AIRWORTHINESS DECISION FACTORS IN THE US AIR FORCE

THESIS

Derek N. Dennis, Captain, USAF

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Derek N. Dennis, BS

Captain, USAF

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Derek N. Dennis, BS

Captain, USAF

Committee Membership:

Lt Col A. M. Cox, PhD
Chair

Lt Col J. R. Geiger, PhD
Member

Dr. D. S. Long
Member

Abstract

There are multiple airworthiness (AW) certification paths for aircraft platforms and their modifications. Specifically, military commercial derivative aircraft (MCDA) have a unique opportunity to pursue either FAA certification, military certification or a combination of both. Policy tells MCDA programs to pursue FAA certification to the maximum extent possible, however, the policy lacks clarity regarding where that extent ends. This concept of extent encompasses multiple factors and the choice of an AW basis is a complex decision. Under ideal conditions the decision maker, the program manager, has the experience and insight to support their decision, however, this is not always the case.

This research unpacks the factors weighed by experienced personnel in an effort to inform future AW decisions. A comparative case study analysis was conducted using the same military specific modification on two MCDAs and one military specific aircraft. Interview data from multiple stakeholders was gathered for each case. While, the data set is small, it is representative, and generalizable to a common type of platform modification.

A recurring challenge is a lack of experience in AW among Program Mangers. The distilled insights from this research provides continuity and lessons learned. An AW PM Guidance Sheet summarizes key decision factors and is a key deliverable of this research. The objective of this Guidance Sheet is improved and informed decision making for future certification decisions.

While estimated cost and schedule requirements are two major factors considered in the choice of a certification basis. However, we find that the different paths are relatively equal in cost and schedule outcomes. Therefore, programs should not let a time or cost constraint dictate their decision. The primary decision factor should be focused on the technical level of integration of the modification necessary to meet FAA and military AW standards.

Acknowledgments

I would like to express my sincere appreciation to my thesis advisor, Lt Col Amy Cox, for her guidance and support throughout the course of this thesis effort. The insight, experience, and advice she provided were much appreciated. I would also like to thank all the program offices and members of AFLCMC/EZZ that participated in discussions and official interviews that enriched my data collection. Additionally, I'd like to thank all the faculty and peers that I have talked with along the way who have helped me brainstorm, edit, and even at times relax in the pursuit of the final thesis product. Finally, I would like to thank my wife, for her unwavering support and love as I worked through this enlightening 18-month experience at the Air Force Institute of Technology.

Derek N. Dennis

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I. Introduction

1.1 Background

Airworthiness (AW) certification is a necessity in the aerospace world. It implements the proper safety measures for anything that will be in the skies. AW applies to an aircraft itself or any new gadget or modification applied to an aircraft. Airworthiness is formally defined as, "the property of an air system configuration to safely attain, sustain, and complete flight in accordance with approved usage limits" as stated in MIL-HDBK 516C: *Airworthiness Criteria* (AFLCMC/ENRS, 2014). The United States Air Force (USAF) AW certification falls under the umbrella of two organizations: the Technical Airworthiness Authority (TAA) dictating the military AW processes, and the Federal Aviation Administration (FAA) dictating the civil AW processes. The TAA is within the Air Force Lifecycle Management Center (AFLCMC) EN-EZ office located at Wright Patterson Air Force Base (WPAFB), Ohio. The FAA is an agency within the U.S. Department of Transportation, with offices all across the country to be near aircraft manufacturers (Mission – Federal Aviation Administration, 2022).

Between these two AW certification authorities, there are a multitude of ways to obtain certification some of which involve the combination of both parties' processes. The reason for trying to utilize FAA AW certification as well as military AW certification paths, starts with the fact that the USAF throughout its history has used many commercial aircraft and modified them to meet military requirements (Grimes, 2014). These aircraft are called military commercial derivative aircraft (MCDA), because they originated under an FAA certification for a commercial purpose and then modified for military use (FAA & Hempe, 2015).

At present, the Air Force fleet consists of 81 different operational aircraft, in 8 mission categories (Table 1), (2021 USAF & USSF Almanac, 2021). MCDAs exist in all of the categories except for Bombers and Fighter/Attack. MCDA examples would be the E-11A (Bombardier Global Jet), VC-25 Air Force One (Boeing 747) and the KC-46 (Boeing 767), which are private and commercial passenger/cargo jets respectively in the civil domain, but for the military are ISR/BM/C3, Transport, and Tanker aircraft respectively. Bomber and Fighter/Attack are the only two aircraft types made up entirely of military specific aircraft (MSA), meaning that they were built originally for a military purpose and have no civil aircraft equivalent. For example, the A-10 Thunderbolt (Fairchild Republic), F-22 Raptor (Lockheed Martin),

Table 1: Aircraft Types & MCDA Breakout

A/C Type	# of Types	Total Aircraft	# of MCDA Type	# of MCDA AC
Bomber	3	158	-	-
Fighter/ Attack	8	2094	-	-
Spec Ops	6	154	-	-
ISR/BM/C3	26	491	17	104
Tanker	6	526	4	494
Transport	18	668	13	83
Helicopter	4	198	-	-
Trainer	10	1179	6	654
Total	81	5468	40	1335
% MCDA/Full AF Fleet			49%	24%

B-52 Stratofortress (Boeing) do not have a commercial aircraft equivalent. Due to such a unique spread of aircraft the same airworthiness certification is not applied to each platform and the modifications that are applied to them. Of the 81 types of aircraft flying 39 are MCDAs, which is over 49%. It is important to recognize just how many PMOs are having to work these complex AW decisions and that it is hardly a small portion of the Air Force working with these types of aircraft.

Air Force Policy Directive (AFPD) 62-6: *USAF Airworthiness* states that, "For all other civil aircraft acquired or modified by the Air Force, the Air Force shall obtain and maintain Federal Aviation Administration type certification to the maximum extent practical" (SAF/AQ & Roper, 2019). Although this policy is only a few years old this concept has been encouraged for generations. Aircraft initially purchased as commercial-off-the-shelf (COTS), provided initial cost and schedule savings since the aircraft was already built (Marx et al, 1990).

FAA standards and test procedures only cover a portion of military modifications (ex. a routine modification to a Heads-Up Display (HUD) due to Diminishing Manufacturing Sources (DMS)). This lack of coverage leaves certain functionalities of a system to the Air Force to certify through its channels (FAA & Hempe, 2015). This line of where the FAA certification ends and military certification begins is known as the "AW seam." This term had not been formally defined in documentation until 1 Sep 2021 in AWB-360: *Commercial Derivative Aircraft Airworthiness* (AFLCMC/EZZ & Janning-Lask, 2021), but has been a phrase passed along word-of-mouth for many years. Airworthiness Bulletins (AWB's) are guidance from the USAF Airworthiness Office (AFLCMC/EZZ) and the Technical Airworthiness Authority (TAA) that look to explain AW steps and processes. While program management offices (PMOs) must navigate this "AW seam", there is a lack of guidance on how to best approach the decision for a programs' AW certification path. Therefore, this research focuses on understanding the decision factors that different programs took into account as they pursued their AW certification. There are policies and AW Bulletins (AWB) that exist to aid in what to do once a path has been selected but not much research has been done specifically targeting how a program should decide the AW certification path for modifications. The decision of the AW certification path is not a simple binary decision of FAA certification versus military certification, but is a complex decision with multiple options of combining different levels of both certification processes.

1.2 Research Questions

This lack of continuity was motivated from the researcher's past experience in an MCDA program management office (PMO) and the difficulties faced in knowing the best approach for airworthiness certification. The research questions in this thesis are:

1. What factors are key in the choice of an AW certification path for aircraft modifications?

2. How do these decision factors influence each other in the final airworthiness path selection and its execution?

3. What can be done to improve airworthiness certification path decisions?

Hopefully by answering these questions program managers will be able to lead their programs to the clearest and most reliable certification paths for their platform.

