics system installation has been mostly completed. Final placement of the Aviator 300 and GoGo antennas is very much dependent on the required aircraft systems and the structural research modifications. Preliminary and critical design reviews for the antenna provisions are expected at the start of Year 2. Recent corporate-level changes at GoGo will not affect the system to be installed on the new Wyoming King Air and performance of the selected system has been improved – increasing performance of the other Project 5 components at lower flight levels. The user survey is still in progress and will be completed before the end of Year 1.

4 Traffic Light Report

The current traffic light report (TLR) through August 2020, Figure 4.1, communicates risk and performance for significant WBS elements and milestones relative to the baseline as reported by project PIs/leads. The TLR is used in conjunction with the project performance narrative to communicate an overall idea of project state. It is updated quarterly, and the Q3 TLR report is shown in Fig. 4.1. (The excel sheet on which this is based will be made available to NSF upon request.) Additional quarters will be added to the right, as the project progresses.

Project 1 is the most critical of course, given that the 4 other project depend on it. Several highly critical WBS elements have been completed on schedule. There are some minor delays for Projects 3 and 5, as detailed in Sections 5.4. and 5.6, but all Projects are at least approximately within cost, as detailed further in Section 5.

NSF MSRI grant: Next Generation Wyoming King Air
Year 1 Traffic Light Report, 1 Oct 2019 - 30 Sept 2024

Notes:

"Baseline" refers to the project outline given in the Baseline PEP v.3

"Risk": baseline probability of not meeting planned scope within budget ("in budget") or by date ("on time").

"Critical": given in terms of impact on downstream tasks:

"Low": Completion date has little direct downstream effect

"Medium": Dependent tasks within the same Project (1-5) delayed if not completed on time

"High": Dependent tasks within same and one or more other Projects delayed if not completed on time

Baseline color legend		
Traffic Light	Critical?	Risk Severity
1	Low	Low Risk
0	Medium	Medium Risk
-1	High	High Risk

Quarterly Reports color legend		
Current Quarter shaded in blue		
Traffic Light	"time" metric for tasks/milestones	"cost" metric regarding WBS project costs
	task completed	task completed within budget
1	on track	so far within budget
0	< 3 months behind	<10% over planned budget
-1	> 3 months behind	>10% over planned budget