1.3 Methodology

To answer these questions, first, a deeper look into existing literature, policies and procedures was accomplished, and second a focus on PMOs factors for AW certification path. A comparative case study analysis was performed examining different MCDA PMOs and their decision factors that dictated the AW certification decision made. The data collected was through a series of semi-structured interviews with at least one program manager (PM) and one engineer (EN) from each platform along with a representative from the TAA. This triangulation of perspectives will identify any distinctions specifically tied to personnel views. Personnel from MSA platforms are also included in these interviews in order to see how the MCDA mixed certification approach compared with a military only AW certification. The questions were categorized to bring in certain data tied to personnel's experience, the understanding of the program's modification and programmatic measures, the airworthiness certification path and

the decisions made along the way, as well as reflections of what they thought worked and lessons learned. Through coding responses, Similarities & Difference tables and direct quotes were used to identify decision factors see what influences them.

1.4 Assumptions/Limitations

There are over 80 types of aircraft flying today, and more in development, and even more modifications that occur on these platforms. The wide range of aircraft modifications (Figure 1) that are applied to our systems have the potential meet different levels of FAA certification across the "AW seam." The research focused on one type of modification, military global positioning system (Mil GPS), due to former experience with this modification. This also allowed easier access to contacts and interviews. More importantly, the research team asserted that insights from the Mil GPS modifications are extensible and representative to other modifications with similar roles (e.g., navigation and communication, Identify Friend or Foe (IFF)).

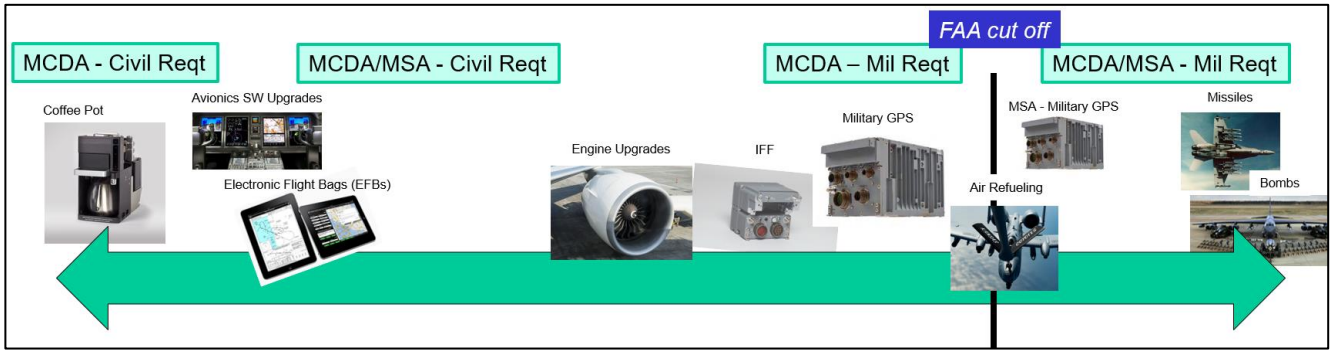


Figure 1: Spectrum of Aircraft Modifications

1.5 Implications or Expected Contributions

This research intends to better inform decision making processes for future PMOs of what decision factors current programs had going into their AW certification paths. The prior AW experience of the research team was limited going into this researcher and expected that to be the case for program managers on other platforms. Therefore, a guidance specifically for PMs as the leaders of these programs was created in hopes to better educate them before AW certification decisions are made.

1.6 Summary

Chapter II. Literature Review explains the policies behind airworthiness certification, a closer look at the AW "seam" and the different certification paths it can take. Chapter III. Methodology shows the steps taken within the interview-based comparative case study conducted. Chapter IV. Analysis and Results walks through the findings from applying the methodology. Lastly, Chapter V. Conclusion shows exactly how the results have answered the research questions, recommendations for future research, and the significance of continuity and guidance delivered form this research.

II. Literature Review

2.1 Chapter Overview

The purpose of this chapter is to show further details of the existing policies and guidance, to define the AW seam, and show applicable literature for the methodology.

2.2 Policies and Guidance

According to Cook & Haverkamp (2020), the FAA has a more proven track record, is more familiar on the international scale, and is easily repeatable. In contrast, the military approach is based on risk acceptance levels and can lead to unique certification and requirements. A common assumption that exists is that military AW process's use of risk acceptance for aircraft modifications can be a cost and schedule saver as not all compliances are necessarily met to fly operationally. This view of the FAA versus the TAA and the assumption of cost and schedule savings are something the interviews discussed in the following chapters will consider.

The FAA has very detailed instruction for obtaining an aircraft's type certificate in FAA Order 8110.4C – *Type Certification* (2017) over 200 pages, dictated by the encompassing Title 14 – *Aeronautics and Space Code of Federal Regulations* (14 CFR) specifically Part 21 – *Certification Procedures for Products and Articles* (National Archives and Records Administration [NARA], 2021). These instructions are primarily for civilian and commercial type aircraft, but do mention military aircraft and their ability to be certified as well. A type certificate (TC) is a design approval issued by the FAA saying the aircraft has met applicable compliances or standards, meaning an aircraft with a TC has received AW certification (FAA, 2017). When modifications occur a supplemental type certificate (STC) is issued indicating a major design change to the original TC, and the aircraft would continue to have its AW certification (FAA, 2017). Figure 2 shows the typical certification process for a civil aircraft.

A design is created, a certification basis and plan are set then a series of inspections, and tests are implemented to show compliance with the criteria