WBS	Tasks / Milestones	Baseline plans from PEP v.3						31-Dec-19		31-Mar-20		30-Jun-20		30-Sep-20		31-Dec-20	
		Schedule			Critical?	Risk		Q1		Q2		Q3		Q4		Q5	
		Start	Complete	End Date (milestones)		On time	In budget	time	cost	time	cost	time	cost	time	cost	time	cost
Project 1: Research Aircraft Acquisition and Modification (Lead: Jeff French, University of Wyoming)																	
1	**Project 1: Research Aircraft Acquisition and Modification**	**Q1**	**Q20**		***-1***	***0***	***0***	***1***	***1***	***1***	***1***	***1***	***1***	1	1		
1	***Aircraft Ready to conduct Research***		***Q17***	***12/31/2023***	***-1***	***0***	***0***										
1.1	**Baseline Aircraft**	**Q1**	**Q6**		**-1**	**0**	**1**	**1**	**1**	**0**	**1**	**1**	**1**	**1**	**1**		
1.1.1	Aircraft Acquisition	Q1	Q4		-1	0	1	1	1	0	1						
1.1.1	*Aircraft SLIB loan approved*		*Q1*	*12/5/2019*	*-1*	*1*	*1*	*1*	*1*								
1.1.1	*UW BOT contract approvals*		*Q3*	*4/20/2020*	*-1*	*1*	*1*					*1*	*1*				
1.1.1	*Contract with Avcon for aircraft selection*		*Q3*	*6/1/2020*	*0*	*1*	*1*					*1*	*1*				
1.1.1	*Purchase agreement signed by UW BOT*		*Q4*	*7/1/2020*	*-1*	*0*	*0*										
1.1.1	*New aircraft acquired, purchase complete*		*Q4*	*8/28/2020*	*-1*	*0*	*0*										
1.1.2	Avionics Upgrades	Q3	Q6		0	1	1					1	1	1	1		
1.1.2	*Avionics upgrade contract signed with Avcon*		*Q4*	*7/15/2020*	*0*	*1*	*1*							*1*	*1*		
1.1.2	*Avionics upgrade completed*		*Q6*	*3/1/2021*	*0*	*1*	*1*							*1*	*1*		
1.2	**Project Oversight and Contract Administration**	**Q1**	**Q16**		**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**		
1.2.1	*UW acceptence of modified aircraft*		*Q16*	*8/1/2023*	*0*	*0*	*1*										
1.3	**Special Mission Modifications**	**Q3**	**Q6**		***-1***	***0***	***0***					*1*	*1*	*1*	*1*		
1.3,4	*Modification contracts with Avcon*		*Q3*	*6/1/2020*	*-1*	*0*	*0*					*1*	*1*	*1*	*1*		
1.3	*Special mission modifications test flight*		*Q6*	*2/1/2021*	*0*	*0*	*1*							*1*	*1*		
1.3	*Special mission modifications completed*		*Q6*	*3/1/2021*	*0*	*0*	*1*							*1*	*1*		
1.3.1	*New engines ordered*		*Q5*	*10/1/2020*	*0*	*1*	*1*										
1.3.1	*New engines installed*		*Q7*	*3/1/2021*	*0*	*1*	*1*							*1*	*1*		
1.3.2	*MTOW kit ordered*		*Q5*	*10/1/2020*	*0*	*1*	*1*										
1.3.2	*MTOW kit installed*		*Q7*	*3/1/2021*	*0*	*1*	*1*							*1*	*1*		
1.4	**Research Modifications**	**Q2**	**Q11**		**-1**	**0**	**0**			**1**	**1**	**1**	**1**	**1**	**1**		
1.4	*Research modifications test flight*		*Q10*	*2/1/2022*	*0*	*0*	*1*										
1.4	*Research modifications completed*		*Q11*	*3/31/2022*	*0*	*0*	*1*										
1.4	*Aircraft returned to UW*		*Q11*	*4/1/2022*	*-1*	*0*	*1*										
1.4.1	Electrical Modifications	Q3	Q10		-1	0	0					1	1	1	1		
1.4.1.2	*Mission electrical bus critical design review*		*Q5*	*11/2/2020*	*-1*	*0*	*0*										
1.4.1.2	*Mission electrical bus load shed test*		*Q6*	*2/1/2021*	*-1*	*0*	*0*										
1.4.2	Structural Modifications	Q2	Q11		-1	0	0		1	1	1	1	1	1	1		
1.4.2.1	*Wing pylon critical design review*		*Q5*	*10/15/2020*	*-1*	*0*	*0*										
1.4.2.2	*Nadir ports critical design review*		*Q6*	*1/4/2021*	*0*	*0*	*1*										
1.4.2.3	*Zenith ports critical design review*		*Q6*	*1/4/2021*	*-1*	*0*	*0*										
1.4.2.4	*Noseboom critical design review*		*Q5*	*11/2/2020*	*-1*	*0*	*0*										
1.4.2.5	*Nose extension critical design review*		*Q5*	*11/2/2020*	*-1*	*0*	*0*										
1.4.2.6	*Upper multi-use ports critical design review*		*Q6*	*1/4/2021*	*-1*	*0*	*0*										
1.4.2.7	*Air sampling ports critical design review*		*Q7*	*5/3/2021*	*-1*	*0*	*0*										
1.4.2.9	*Antenna support critical design review*		*Q6*	*1/4/2021*	*-1*	*0*	*0*										
1.4.2.10	*Misc. modifications critical design review*		*Q5*	*11/2/2020*	*-1*	*0*	*0*										
1.5	**Certification**	**Q4**	**Q20**		**-1**	**0**	**0**							1	1		
1.5.1	Fatigue Safe-Life	Q8	Q10		0	0	1										
1.5.2	Normal Category	Q4	Q11		-1	0	0							1	1		
1.5.2.1-4	*Normal Category Modification PSCPs submitted to FAA*		*Q5*	*10/1/2020*	*-1*	*0*	*0*										
1.5.2.1-4	*Normal Category Modification PSCPs approved by FAA*		*Q6*	*1/4/2021*	*-1*	*0*	*0*										
1.5.2.1-4	*Normal Category Modification Document package submitted to FAA*		*Q9*	*10/1/2021*	*0*	*0*	*0*										
1.5.2.1-4	*Normal Category Modification STCs issued by FAA*		*Q10*	*2/1/2022*	*-1*	*0*	*0*										
1.5.3	Restricted Category	Q8	Q16		-1	0	0										
1.5.3	Intrument installation certified in restricted category		Q16	8/31/2023	-1	0	0										
1.5.4	Lidar Certification	Q13	Q20		1	0	1										
1.5.4.1-2	*Lidar STC PSCP*		*Q14*	*1/4/2023*	*1*	*0*	*1*										
1.5.4.1-2	*Document package submitted to FAA*		*Q19*	*4/1/2024*	*1*	*0*	*1*										
1.5.4.1-2	*Lidar STCs issued by FAA*		*Q20*	*7/1/2024*	*1*	*0*	*1*										
1.6	**Aircraft Completion**	**Q11**	**Q20**		**1**	**0**	**1**										
1.6.1	Research Infrastructure	Q8	Q20		0	0	1										
1.6.1.3	*Power distribution system test*		Q16	7/31/2023	0	0	1										
1.6.1.4	*Cabling test*		Q14	3/31/2023	0	1	1										
1.6.2	Research Instrumentation	Q10	Q17		1	0	1										
1.6.2.2	*Permanent instrumentation installed*		*Q13*	*11/30/2022*	*0*	*0*	*1*										
1.6.2.3	*Research Systems sucessful flight test*		*Q17*	*12/31/2023*	*1*	*0*	*1*										
1.6.3	Flight Testing and Training	Q1	Q20		0	1	1	1	1	1	1	1	1	1	1		
1.6.3.2	Flight Testing Y3-5	Q10	Q20		1	1	1										
Project 2: WCR and KPR Radar Development (Lead: Sam Haimov, University of Wyoming)																	
2	**Project 2: WCR and KPR Radar Development**	**Q1**	**Q18**		**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**		
2.1	**WCR4**	**Q1**	**Q17**		**0**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**		
2.1	*Make decision to take WCR3 out of service*		*Q4*	*9/25/2020*	*0*	*0*	*1*							*-1*	*-1*		
2.1	*WCR3 taken out of service*		*Q8*	*9/30/2021*	*-1*	*0*	*1*										
2.1.1	WCR4 KA 350 Radar Ports	Q1	Q5		1	0	0	1	1	1	1	0	1	0	1		
2.1.1	*WCR4 radar port design and approval*		*Q5*	*12/31/2020*	*1*	*0*	*0*										
2.1.2	WCR4 Transmitter	Q4	Q9		1	0	1							0	0		
2.1.2	*New modulator ordered*		*Q5*	*10/1/2020*	*1*	*0*	*1*										
2.1.2	*Completed and tested transmit section*		*Q9*	*12/30/2021*	*1*	*0*	*1*										
2.1.3,4,5	WCR4 RF Reconfiguration	Q5	Q11		1	0	1										
2.1.5	*ProSensing delivers WCR4 to UW*		*Q11*	*6/30/2022*	*1*	*0*	*1*										
2.1.7	WCR4 Aircraft Installation	Q12	Q13		1	0	1										
2.1.7	*WCR4 installed and operational in new King Air*		*Q13*	*12/29/2022*	*1*	*0*	*1*										
2.1.8	WCR4 L1 and L2 Processing	Q14	Q16		1	0	1										
2.2	**KPR2**	**Q1**	**Q18**		**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**		
2.2.1	KPR2 Contract	Q1	Q1		1	1	1	1	1								
2.2.2,3	KPR2 Antenna Head, Radar and Pod Development	Q2	Q5		1	1	1			1	1						
2.2.2	*KPR2 head and pod design approval by UW*		*Q2*	*3/31/2020*	*1*	*1*	*1*			*1*	*1*						
2.2.3	*KPR2 instrument and pod delivered to UW by ProSensing*		*Q5*	*12/31/2020*	*1*	*0*	*1*										
2.2.4	KPR2 Ground and Airborne Testing and Data Analysis	Q6	Q7		1	0	1										
2.2.5	KPR2 QPC Mode	Q6	Q9		1	0	1										
2.2.7	KPR2 KA350 Aircraft Installation	Q11	Q13		1	0	1										
2.2.7	*KPR2 successful test flight on new King Air*		*Q13*	*11/21/2022*	*1*	*0*	*1*										
2.2.8	KPR2 L1 Processing Code	Q14	Q15		1	0	1										
2.2.9	KPR2 QPC Data Analysis	Q15	Q18		1	0	1										

Figure 4.1a TLR for Projects 1 and 2

Project 3: New Lidar capabilities: MARLi-2 and ADL (Lead: Zhien Wang, University of Colorado)																				
3	**Project 3: New Lidar capabilities: MARLi-2 and ADL**	**Q1**	**Q20**		**1**	**1**	**1**		**1**	**1**	**0**	**0**	**0**	**1**						
3.1	**MARLI2 Development**	**Q1**	**Q9**		**1**	**0**	**0**		**1**	**1**	**0**	**1**	**0**	**1**						
3.1.1	*MARLi2 Laser PO issued*		*Q2*	*2/3/2020*	*1*	*1*	*1*		*1*	*1*										
3.1.4	*Lidar specifications available for STC development*		*Q9*	*10/1/2021*	*0*	*0*	*0*													
3.1.4	*MARLi2 ready for aircraft installation*		*Q9*	*10/1/2021*	*0*	*0*	*0*													
3.2	**ADL development**	**Q1**	**Q20**		**1**	**1**	**1**		**1**	**1**	**0**	**0**	**0**	**0**						
3.2.1	**One-beam prototype ADL development**	**Q1**	**Q8**		**0**	**1**	**1**		**1**	**1**	**0**	**0**	**0**	**0**						
3.2.1.1	*FPGA Specs for flight data system finalized*		*Q4*	*7/1/2020*	*1*	*1*	*1*						*1*	*1*						
3.2.1.2	Optical telescope system POs issued	Q4	Q5		1	1	1						1	1						
3.2.1.3	*One-beam prototype successful*		*Q8*	*9/29/2021*	*1*	*1*	*1*													
3.2.1.4	*ADL Laser PO issued*		*Q3*	*5/1/2020*	*1*	*1*	*1*						*1*	*1*						
3.2.2	**Five-beam fixed ADL Development**	**Q9**	**Q20**		**1**	**0**	**0**													
3.2.2.1	*FWD nadir port specs received from Avcon*		*Q9*	*10/1/2021*	*0*	*0*	*0*													
3.2.2.1	*Five-beam ADL design review*		*Q9*	*11/15/2021*	*0*	*1*	*1*													
3.2.2.2	*Issue PO for lasers, data system and optics*		*Q10*	*1/3/2022*	*1*	*1*	*1*													
3.2.2.3	*Fitment verified in new King Air*		*Q12*	*9/1/2022*	*0*	*1*	*1*													
3.2.2.4	*Five-beam ADL ready for aircraft installation*		*Q18*	*3/1/2024*	*0*	*0*	*0*													
3.2.2.5	*Five-beam ADL ready for deployment*		*Q20*	*9/27/2024*	*0*	*0*	*0*													
Project 4: Trace Gas and Air Chemistry Development (Lead: Dana Caulton, University of Wyoming)																				
4	**Project 4: Trace Gas and Air Chemistry Development**	**Q7**	**Q20**		*1*	*1*	*1*													
4.1	**Instrumentation Acquisition, Calibration and Testing**	**Q7**	**Q20**		0	1	1													
4.1.1	Instrument Development	Q7	Q18		0	1	1													
4.1.1.1	NOx Instrument Procurement	Q14	Q17		0	1	1													
4.1.2.1,3	Ozone & Trace Gas Instruments Procurement	Q15	Q17		0	1	1													
4.1.4	Aircraft Aerosol Inlet Development	Q7	Q18		0	1	1													
4.1.4.1	Aircraft Aerosol Inlet Procurement	Q7	Q9	12/31/2021	0	1	1													
4.1.5	Ground Testing	Q19	Q19		1	0	1													
4.1.6	Flight Testing	Q20	Q20		1	0	1													
4.1.7	Certification	Q20	Q20		0	0	0													
4.1.7	*Aircraft Certification Complete*		*Q20*	*9/30/2024*	*0*	*0*	*0*													
4.2	**Research Scientist Position**	**Q14**	**Q20**		0	0	1													
4.2	*Research Scientist Position Hired*		*Q17*	*10/2/2023*	*0*	*0*	*1*													
Project 5: Enhanced Communication and Education (Leads: Matt Burkhart & Shane Murphy, UWyo)																				
5	**Project 5: Enhanced Communication and Education**	**Q1**	**Q20**		1	1	1		1	1	1	1	0	1	0	1				
5	*User Survey Complete*		*Q4*	*7/30/2020*	*1*	*1*	*1*								*0*	*1*				
5.1	**Broadband Connectivity Infrastructure**	**Q1**	**Q20**		-1	0	0		1	1	1	1	0	1	1	1				
5.1.2	*Antenna locations for communications systems identified*		*Q4*	*8/3/2020*	*-1*	*-1*	*-1*								*0*	*1*				
5.1.2	*Antenna provisions critical design review*		*Q5*	*10/15/2020*	*-1*	*0*	*0*													
5.1.3	*Procurement of communications systems hardware complete*		*Q7*	*6/30/2021*	*0*	*0*	*0*													
5.1.4	Aircraft installation and integration	Q12	Q14		1	1	1													
5.1.5	Flight testing and certification of communication systems	Q16	Q18		-1	-1	-1													
5.1.6	*Communications systems operational for research flights*		*Q20*	*9/27/2024*	*1*	*1*	*1*													
5.2	**Remote Instrument Interaction**	**Q3**	**Q19**		1	1	1						0	1	0	1				
5.2.2	*Critical design review of hardware and software system*		*Q6*	*3/31/2021*	*1*	*1*	*1*													
5.2.3	*Hardware procurement and delivery*		*Q8*	*7/1/2021*	*0*	*0*	*0*													
5.2.4	*System integrated with aircraft communications system*		*Q15*	*6/30/2023*	*0*	*0*	*0*													
5.2.4	*Flight Testing of instrument interaction system*		*Q18*	*1/1/2024*	*0*	*0*	*1*													
5.2.5	*Instrument integration systems operational for research flights*		*Q20*	*7/1/2024*	*1*	*1*	*1*													
5.3	**In-Flight PI Display**	**Q3**	**Q20**		0	0	1						0	1	0	1				
5.3.2	*Critical design review completed*		*Q18*	*2/15/2021*	*-1*	*-1*	*-1*													
5.3.3	*Hardware and software procurement*		*Q12*	*9/30/2022*	*0*	*0*	*0*													
5.3.4	Aircraft installation and flight testing	Q17	Q18	10/30/2023	-1	0	0													
5.3.6	*PI-display system operational for research flights*		*Q20*	*8/30/2024*	*0*	*1*	*0*													
5.4	**Immersive Operational Environment**	**Q3**	**Q19**		0	1	1						0	1	0	1				
5.4.2	*Critical design review of supporting aircraft modifications completed*		*Q6*	*3/31/2021*	*-1*	*0*	*0*													
5.4.2	*Critical Design Review Completed*		*Q12*	*9/30/2022*	*0*	*0*	*0*													
5.4.3	*Hardware and software procurement*		*Q14*	*1/2/2023*	*0*	*0*	*0*													
5.4.4	Aircraft installation and testing	Q18	Q19	4/1/2024	0	0	0													
5.4.5	*Operational environment operational for research flights*		*Q20*	*7/1/2024*	*1*	*1*	*1*													
5.5	**Training and Educational Experiences**	**Q7**	**Q20**		1	1	1													
5.5.1	*Identify collaborating institution for graduate course pilot*		*Q11*	*5/16/2022*	*1*	*1*	*1*													
5.5.2	*Course development complete*		*Q16*	*8/15/2023*	*1*	*1*	*1*													
5.5.3	*Initial course offering complete*		*Q19*	*5/15/2024*	*0*	*0*	*1*													
5.5.4	*Course rollout to other institutions*		*Q20*	*8/2/2024*	*1*	*1*	*1*													
5.6	**Offline Interactive Experiences and Course**	**Q11**	**Q20**		1	1	1													
5.6.2	*Statement of work complete and contract with Shell Visualization Center*		*Q12*	*9/30/2022*	*0*	*1*	*0*													
5.6.3	Interactive aircraft course materials testing	Q18	Q20		1	1	1													
5.6.4	*Course rollout to the public via facility website*		*Q20*	*8/15/2024*	*1*	*1*	*1*													

Figure 4.1b TLR for Projects 3, 4 and 5

5 Earned Value Update

Performance graphs for the overall UW MSRI and each individual project are shown by the earned value charts in Figure 5.1 through Figure 5.7. Baseline PEP (v.3) sections 7.3 and 7.6 specify that an earned value management system (EVMS) is being used to support the project and track project performance. Time efficiency of the project is given by the calculated schedule variance and *schedule performance index* (SPI). Cost efficiency of the project is given by the calculated cost variance and *cost performance index* (CPI). The methods of calculating the displayed values and the indices are given in the MSRI PEP. In essence, SPI is the ratio of the earned value over the scheduled (planned) value, and CPI is the ratio of the budgeted to the actual cost of work performed, not just for the reporting quarter, but to date. In general, SPI and CPI values > 1.0 indicate efficient performance, while SPI and CPI values < 1.0 indicate some deficiencies.

The charts shown in this Year 1 Annual Report are derived from current schedule and cost information, as maintained by the project management software, in relation to the baseline schedule and planned value costs presented in the baseline PEP (v.3). The data is valid through the end of August 2020. The remaining month of Year 1 (September 2020) will be incorporated when the month closes and reflected in the Q5 report. Delays in financial reporting and capturing accurate schedule performance are being addressed and accuracies will continue to improve for subsequent reports.

5.1 MSRI

The overall MSRI performance, Figure 5.1, is presently on track. The CPI value of 1.21 shows that the overall project is under budget. However, this is primarily due to the lack of cost expenditures for Project 3: Lidars. UW is working with PI Wang and CU to improve the timeliness of the financial reporting. To improve the EVM report, PI reported values for outstanding purchase orders were used in conjunction with UW payments to CU.