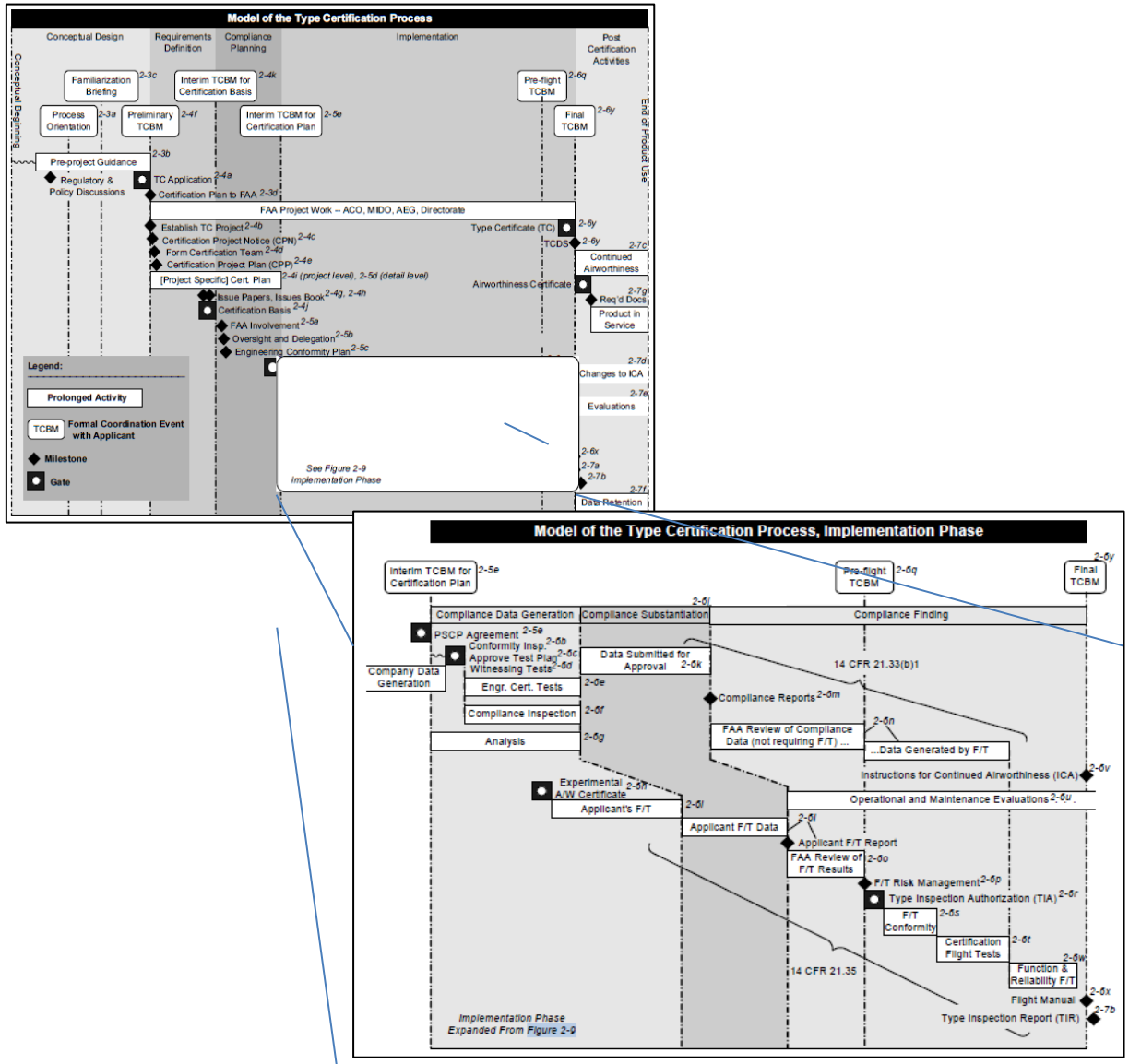


Figure 2: FAA Typical AW Type Certification Process (FAA, 2017)

set in the certification plan. When all compliances have been met, a type certificate is achieved.

The USAF's equivalent of the FAA's guidance for requirements and checklists is documented in the MIL-HDBK 516C – *Airworthiness Certification Criteria*, as directed to use by Air Force Instruction (AFI) 62-601 – *USAF Airworthiness*, stemming from policy AFPD 62-6 – *USAF Airworthiness* (ACQNow, 2021). MIL-HDBK 516C breaks down airworthiness criteria through conducting checklists that will meet different specifications from a series of different categories represent by each chapter of the document. The criteria are tailorable as not all modifications will need to meet every standard. For instance, chapter 5: *Structures*, lays out the checklist necessary for compliance as it relates to the load and mass properties of the modification and the different tolerances it must meet, while chapter 15: *Computer Systems and Software*, focuses on the standards of what pedigree the software and software architecture of the modification was developed at and if it is meeting the quality set by the checklist standards (AFLCMC/ENRS, 2014). If installing new flaps made of a new material Chapter 5 would have more AW criteria involved than 15, where as a cockpit HUD modification would have a lot more Chapter 15 criteria. Table 2 is a list of all the chapters of MIL-HDBK 516C.

Table 2: MIL-HDBK-516C Chapters (AFLCMC/ENRS, 2014)

MIL-HDBK-516C Chapters	
1. Scope	11. Avionics
2. Applicable Documents	12. Electrical System
3. Definitions and Abbreviations	13. Electromagnetic Environmental Effects (E^3)
4. Systems Engineering	14. System Safety
5. Structures	15. Computer Systems and Software
6. Flight Technology	16. Maintenance
7. Propulsion and Propulsion Installations	17. Armaments and Stores Integration
8. Air Vehicle Subsystems	18. Passenger Safety
9. Crew Systems	19. Materials
10. Diagnostics Systems	20. Air Transportability, Airdrop, Mission/Test Equipment and Carfo/Payload Safety
	21. Notes

The TAA advised the research team to take the course AIR 116 – *Introduction to AF Airworthiness Certification* on the AF course site ACQNow (2021). This was extremely helpful in the understanding of the military AW certification process. The basic process model for AW certification through the military is seen in Figure 3. A modification airworthiness certification criteria (MACC) matrix is developed based on the certification basis established through MIL-HDBK 516C, and is used as the grading rubric for the Compliance Reviews. Once tested for compliance, a final risk assessment is conducted and if all compliances are met a military type certificate (MTC) to fly is issued, but if all compliances are not met and some risk remains, depending on its severity, certain levels of leadership can accept the risk and fly on an operational military flight release without certification. The FAA is similar in that it certifies if all compliances are met, but differs from the military process in that there is no option for noncompliant certifications or risk approved operations.

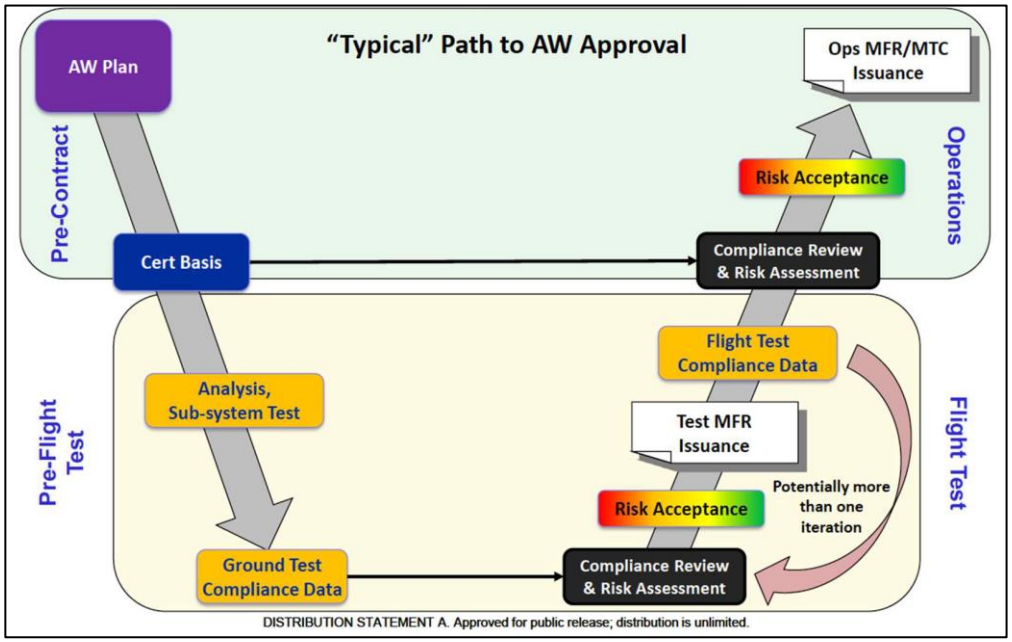


Figure 3: Military Typical AW Certification Process (ACQNow, 2021)

Another unique aspect to the military certification is whether or not the modification is reportable or nonreportable. As seen in Figure 4, all the same steps occur but the authority no longer has to go through the third party TAA office but can stay within PMOs chain of command.

A TC with the FAA and an MTC through the military process seem similar but the requirements and standards differ enough that the cert basis are not interchangeable and so MCDA aircraft often have aspects of both certification paths implemented in their AW certification. Ultimately

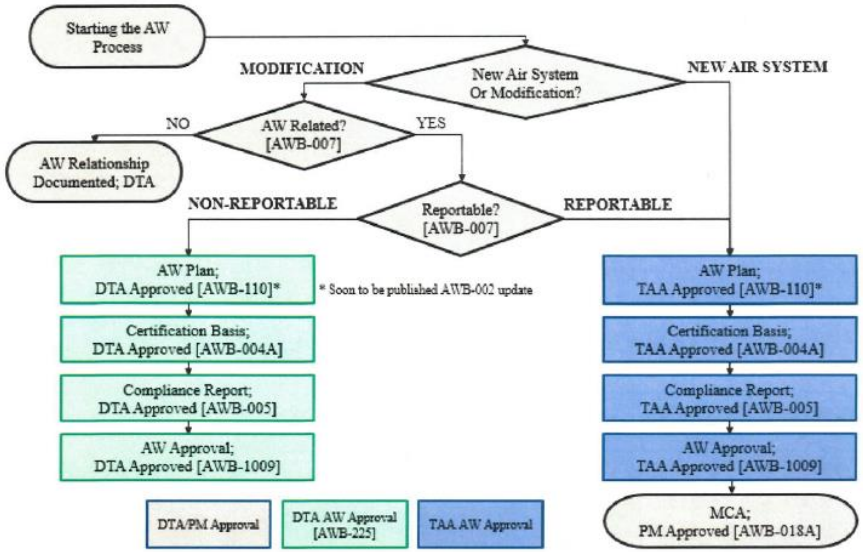


Figure 4: USAF Certification Process w/ Nonreportable Option (AFLCMC/EZZ, & Fischer, 2020)

as a military aircraft an MCDA will hold an MTC but a certain level of TC from the FAA can fall within it as well. FAA Order 8110.101A is the document that shows the different levels of FAA certification available to MCDA aircraft and what some steps are required to obtain those certification levels (FAA & Hempe, 2015). The FAA Order also establishes the roles and responsibilities of the different parties involved in an

airworthiness certification for an MCDA. There are 4 levels of FAA approval that can be applied to MCDA aircraft and their modifications as defined in Order 8110.101A (FAA & Hempe, 2015):

- Full approval – meaning equipment installation and operations without special restrictions or limitations.
- Approval with operational limitations – equipment and installation are approved but with certain limitations on operation from the FAA standpoint; also known as limited approval.
- Safe Carriage – equipment has a partial approval that allows for installation (approval of aerodynamics, weight and balance, etc.) but does not approve the functional aspects i.e., unplugged and no power.
- Provisions only – the equipment is not installed but only safety implications and limits are defined for the military to keep in mind when they go for a military installation.

Beyond the certification/approval provided by the FAA, the remaining functionality must undergo some level of military airworthiness certification process in order to be deemed safe for flight. The military certification with the TAA helps to dictate the remaining certification. This combination of certifications is referred to as the AW "seam".

2.3 AW "Seam"

The AW "seam" is a term to describe the mixing of certifications between FAA and military processes. While being a term used in this field, it was only recently codified (September, 2021). Airworthiness bulletin (AWB)-360 is a product of the TAA and defines the AW "seam". AWB-360 – *Commercial Derivative Aircraft Airworthiness*, defines the AW "seam" as "the junction between the FAA and USAF compliance assessments" (AFLCMC/EZZ & Janning-Lask, 2021). Figure 5 is an informative chart laying out what the AW "seam" looks like at each of the 4 levels of

approval. AWB-360 will be helpful in understanding the disconnects that PMOs may have with the certification processes in the future. The platforms interviewed in this research were all in execution a couple years before the release of this AWB, but the interviews will shed light on the usefulness of this AWB as well as additional insight that would be helpful for future programs.

The AW "seam" is a balance of using both FAA and military certification processes. Cook & Haverkamp (2020) have introduced four different approaches to interpreting requirements and understanding how they fit in an AW certification path for MCDAs: Superset approach – large

Level of FAA Approval	Aspect Approved by FAA or USAF				CB
Full Approval	SWaP-C	Equipment Qualification	Installation Approval	No restrictions on Use	14 CFR [6]
Limited Approval	SWaP-C	Equipment Qualification	Installation Approval	Military Use Only with Statement of Functionality	14 CFR/516 [4]
Safe Carriage	SWaP-C	Equipment Qualification [5]	Installed; Not Connected	Operational Approval	14 CFR/516
		Equipment Qualification	Connected forOperation		
Provisions Only	SWaP-C	Equipment Qualification	Installation Approval	Operational Approval	14 CFR/516
None	SWaP-C	Equipment Qualification	Installation Approval	Operational Approval	516

Notes:
1. Red line represents the AW seam.
2. Blue shading represents aspects the FAA will approve. Green shading represents aspects the USAF will approve.
3. SWaP-C is Space, Weight, Power, and Cooling.
4. MIL-HDBK-516 certification basis limited to AW-related aspects of the Statement of Functionality.
5. For FAA Equipment Qualification, equipment is in a non-functional state. Additional testing may be required by the USAF.
6. Certification basis also includes MIL-HDBK-516, criterion 4.1.3.

Figure 5: Levels of FAA Approval and AW Seam (AFLCMC/EZZ & Janning-Lask, 2021)

joint military and civil software development and verification process; Subset approach – finding common attributes at core competencies and determine a joint compliance; Model-based approach – modeling the software certification process; and Assurance Case approach – the safety case where utilizing backed evidence to explain why the software used is reliable based on similar previous functionality. The advantages and

disadvantages of these approaches are listed in the Table 3. Their approaches look at the specific software aspects of the AW seam and how the standard for civil software and mil grade software do not perfectly align, although these approaches still relate to the entirety of the AW "Seam".

Table 3: Key Advantages and Disadvantages of Each Approach

Approach	Advantages	Disadvantages
Superset	High likelihood of global acceptance Simplicity	Cost May obscure risk
Subset	Common best practices Cost	Risk of non-acceptance Potential late discovery of compliance gaps
Model-based	Transparency/ Risk identification Flexibility	Cost Tool maintenance as standards evolve
Assurance Case	Adaptable / Portable Cost	Brittle to changes/hard to maintain Long lead item requirements

2.4 Methodology Application

Outside of Cook & Haverkamp (2020), no significant literature showed how to approach the decision factors and mindset of making an AW certification path decision. With no prior literature to extend the research, the methodology quickly turned to the focus on collecting straight from the platforms directly in the form of interviews. Knowing the difficulties making contact and scheduling a multitude of interviews the focus was reduced to a few case studies involving a comparative analysis. The interview itself is just one step in the multistep sensemaking research method (DeCuir-Gunby et al, 2010). Interviews bring to light multiple aspects of a problem, if asking the right questions. Asking the right questions, will provide raw data that will tie to the theory investigated, that is also supported with some level of literature. But to make sense of these three aspects code development needs to occur of the data needs to take place. Figure 6, from DeCuir-Gunby et al. (2010) shows the cyclic nature of coding in interpreting data. This coding is not software code but a way of upfront identifying what sort of results that are to be pulled from responses in an interview. The use of semi-structured interviews allows more freedom in response and additional layers of what could be recognized as important

contribution to theory (Rubin & Rubin, 2005). In developing a codebook, it is important that the labels and phrasing are assigned to different sections of data (Miles & Huberman, 1994). This will keep the data organized as it is compressed to answer specific research questions and draw comparisons across multiple interviews as the coded phrases from different questions come to light. In these comparisons, data expansion through new connections that were unexpected can come to light allowing for new theories and perspectives to be observed (Coffey & Atkinson, 1996). Applying these coding tools can be organized in a way that can be set into decision matrices that compare particular coded interview responses head-to-head (Clarkson & Eckert, 2001).