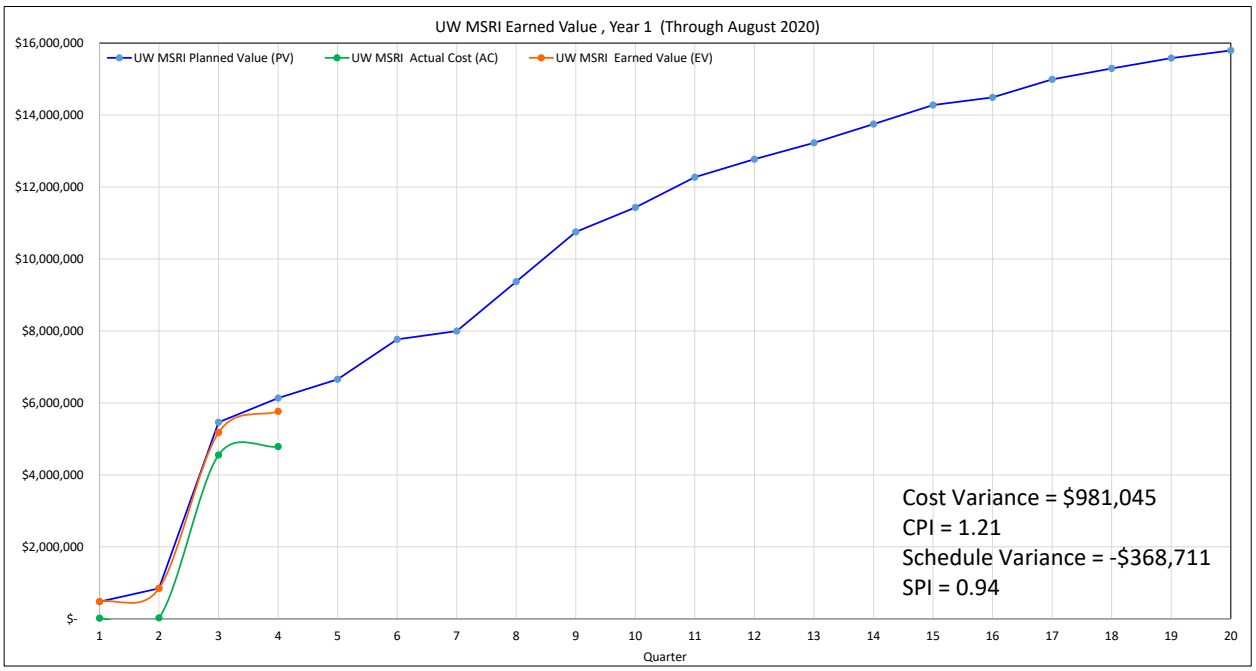

Figure 5.1 MSRI EVM Chart

The SPI value of 0.94 shows that the project is slightly behind schedule. This is due to a delay in lab work for Project 3 due to the COVID pandemic, as well as slight delays in Project 1 and Project 5. The impacts due to specific Projects are discussed in the following sections.

5.2 Project 1: Aircraft

Project 1: Aircraft is presently on track. The 1.07 CPI shows the project is slightly under budget. This is due to any payments to Avcon for the remainder of Year 1/Q4 not being reflected in the financial data. The 0.94 SPI shows the project is slightly behind schedule. However, the aircraft contractor, Avcon, is actually ahead of their schedule for some of the key orders (engines and gear) and the submission of PSCPs to the FAA. The delay is an artifact of the early annual report submission and the delay of preliminary design reviews. The MSRI project team is integrating Avcon's modification schedule and communicated specific performance by Avcon (via Blosser Engineering performance reports) into our schedule to improve reporting accuracy.

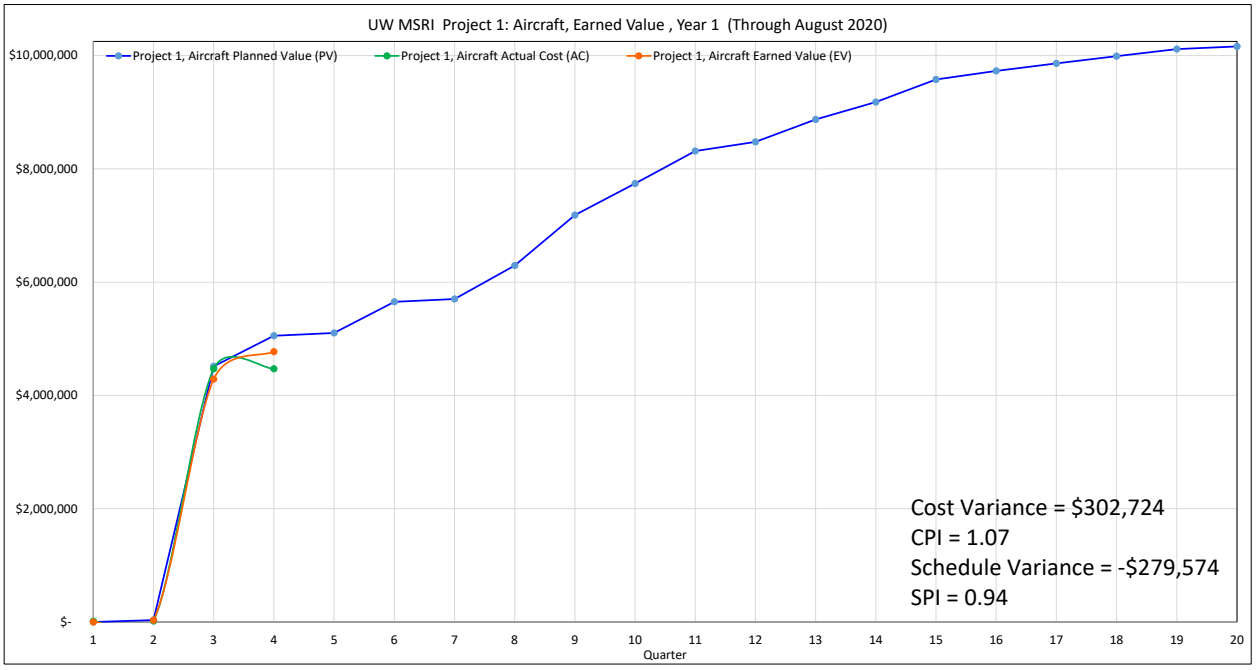

Figure 5.2 Project 1: Aircraft EVM Chart

5.3 Project 2: Radars

Project 2: Radars is presently on track. The 1.39 CPI shows the project is slightly under budget. The 0.97 SPI shows the project is on schedule. There will be a change to the schedule performance due to the CAESAR project, affecting the decision to take WCR3 offline – this will not appear until full Q4 data is available. The Quarter 5 report will reflect this change.

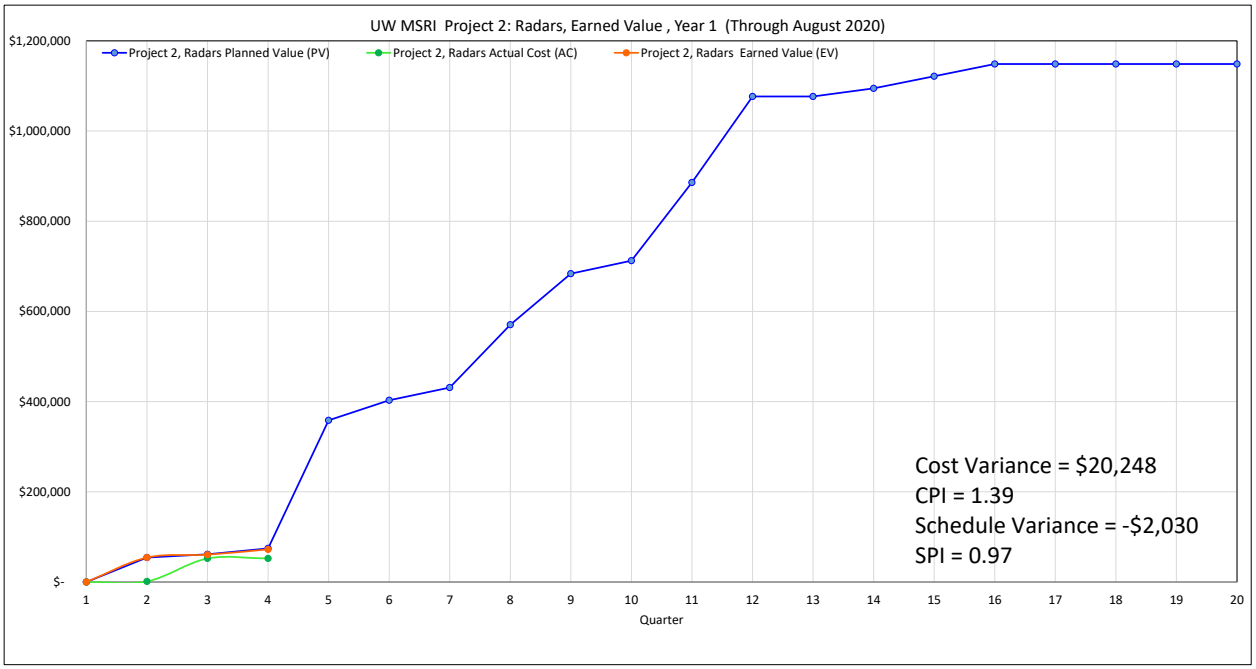

Figure 5.3 Project 2: Radars EVM Chart

5.4 Project 3: Lidars

Project 3: Lidars is presently on track, based on communications from Zhien Wang, Project 3 PI. The 3.86 CPI shows the project is very much under budget. The 0.91 SPI shows the project is slightly behind schedule. These values have improved from the Q3 Report due to better communication between UW and CU regarding expenditures. Additionally, PI reported values for Purchase Order (PO) amounts are being used. These values, especially the high CPI, are not a true representation of the project state. They continue to be artifacts of the reporting and involve delays between the University of Wyoming and the University of Colorado (CU), the Subawardee. POs for many of the items specified in the WBS have been issued as scheduled according to PI Wang – these are now included in the reporting. The two institutions are working on a solution that will allow more timely communication of direct expenditures for Project 3 so cost and schedule performance will be more reflective of the current project state. Project 3 schedule has additionally been impacted by CU's COVID-19 shutdown for research labs and on-campus work as described in the Project 3 summary. UW and CU are separate institutions in different states and COVID-19 policies are different between the institutions as to what research work is allowed. The Project 3 CPI and SPI impact the overall MSRI CPI and SPI. The high CPI is primarily responsible for an MSRI CPI of greater than 1.0, and partially responsible for an MSRI SPI of less than 1.0.

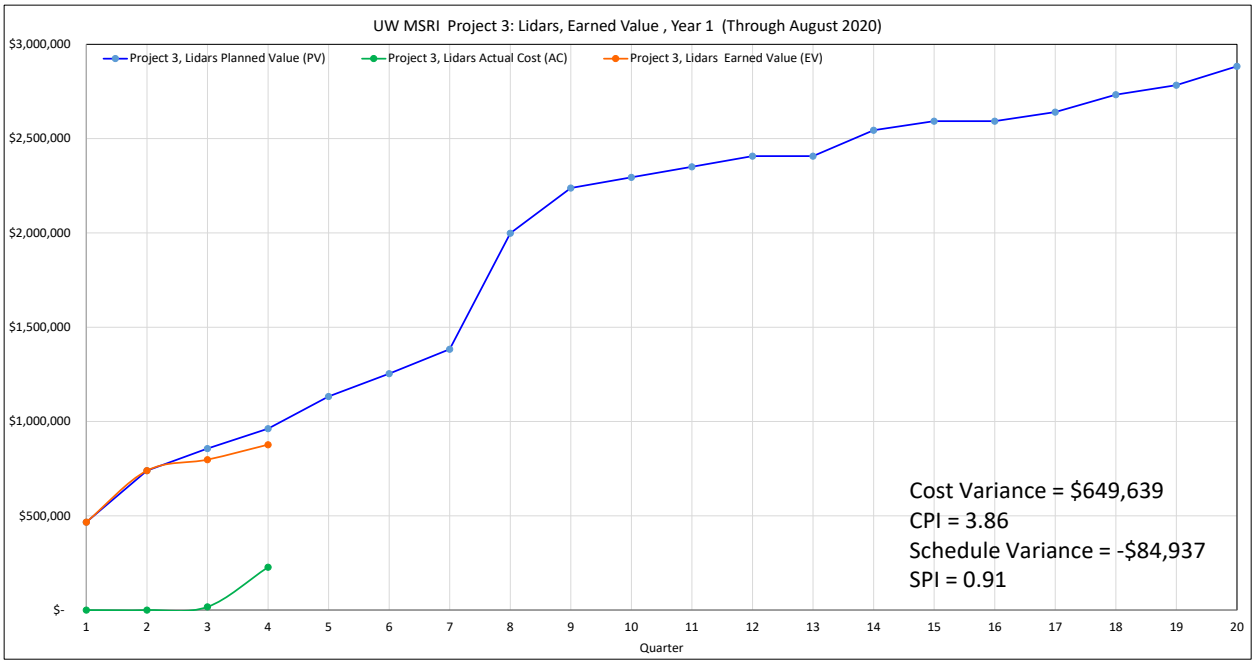

Figure 5.4 Project 3: Lidars EVM Chart

5.5 Project 4: Air Chemistry

Project 4: Air Chemistry is presently on track. The project is not scheduled to start until MSRI quarter 8. There is a small unplanned PI labor cost in Q4 related to the evaluation of an emerging technology for trace gas sensing.