Semi-structured interviews questions with a coded sequencing were utilized, but the matrixing for comparison of the interviews was modified into the form of Similarities & Differences tables for the methodology section in this research effort

2.5 Summary

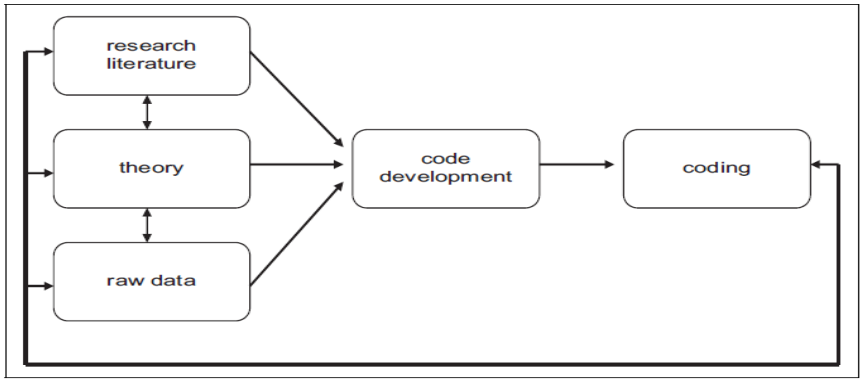


Figure 6: Circular Process of Coding (DeCuiry-Gunby et al, 2011)

There are policies, documents and even short courses that explain either the FAA or TAA airworthiness certifications. The FAA Order 8110.101A (2015) provides four options for the AW "seam" and AWB-360 (2021) defined the AW "seam", however the guidance is silent on how

PMOs have actually implemented these seams and what the key decision factors were for their course of action. Due to this gap, the research team has selected qualitative methods to characterize PMO decision factors in selecting their AW certification path. The specific methods are discussed in Chapter III. Methodology.

III. Methodology

3.1 Chapter Overview

The purpose of this chapter is to show the methods used to better understand the airworthiness decision factors of different PMOs for MCDA modifications within the Air Force. The next section is an overview of the research methodology and overall approach. The third section establishing the case study criteria. The fourth section shows how data was collected from interviews. Finally, the layout of how the data analysis was done through taking interview responses and transitioning them into tangible outputs.

3.2 Overview of Research Methodology

The primary method for this thesis was a comparative analysis of different PMOs decision factors that led to their AW certification path using semi-structured interviews. The unit of analysis was an individual aircraft modification that was a military requirement: Mil GPS. Decision factor rationale for each aircraft platform modification was gathered from multiple sources. The interviews were of PMO and TAA personnel who have worked on the aircraft modification and established an airworthiness certification process for their project. This data contributed to a case history for each modification.

A series of open-response questions were used in interviews conducted with different engineers and program managers in aircraft PMOs to learn about the airworthiness certification paths followed and the decision factors that were made along the way. Members under the Technical Airworthiness Authority (TAA) in the AFLCMC/EZZ airworthiness office were sought for interviews as they have assessment duties and, in some cases, approve the PMOs airworthiness pursuits. The interviews allowed for a matrix to be created that coded the important similarities and

differences of the informants. The matrix led to the final stage which delivered a final guidance, or cheat sheet, for future program managers to use when preparing their airworthiness certification paths for their own programs.

3.3 Case Study Criteria

There are over 5,400 aircraft within the Air Force today across 81 types or models of aircraft (Table 1). Some are being built solely with a military purpose and others had an initial design for a commercial purpose that were then purchased for use in the military. 49% of the types of aircraft are MCDA and over 1,300 aircraft are MCDA (Table 1), and so a significant portion of the Air Force mission and PMOs are supported with MCDA. Military aircraft can be identified into four major categories of aircraft and any modifications requiring airworthiness certification pertaining to them (Figure 7). These categories are based on the origin of the aircraft and then the type of modification requirement being implemented. The 4 categories are: commercial derivative aircraft (CDA) with a civil requirement, CDA with a military requirement, military specific aircraft (MSA) with a civilian requirement, and MSA with a military requirement.

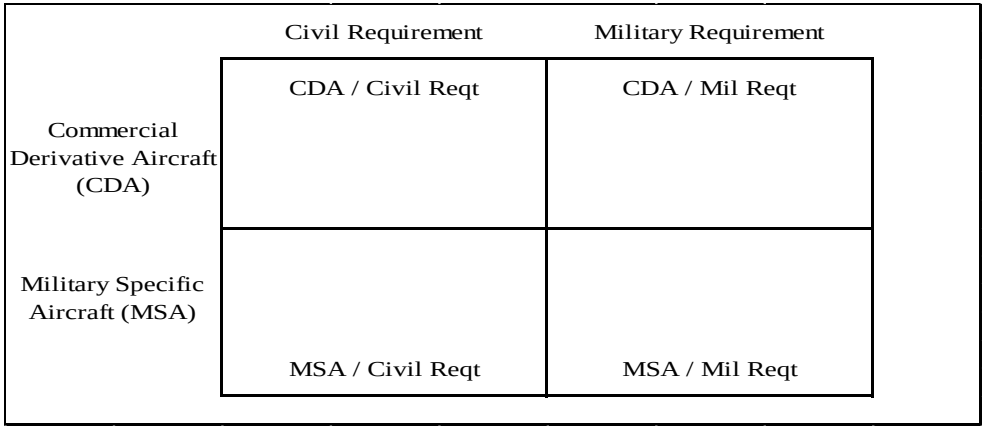


Figure 7: Aircraft Categories and Modifications

PMOs their GPS the it is

The case selection for this research was scoped to that were all working a common military modification for aircraft. A military global positioning system (Mil GPS) modification was implemented on each of the platforms. Mil was selected as the constant in this research for four reasons: research team had previous experience with the modification, representative of many types of common aircraft

modifications; provided a good chance for data collection; and it is a modification that exist at the AW "seam". This control brings the focus from a wide variety of modifications to a strict military modification that is also very similar to a civilian system in that it is a GPS which all civilian aircraft have.

Interview informants for three different PMOs were secured as case studies for the research. Each PMO managed a different aircraft. Two MCDA aircraft and 1 military specific aircraft (MSA) were selected (Figure 8).

The cases obtained allow for cross examining of similarities and differences from commercial aircraft to military in certification requirements

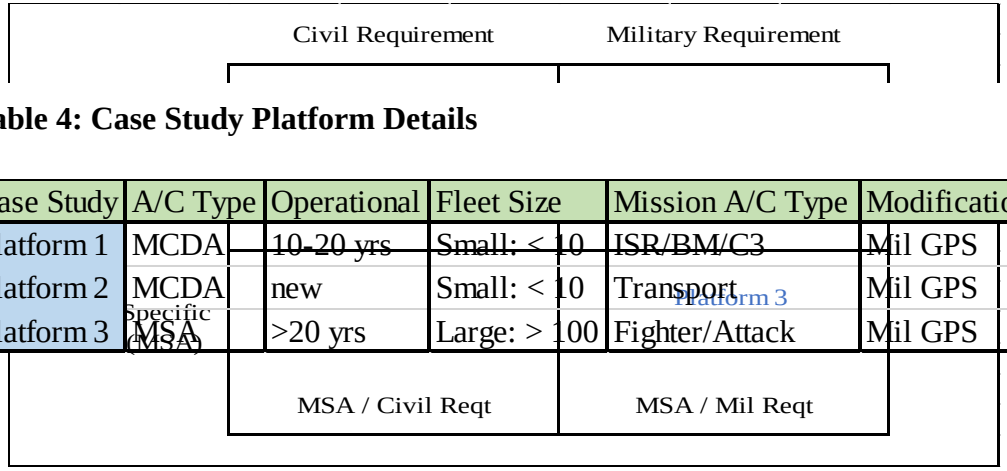


Table 4: Case Study Platform Details

Case Study	A/C Type	Operational	Fleet Size	Mission A/C Type	Modification
Platform 1	MCDA	10-20 yrs	Small: < 10	ISR/BM/C3	Mil GPS
Platform 2	MCDA	new	Small: < 10	Transport	Mil GPS
Platform 3	MSA	>20 yrs	Large: > 100	Fighter/Attack	Mil GPS

Figure 8: Aircraft Type and Modification with Case Studies

and decisions made. Further, duplication among MCDA allows for a comparison between similar systems. Both of the MCDA aircraft are small fleet aircraft with a communication heavy mission, but are very different in overall portfolio. One MCDA falls under the ISR/BM/C3 aircraft portfolio, while the other is a new platform within the Transport aircraft portfolio (Table 4).

Informants from multiple roles were attained for each modification case. PMOs have personnel who have unique roles, notably in management and engineering. These roles can influence the person's perspectives and priorities. Therefore, the informants representing the PMO for each platform consisted of at least one program manager and one engineer. This is to identify what similarities and differences may have come from the mindsets of the two different roles. Their experience levels and knowledge will be measured.

Beyond the internal personnel (PM and EN) from the PMO, the AW process often involves the external agency of the TAA. Therefore, a member of the TAA associated with the case studies were sought for interviews. This will add a third perspective on the airworthiness decisions

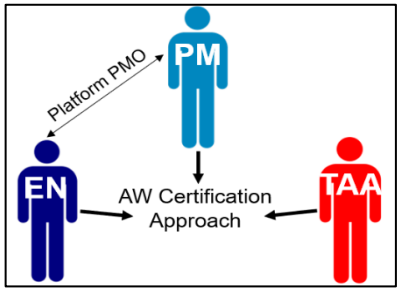


Figure 9: Interview Personnel Perspective Triangulation

made in each of the program (Figure 9). The TAA perspective is unique as its goals are strictly to address airworthiness of any system whereas the PMs and ENs in the PMO are ensuring they are fielding technology according to certain cost, schedule and performance constraints.

3.4 Data Collection

3.4.1 Interview Structure

To reiterate, interviews were conducted with informants from two different MCDA and one MSA. All three aircraft programs have engaged in the AW process for the Mil GPS modification. The two MCDA programs have sought a hybrid FAA/military certification along the AW "seam", while the MSA program had a military only certification.

The interviews conducted with the PMs, ENs, and TAA representative consisted of 20 semi-structured questions that collected information about the informant work level and experience with airworthiness, the details surrounding the program and its requirements and history, the airworthiness certification path taken and why their program went the way they did, and lastly what information had they wish they had and were there things they would have done differently etc. The semi-structured interview questions (Appendix A: Interview Script), allowed open-ended responses where similarities and key differences in certain approaches and decision-making occurred across the PMs and ENs for their programs respectively. The TAA representative was asked the same questions modified the more PMO-specific questions to be from the vantage point of being a viewer of the program and not one within it.

3.4.2 Institutional Review Board

Interview and research protocols underwent Air Force Institute of Technology's Institutional Review Board process. A package including the interview script, matrix, and consent form, along with other AFIT specific documents were submitted. As part of data collection all names and organizations of informants were redacted from all final transcripts. Recordings were also deleted upon final submission of this thesis. There will only be one unedited copy of full transcripts to be kept within AFIT in case there is a continuation of study off of this thesis and therefore references need to be carried over. Therefore, the interviews would incur low to no risk to the informants from any sort of physical or mental harm justifying the

IRB to deem the interview an exception to the full IRB approval process. By making the interview results anonymous in the end it should help put the informants in a more honest and vulnerable state when answering the questions.

3.4.3 Tools & Execution

Before conducting interviews, the researcher met with AFLCMC/EZZ, the USAF airworthiness office, to present this research topic. AFLCMC/EZZ became the sponsor for the research. Their feedback helped with case identification providing some contacts to PMOs fit for the research. The researcher's own experience in aircraft PMOs established reliable sources for interviews. The first interactions with informants were through email. Since all contacts were employees of the USAF it was easy to establish contact using the Global Address List (GAL). When reaching out to members of the different PMOs, the Division Chiefs, Colonel or O-6 equivalents, (platform level program managers) were contacted as well to make sure they were aware that their personnel (PMs and ENs) were participating in interviews for research and if that was acceptable to them. Contacting the Division Chiefs, also, brought extra visibility and awareness to the concerns in this research and established additional potential contacts for the future.

In the initial emails an Interview Consent Document (ICD) from the IRB package was sent to each of the potential informants. This gave the informants a breakdown of what the research is, why it is being conducted, how interviewing them will contribute, and most importantly how they will be protected. From there, meetings were set up in Outlook with the ICD and the Interview Script attached and a link for a video call. The Interview Script created in Microsoft Word starts with an introduction of the research and a brief reminder to the interviewee that they will be anonymous, before introducing the four categories of questions and then listing the questions themselves.

The interviews were conducted using Microsoft Teams (MS Teams) to utilize its capabilities to record with as a video conference and create a downloadable transcription of everything said to a single Word document with time stamps and identification of speaker. This allowed for cleaner data collection and not having to rely on recollection as the researcher. The transcripts and recording were saved.

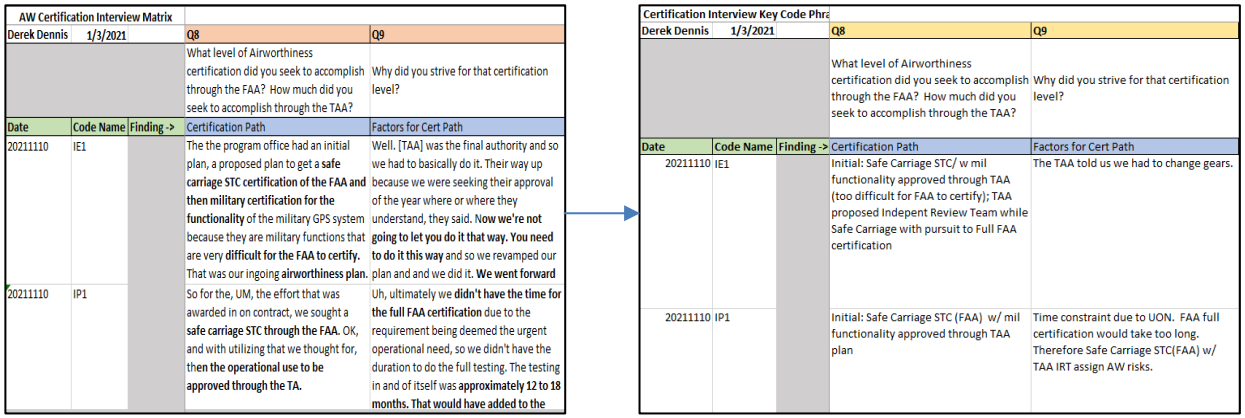
The Interview Matrix was created in Microsoft Excel. Appendix B: Interview Matrix – Raw Data (Anonymized) shows all the interview questions are listed as their own column with each interviewee as their own row. To maintain anonymity each interviewee was designated a code. Under each question a finding type was established to know what type of information was to be pulled from the responses for each question. Once an interview was conducted the exact responses were copied from the transcript file to the corresponding cells in the Interview Matrix. Then, key phrases were bolded within each question as they related to the finding type for that question and paraphrase onto a second sheet of the same format Interview Matrix called, Key Code Phrases (Clarkson et al., 2001; DeCuir-Gunby et al., 2010). The Key Code Phrases sheet seen in

Appendix C: Key Code Phrases Matrix (Anonymized Data) of the Interview Matrix helped to define key takeaways from each of the questions.

The "Key Code Phrases" sheet of the Interview Matrix would identify initial similarities and differences among personnel and their decision factors as they pursued different airworthiness certification paths. A final checklist of necessary AW knowledge, key decision factors and other advice was created for future PMs to aide them in future AW decisions. The process from "Key Code Phrases" Sheet to the final deliverable of the PM Guidance is laid out in the next section.

Eight interviews were planned and executed over the course of two months in November and December 2021. One interview was with an EN over MCDA modifications that did not include Mil GPS and therefore was dropped from the analysis of the research as it was an outlier to the setting of the other seven interviews. Of the seven interviews that were used in the data, six interviews involved the three platforms discussed above with one EN and one PM. The 7th and final interview used in the analysis was from one TAA member who was able to speak to the two MCDA aircraft

airworthiness certifications. Figure 10 is an example of the coding of Platform 1's informants answers to questions 8 and 9 being narrowed down through key code phrases related to "Certification Path" and "Factors for Cert Path" respectively.