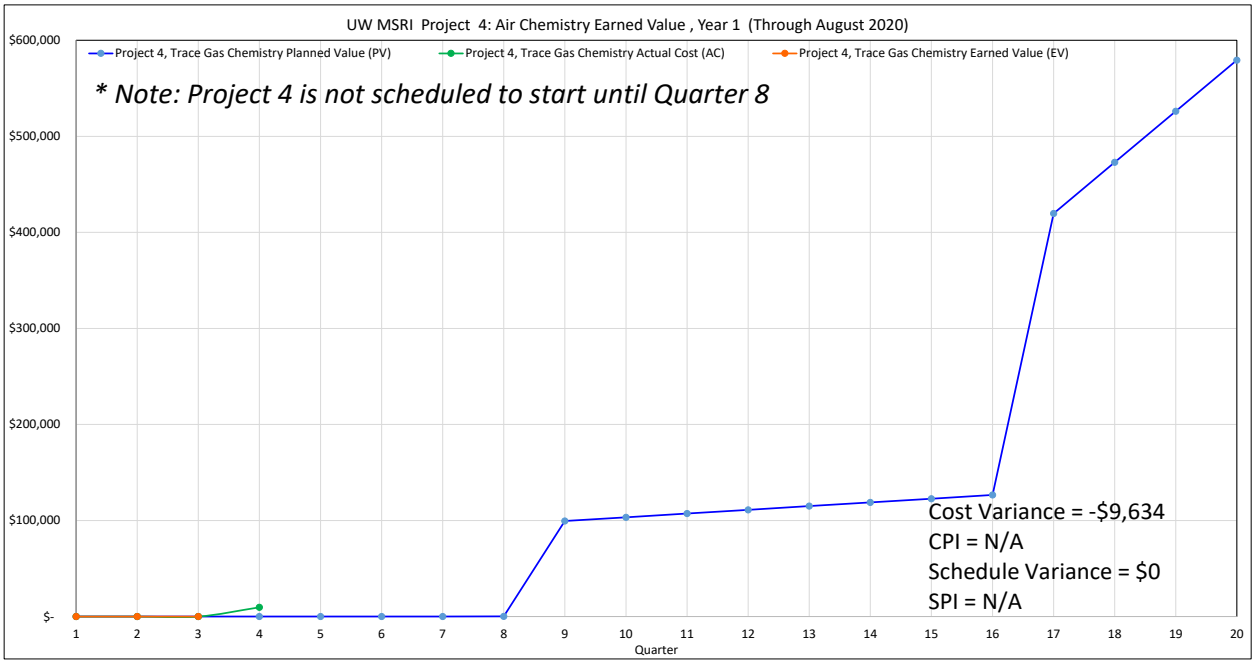

Figure 5.5 Project 4: Air Chemistry EVM Chart

5.6 Project 5: Enhanced Communications and Educational Opportunities

Project 5: Enhanced Communications and Educational Opportunities Radars is slightly behind schedule due to personnel resources scheduled for the project being allocated to the overall MSRI and commitments within the Wyoming King Air cooperative agreement (CA8). The 1.78 CPI shows the project continues to be under budget. However, this is due to labor expenditures for senior personnel not being utilized due to resource commitment issues outside the MSRI. The labor efforts will still be expended on Project 5, but in late Q4 or Q5. The 0.85 SPI shows the project is slightly behind schedule. Project personnel time has not been spent as scheduled. As mentioned in previous reports, some of the final quotes and hardware specification from the communication vendors were delayed due to the need for an actual aircraft serial number. Additionally, the user survey was shifted to Q4 based on project personnel being committed to the overall MSRI. Neither delay will impact the overall schedule, as enough slack was available in the schedule to handle the adjustment. The Project 5 SPI impacts the overall MSRI SPI and is partially responsible for an MSRI SPI of less than one.

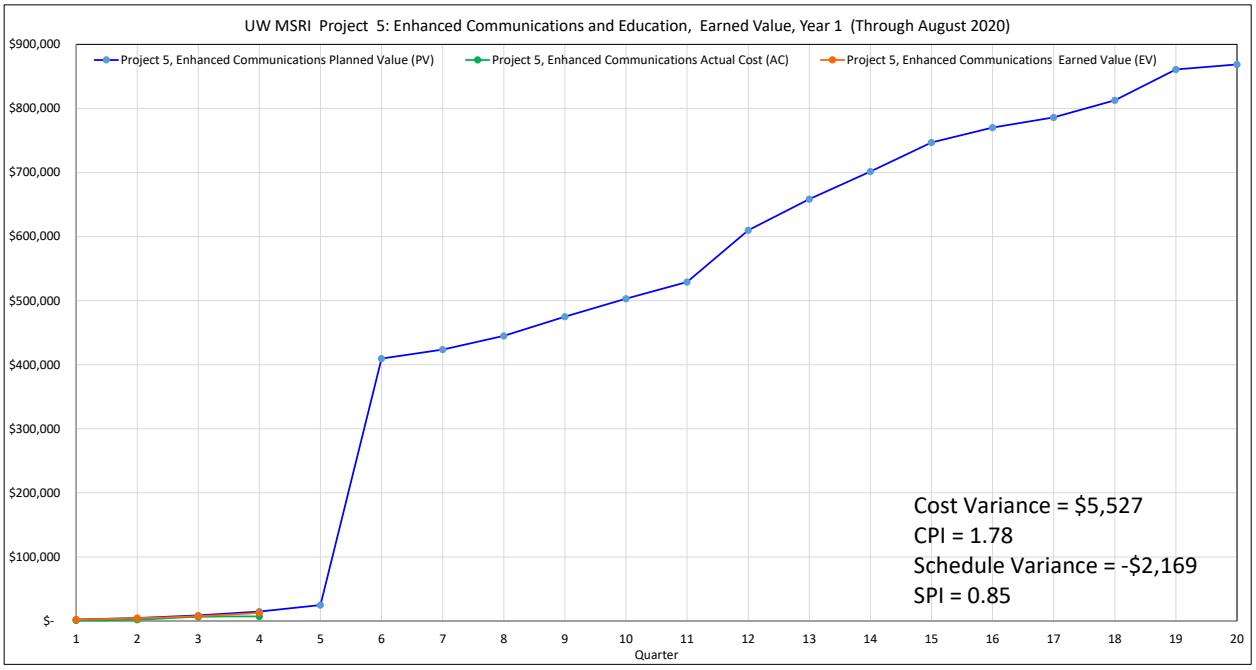

Figure 5.6 Project 5: Enhanced Communications and Educational Opportunities EVM Chart

5.7 Project 6: Project Management

Project 6: Project Management is presently on track. The 1.68 CPI shows the project is under budget. The 1.00 SPI shows the project is on schedule. The MSRI PI, Project Manager, and Project Leads are working with the Department's executive business manager (EBM) to ensure all charges for MSRI project management activities are being properly tracked through the University's financial system. Additionally, a change in EBM personnel and efforts for Project 6 has resulted in reduced personnel expenses. The reduced project management costs improve the overall CPI for the MSRI.