AW Certification Interview Matrix

Derek Dennis	1/3/2021		Q8	Q9
			What level of Airworthiness certification did you seek to accomplish through the FAA? How much did you seek to accomplish through the TAA?	Why did you strive for that certification level?
Date	Code Name	Finding ->	Certification Path	Factors for Cert Path
20211110	IE1		The the program office had an initial plan, a proposed plan to get a **safe carriage STC certification of the FAA and then military certification for the functionality** of the military GPS system because they are military functions that are very **difficult for the FAA to certify.** That was our ingoing **airworthiness plan.**	Well. [TAA] was the final authority and so we had to basically do it. Their way up because we were seeking their approval of the year where or where they understand, they said. **Now we're not going to let you do it that way. You need to do it this way** and so we revamped our plan and and we did it. **We went forward**
20211110	IP1		So for the, UM, the effort that was awarded in on contract, we sought a **safe carriage STC through the FAA.** OK, and with utilizing that we thought for, then **the operational use to be approved through the TA.**	Uh, ultimately we **didn't have the time for the full FAA certification** due to the requirement being deemed the urgent operational need, so we didn't have the duration to do the full testing. The testing in and of itself was **approximately 12 to 18 months. That would have added to the**

Certification Interview Key Code Phra

Derek Dennis	1/3/2021		Q8	Q9
			What level of Airworthiness certification did you seek to accomplish through the FAA? How much did you seek to accomplish through the TAA?	Why did you strive for that certification level?
Date	Code Name	Finding ->	Certification Path	Factors for Cert Path
20211110	IE1		Initial: Safe Carriage STC/ w mil functionality approved through TAA (too difficult for FAA to certify); TAA proposed Indepent Review Team while Safe Carriage with pursuit to Full FAA certification	The TAA told us we had to change gears.
20211110	IP1		Initial: Safe Carriage STC (FAA) w/ mil functionality approved through TAA plan	Time constraint due to UON. FAA full certification would take too long. Therefore Safe Carriage STC(FAA) w/ TAA IRT assign AW risks.

Figure 10: Raw Interview Data to Key Code Phrases Example

Areas that were compared and key code phrases found across the informants were founded in the 4 sections of the interview: *About the Interviewee*, *The Program*, *Airworthiness Certification*, and *Reflections* on the project. Under *About the Interviewee*, individuals' level of experience in their fields and in aircraft systems / airworthiness, and role in the program were measured and compared. Under *The Program*, the specifics of their programs to include cost, schedule, performance, mission setting, age and type of aircraft were measured and compared. Under *Airworthiness Certification*, the actual certification paths are explained, the decision factors that went into them, the cost and benefits through the eyes of the interviewee, major setbacks and risks incurred were and what final certification would look like, were measured and compared. Finally, under *Reflections*, a layout of the most helpful knowledge (documents, communication, etc.) for the certification path, whether they thought it was the correct path, and what information they wish they had known were measured and compared.

To further layout the comparisons Similarity and Differences Tables (examples in Table 5) were created comparing each relation type: MCDA v MCDA - Platform 1 v Platform 2, MCDA v MSA - Platform 1&2 v Platform 3, PMs – IP1 v IP2 v IP3, ENs – IE1 v IE2 v IE3, PMs v ENs – IPs v IEs, and Platform 1&2 Personnel v TAA – IP1/IE1 & IP2/IE2 v IT1.

Table 5: Similarities & Differences Table Examples

MCDA v MCDA		
Similarities	Differences	
	Platform 1	Platform 2

Platform 1&2 Personnel v TAA		
Similarities	Differences	
	IP1/IE1 & IP2/IE2	IT1

Using quotes straight from the interviews, key code phrases, and evaluating the similarities and differences of the decision factors in establishing their AW certification allowed the formulation of guidance and best practices for program managers to better prepare them for airworthiness decisions on future aircraft modifications.

3.5 Summary

The methods used in this research was a comparative case study qualitative analysis through semi-structured interviews. The informants included three types of personnel (EN, PM and TAA representative), to form triangular views on the airworthiness decision factors that led to certain airworthiness certification paths. The 20-question interview recorded and transcribed on MS Teams, allowed a comparison of key areas of the informants' experience levels, the programs settings, the airworthiness certification paths and what was good and bad with in their decisions, and lastly what items were most helpful and what they wish they had when reflected back on the program. The responses populated in an Interview

Matrix was simplified to key phrases in a second “Key Code Phrase” matrix. Using direct quotes, and key code phrases placed into similarity and difference tables allowed for insight into the decision factors seen by the programs. These methods then allowed for the creation of a one-page word document to PMs of best practices and guidance on how to approach making their own airworthiness decisions on future programs.

The following chapter, IV. Analysis & Results, shows the details of what information was collected in the interviews along with any unexpected results, key takeaways from this effort, and the final product document for future programs.

IV. Analysis and Results

4.1 Chapter Overview

This Analysis and Results chapter shows the decision factors, execution of the airworthiness paths, and a comparison. Using direct quotes and key code phrase comparisons through similarity and differences tables, the common factors found were used to implement a final guidance for future PMs as a quick reference tool of how to approach airworthiness for their program. The following sections are summaries of the three platforms, expected and unexpected findings, resulting decision factors, and finally the guidance for PMs.

4.2 Summaries of the Three Platforms

Below are three summaries of how the programs were executed based on the information presented in the interviews. Appendix B: Interview Matrix – Raw Data (Anonymized) and

Appendix C: Key Code Phrases Matrix (Anonymized Data) has the raw interview data and key code phrases used to build these summaries. These summaries will help in understanding the specific findings discussed in the following section and ultimately the categorized decision factors.

4.2.1 Platform 1 – MCDA

Platform 1 is a small aircraft fleet (< 10) and has been in operations for over 10 years. The Mil GPS program was carried out under an Urgent Operational Need (UON). The UON designation sets a higher resource priority so that a system fielding can be expedited. In this instance they had a two-year deadline to be flying operational with the Mil GPS capability. Their prime contractor was not the Original Equipment Manager (OEM) of the aircraft. The OEM was a subcontractor.

In Fall 2018, the PMO awarded a contract of $72M that would pursue an FAA safe carriage STC with an independent review team (IRT) from the TAA that would do a risk assessment on all aspects of functionality of the Mil GPS system, while the FAA would certify the installation. The safe carriage approach falls along the AW "seam". It was chosen primarily on the assumption that less work from the FAA and more work through the TAA and military would provide the quickest path to operations. The program started at a high risk (the highest in airworthiness) deemed by the TAA. The installations and majority of flight tests were done by the OEM but results of flights were evaluated by the TAA. All installations and flight testing have since been complete and the program sits at a serious risk. At the serious risk level, they await the Program Executive Officer (PEO) signature to fly the capability operationally as intended, but is still waiting for signature as of December 2021. The PEO position typically the one or two-star general in the PMOs chain of command and is the decision authority for serious

AW risks, as well as other major milestone decisions on programs within his or her portfolio. A separate Phase II effort is planned to pursue full FAA certification to potentially relieve the PEO of acceptance of AW risk in the future. This additional effort was quoted at $20 million. With a risk approval from the PEO the aircraft would fly under a Military Flight Release (MFR) based on risk (paperwork saying you are eligible to use the modification in operations) versus holding an official MTC

4.2.2 Platform 2 – MCDA

Platform 2 is a new program targeted to a small aircraft fleet (< 10) that is a replacement platform and has yet to be fielded. The mil GPS modification is one of multiple projects being implemented in the overarching $3+ billion program, for a new aircraft. There is familiarity with the green aircraft (basic FAA design of an aircraft right off of the production line) used for this platform, because it has been utilized for other existing MCDA programs in the USAF, but these particular tail numbers have never been used or flown operational. The prime contractor is the OEM of the aircraft and is a familiar defense contractor. The program started in the last decade. The mil GPS effort is pursuing a limited FAA certification with a letter of functionality (LOF) from the military for military-specific functionality, such as anti-jam and anti-spoof. The mil GPS effort is about $50M. The mil GPS effort is installed and ready for flight test with approved airworthiness certification plans but is waiting on other projects to reach the flight-testing stage. Operations for the fleet are scheduled for 2025.