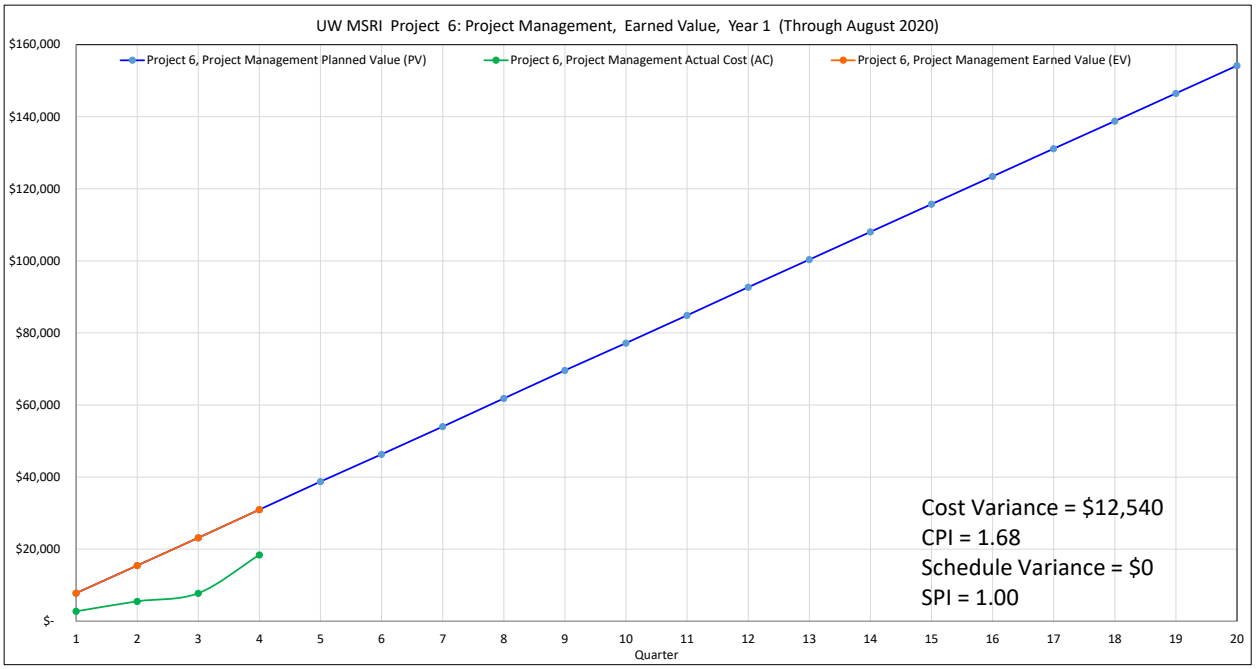

Figure 5.7 Project 6: Project Management EVM Chart

6 Opportunities for training and professional development

As part of Project 1 [WBS 1.6] the flight operations group started plans for formal training in Quarter 4 specific to flying and maintaining the new research aircraft. This training will starting Q5 and continue throughout Year 2. The University's aircraft mechanic will be attending a two-week long "initial course for maintainers" that covers the King Air 350 platform in-depth. The first of three pilots will attend a 16-day course with Flight Safety International to obtain a type rating for the King Air 350 late in late Q5 or early Q6. The other two pilots will take the same course in Year 2. By the end of Year 2, all UW pilots and mechanics will be type-rated/certified to conduct flight operations with the Wyoming King Air.

7 Information dissemination

With the acquisition of the FL-862, and with NSF closing in on funded projects through early 2022, we communicated the downtime of the UWKA as a national facility to NSF. This information has been posted on the NCAR EOL website (https://www.eol.ucar.edu/request-lower-atmosphere-observing-facilities) and the UW King Air website (http://www.atmos.uwyo.edu/uwka/users/request.shtml). The old King Air will retire following the deployment for CHACHA (which ends in April of 2022). The WCR-3 will not be available following the deployment in CAESAR (which ends in April of 2022), or earlier if CAESAR does not proceed, as discussed above. The date by which we will be able to begin supporting projects with the new aircraft and MSRI-funded new instruments is less certain. The target date is early to mid-2023 for a simple project, and late 2023 for more complex deployments.

8 Plans for the next year

8.1 Project 1: Research Aircraft

The start of Year 2 will see the major special mission modifications for the new aircraft completed. By the end of Quarter 5, the avionics, cockpit audio system, -67 engines, heavyweight gear and 400 Amp

generators will have been test flown. Design reviews for all structural and electrical research modifications will be completed by the end of Quarter 6. By the end of Year 2 all research modifications will be completed or nearing completion and certification activities will start. UW will begin the internal design tasks for the research power system, equipment racks and cabling to support the transfer of research infrastructure from N2UW to the new aircraft in Year 3. Pilot and mechanic training will occur through Year 2, with one pilot being type-rated for the new KA350 by the end of Q6.

8.2 Project 2: Radars

WCR4 will see significant progress in Year 2 with the purchase and development of the modulator along with design of the transmit section. The aircraft antenna assembly will be designed and built based on Avcon's final design specifications for the Zenith and Nadir ports. The decision to take WCR3 out of service was postponed to Year 2 due to the CAESAR project.

KPR2 hardware will be finished in Quarter 6 with the instrument and pod being delivered to UW for testing soon thereafter. Ground tests in late Quarter 6 will be followed by test flights for KPR2 on the old UWKA in Quarter 7. Test data will be analyzed and processing software development will start. ProSensing will start on the QPC development in Quarter 6.

8.3 Project 3: Lidars

The MARLi2 laser and data system upgrade will be completed in Quarter 6 with lab testing starting thereafter. Ground testing will occur in Quarter 7 and 8. MARLi2 will be ready for aircraft installation at the end of Year 2. Work will continue on the one-beam ADL and the development of an aircraft data system. The laser and optical system will be ordered and fabricated in Quarter 7. Completion of the aircraft data system in Quarter 7 will allow ground testing through the end of Year 2. A successful one-beam ADL will be the capstone of Year 2 efforts.

8.4 Project 4: Trace Gas Chemistry

The project is scheduled to start in MSRI quarter 8. The Ozone, NOx and other trace gas instruments will be researched and specified. Purchases will be made in Quarter 14 with delivery expected in Quarter 17. The aircraft aerosol inlet will be specified and purchased in Quarter 8 with a design review for the supporting King Air modifications happening shortly after. Aircraft aerosol inlet delivery is expected in Quarter 10.

8.5 Project 5: Enhanced Communications and Educational Opportunities

Final communications system selection will be made at the start of Year 2. Detailed development of the antenna and hardware provisions for the enhanced communications systems will happen in Quarter 5 and design reviews for Avcon-developed aircraft mounting provisions will happen in Quarter 6. The Aviator and GoGo communications systems will be procured midway through Quarter 6. Development and initial lab testing for the system will begin towards the end of Year2. Schematic design and design reviews for the remote instrument interaction will happen in Quarter 6 followed by hardware procurement and system code development. The in-flight PI system requirements will be completed and initial design ideas discussed with Avcon in Quart 5 and 6. A critical design review with Avcon in Quarter 7 will support the remainder of the design work through the end of Year 2. Schematic design for the immersive operational environment will occur in the first half of Year 2 with critical design reviews for required aircraft provisions scheduled for Quarter 7. Hardware evaluation will finish by the

end of Year 2. Mid-Quarter 7 will be the start of the course development activities with preliminary objectives and metrics being developed by UW.

9 Products

9.1 Books, Book Chapters

None.

9.2 Journal articles

None.

9.3 Conference papers

French, Geerts, and co-authors, 2020: "The Next-Generation Wyoming King Air Research Aircraft: Plans and Opportunities" Paper 5.1 in the 20th Symposium on Meteorological Observation and Instrumentation. Presented at the AMS Annual Meeting in Boston on 1/14/2020

9.4 Theses/dissertations

None.

9.5 Patents, inventions, licenses

None.

9.6 Website

The Department of Atmospheric Science's King Air Facility webpage is undergoing an update. The new research aircraft, modifications and the MSRI are highlighted on the new site.
https://www.uwyo.edu/atsc/uwka/next-gen-king-air.html

10 Participants and partnerships

10.1 Key participants and their roles

Figure 10.1 shows the internal organization and indicates roles and responsibilities for the UWKA-2 project

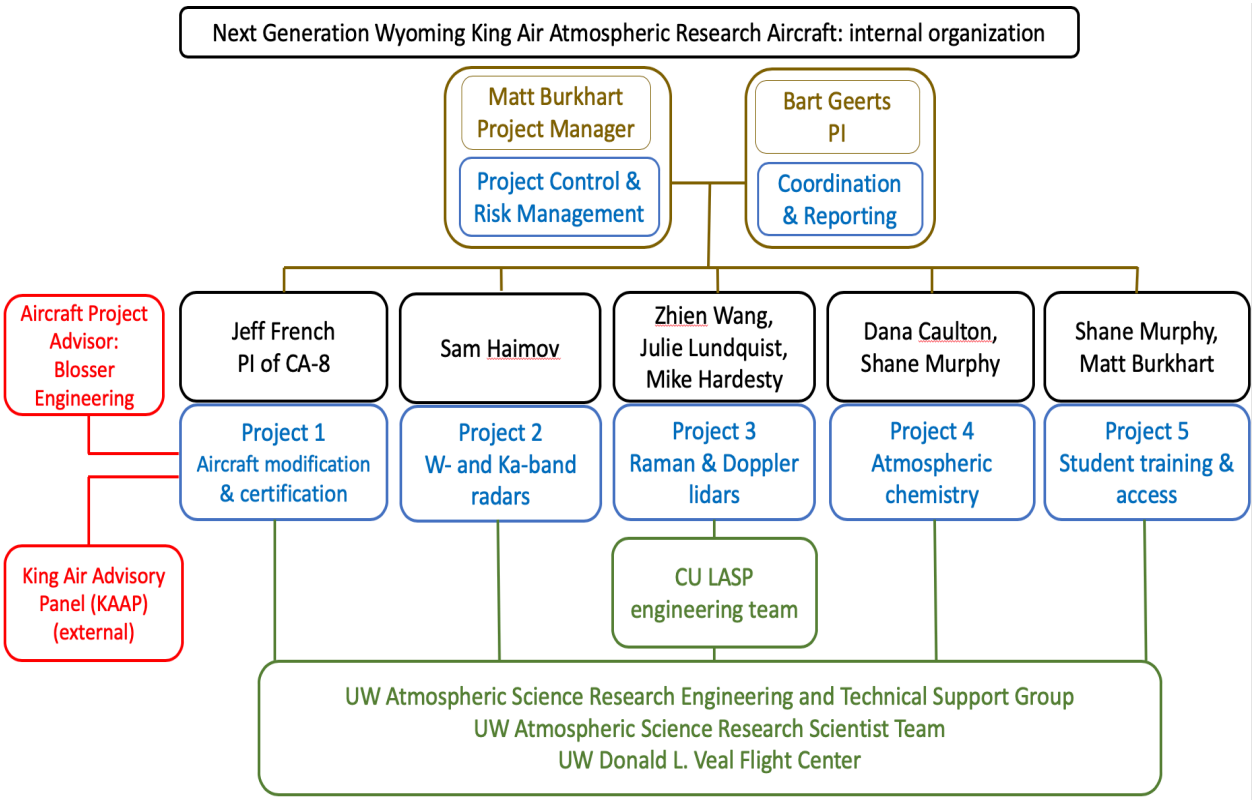

Fig. 10.1: Internal governance and organization

10.2 What other organizations have been involved as partners?

10.2.1 The King Air Advisory Panel

The scientific mission and operation of the UWKA research facility is advised by the King Air Advisory Panel (KAAP), composed of five scientists with expertise and experience using research aircraft to study atmospheric phenomena. Current KAAP members are:

- Paquita Zuidema, Professor, University of Miami, KAAP Chair
- Paul Shepson, Professor, Stony Brook University
- Jeff Stith, Facility Manager (retired), NCAR Research Aviation Facility
- Teresa Campos, Project Scientist II, NCAR Research Aviation Facility
- Beat Schmid, Manager, DOE ARM Airborne Facility

10.2.2 Industry Partners

As part of Project 1, Avcon Industries acted as the buying agent for UW. Avcon also manages the modifications to the aircraft, including special mission and atmospheric research modifications, and coordinates the aircraft certification. Blosser Engineering, Randy Blosser, is serving as the University's representative for the aircraft modification and certification process.

ProSensing, Inc. is our partner for the development of the airborne radars (KPR-2 and WCR-4).

10.3 What other collaborators or contacts have been involved?

- We worked with the NCAR Director Office (courtesy Krista Laursen) to develop our Earned Value Management.
- We exchanged thoughts with ARM Aerial Facility Manager Beat Schmid and other DOE ARM personnel about the aircraft modification and certification process. DOE ARM recently acquired piloted aircraft (a Bombardier Challenger 850) and is exploring the same issues we are regarding aircraft modification for atmospheric sensors.
- Jeff French reported on the next-generation UWKA and instrument development funded under this grant at the NSF Fall 2019 and Spring 2020 Observational Facilities Advisory Panel (OFAP) meetings at NCAR. (The latter meeting was online only.)
- The University Of Wyoming Shell Visualization Center is a collaborator for the offline interactive courses and experience for Project 5. Engagement with the Shell Visualization Center has happened on an informal basis to-date and helps maintain the relationship until late in Year 3 when the development contract begins.

11 Impacts

11.1 Impact on the development of the principal discipline(s) of the project

The UWKA-2 will serve as an ideal platform to train the next generation of observational atmospheric scientists. This facility will lower the barriers of access to the operation of advanced atmospheric airborne instrumentation, and provide these research opportunities to a broader sector of the academic community, including students not just from the University of Wyoming (an EPSCoR state), but from any university that requests the UWKA-2 for NSF-funded educational or research-focused campaigns.

11.2 Impact on other disciplines

Nothing to report

11.3 Impact on the development of human resources

Nothing to report

11.4 Impact on physical resources that form infrastructure

The UWKA-2 will be an atmospheric research platform more capable than the current aircraft. It will be equipped with instruments that allow new research perspectives. These new capabilities will be developed to a technical readiness level and a data accessibility level where they can be requested and used by the NSF-funded community.

11.5 Impact on institutional resources that form infrastructure

Nothing to report

11.6 Impact on information resources that form infrastructure

Nothing to report

11.7 Impact on technology transfer

Nothing to report

11.8 Impact on society beyond science and technology

Nothing to report

12 Changes/problems

12.1 Changes in approach and reason for change

There are no changes in the proposed work in general.

At NSF's request, we built the baseline PEP, approved as of Q3. This contains a formal project management and scheduling structure, to guide the project and adequately forecast work to be performed and the resources needed. We feel comfortable that this system can be used beyond Year 1 to support the MSRI. This system will also serve to track schedule, physical and financial performance. Initial EVM reporting from this system was be presented in Q3 and refined, based on NSF feedback, for the annual report and future quarters. A uniform quarterly report format was introduced for the Q3 report. Future quarterly and annual reports will follow this format.

At NSF's recommendation, a formal contingency management plan was submitted mid-July 2020 (Q4). This plan will help the MSRI team manage contingency needs with cost or scope management should the need arise.

12.2 Actual or Anticipated problems or delays and actions or plans to resolve them

COVID-19 related closures and supply-chain issues are having a minor impact on the project. Some lab work, especially for Project 3, has been postponed. The schedule can handle these delays without a major downstream impact. Project 5 has experienced supplier delays in returning quotes and installation information due to key vendor or manufacturing personnel working remotely. There is currently no negative impact to the schedule from these delays. Meetings with collaborators and the sharing of information is relying on video-conferences when possible. The UW MSRI team anticipates being able to make adequate accommodations for the on-site inspection visits necessary for the aircraft modification process. The UW MSRI team is working with the Department's Executive Business Manager to mitigate delays in obtaining financial information at month-end due to inherent delays in the University's accounting system. The decision to take WCR3 out of service is delayed due to a request to deploy the WCR 3 on the NSF/NCAR C-130 (the CAESAR proposal). If this project moves forward, the ~6-month delay will not affect the final availability of WCR4.

12.3 Changes that have a significant impact on expenditures

No changes are directly noted. However, as the aircraft modification schedule and certification plan is refined, in conjunction with Avcon, there exists the possibility for cost reduction related to the final delivery of the aircraft to UW.

13 Special reporting requirements

The complete "traffic light" progress report has been emailed separately to the cognizant Program Director, Dr. Mishra. This is large Excel sheet that does not lend itself to detailed presentation within the quarterly report.