4.2.3 Platform 3 – MSA

Platform 3 is an attack/fighter aircraft that has been operational and well established for multiple decades. Platform 3 is a large fleet (> 100). The mil GPS effort was a requirement that came out of Air National Guard in 2014, which was then adopted by the Air Force fleet and

pursued in 2019. Since it is a MSA it can only pursue the military airworthiness process. Within that process an AW package was presented to the Director of Engineering (DOE) in the PMO EN chain of command to see if the project would be reportable or nonreportable to the TAA. The DOE is the highest-level engineer that works directly with the PEO of the same portfolio of programs. The modification was deemed nonreportable to the TAA, because it was determined to be a low-risk effort and a form fit function replacement modification. The DOE even delegated the authority down to the Chief Engineer within the PMO. As of December 2021, the capability has been certified under a Military Flight Release (MFR) amended to the MTC to be used in operations and has successfully flown operationally.

4.3 Expected and Unexpected Findings

As each interview was completed, the understanding of each platform's progression would be enhanced by the perspective from PM to EN within each case. Then when cross case analyses of the platforms were introduced, comparisons were made and tracked in the Key Code Phrases Matrix. The matrix needed to be reduced to something more tangible and so the Similarity and Differences tables were created to see from platform to platform, and person to person comparisons of how the programs were executed and the factors that seem to play a role. Some of the findings are repeated but are addressed from different perspectives.

4.3.1 MCDA v MCDA

Table 6 shows the comparison between the two MCDAs Platform 1 and 2. It was a going-in position that both would be a MCDA pursuing the same military GPS

modification. It was expected that their certification paths would not be exactly the same.

Table 6: MCDA v MCDA Similarities & Differences

MCDA v MCDA		
Similarities	Differences	
	Platform 1	Platform 2
Mil GPS Mod with same hardware	Active Fleet stand alone mod	New Replacement Aircraft combined with multiple mods
MCDA with military requirement	Communication Relay (ISR/BM/C3)	VIP passenger transport (Transport)
Small Fleet Size (<5)	CostPlusFixed Fee	Firm Fixed Price Contract
PM personnel no prior AW experience	FAA Safe Carriage STC AW Cert w/ Risk Assessment through TAA	FAA Full AW Cert - Limited FAA STC w/ military letter of functionality
EN personnel 30 AW experience	2 year time constraint because of UON in 2018, still waiting on Risk approval in 2022 wasn't eligible for approval until 2021 so 1+ year slip	2016 start with no required time constraint. Its effort does not fall on Critical Path of the ACAT I effort. Waiting for flight tests. Deliver 2025.
Certification in progress	Fielded but waiting on Risk Acceptance with PEO	Pre Flight Test but carries no official AW risk due to FAA process
Project Costs <$100M (ACAT III Equivalent)	Lacked funding for Full FAA effort	As part of overall ACAT I program was well funded
Lithium battery Certification Issue	$72M for project (safe carriage path), proposed Full FAA cert would be additional $20M, Full TAA approach estimated at $40M	~$50M for project (Full FAA AW cert - limited w/ LOF)
Subjectivity Issues, such as Interpretation of policy or risk criteria	Under Safe carriage no extra effort by FAA for lithium battery but observed in risk assessment	Extra Contract Effort to certify lithium battery by FAA
Multiple meetings with FAA MCO and Contractors	Communication with FAA lacked prior to contract award	Strong Communication well before effort was awarded
Had to follow Mil Hdbk 516 for military portions and MACC.	Extensive MACC	lesser MACC effort
	Prime contractor is not the OEM	Prime Contractor is the OEM
	Will only fly under MFR	Will ultimately fly under an MTC

For expected findings they had different approaches for airworthiness certification. Platform 1 took a safe carriage STC approach and had the TAA have an IRT to do a risk assessment on all functionality of the military GPS system, whereas Platform 2 pursued a limited FAA approval for STC with a military LOF approved through the TAA on the specific aspects that are military requirements such as anti-jam and anti-spoof. Platform 1 was also under a time constraint requirement of 2 years whereas Platform 2 mil GPS effort was a new platform tied to much larger ACAT 1 project and this effort did not dictate any critical path on timeline to fielding. The idea of schedule is seen right away as a potential factor. Since there was still military involvement in certification some level of MACC criteria was going to be done but more for Platform 1 then for Platform 2. It was also expected that there would be multiple meetings with stakeholders such as the FAA and TAA, but the timing of the meetings was unexpected.

The first unexpected finding was that meetings with the FAA and TAA had been well established and reoccurring well before contract award in Platform 2, whereas with Platform 1 had only a few meetings prior to award which was already on a short timeline. This, combined with the difference that Platform 1's prime contractor was not the Original Equipment Manufacturer (OEM), the builder of the aircraft, while Platform 2's prime contractor was also the OEM brings up the potential for disconnects as a factor within communication efforts prior to award to include pre-request for proposal, acquisition strategy panel and the proposal stages.

It was expected that the two similar programs would have comparable costs. However, Platform 1 with a safe carriage STC, meaning less FAA and more military certification is costing more. This may not seem very significant, but further detail in section 4.4 Resulting Decision Factors explains how this breaks a common assumption about military certification.

4.3.2 MCDA v MSA

Table 7 shows the comparison between the two MCDAs Platform 1 and 2 ant the MSA Platform 3. All three platforms were pursuing the same military GPS modification. It was

Table 7: MCDA v MSA Similarities & Differences

MCDA v MSA		
Similarities	Differences	
	Platform 1&2	Platform 3
Mil GPS Mod with same hardware	MCDA	MSP
All systems integrate with Cockpit avioncis systems	Constant Interaction w/ FAA for certification process	No interaction with FAA except for airspace flight test time
Project Costs <$100M (ACAT III Equivalent)	MilHdbk 516 towards military specific (Platform 2) and hybrid - civil/mil, (Platform 1) requirements within FAA certification.	Entire cert process through Mil Hanbk 516C
Some level of MilHdbk 516C & MACC	Platform 1: Originally high/serious risk deemed reportable to TAA. Delegated authority within TAA for risk assessment. Risk Acceptance at PEO.	Deemed nonreportable meaning no TAA involvement in certification. Delegated authority is DOE in PMO chain of command for assessment and acceptance.
Platform 2 & 3 are Firm Fixed Price	Has to be an FAA STC roled into an MTC if Full FAA is achieved. Flying on risk is MFR only.	Final product fly on either MFR ammended to existing MTC, or new MTC. Discetion of DOE preference.
Started about same time	Prime contractor	No prime contractor
	small fleet (<10)	Large fleet (>250)
	Funding & requirement from Air Force	Initial funding & requirement through ANG
	Platform 1: ~$72M (3 aircraft); Platform 2: ~$50M (2 aircraft)	~$60M = ~$20M development ~$40M full rate production
	Certification in Process	Some aircraft are operational with capability
	Communication & Passenger Transport Aircraft	Fighter/Attack Aircraft (weapons)
	Considered full EMD effort	Considered Form Fit Function Replacement Mod

expected that the 2 MCDAs sought some level of FAA certification along the AW "seam", while the MSA sought a military only airworthiness certification.

One of the expected findings was that Platform 3 had no interaction with the FAA from a certification standpoint. All platforms had to follow some level of certification criteria through MIL-HDBK 516C and develop MACCs. Platform 3 had a large fleet and so ultimately the total cost of the effort of about $60M being, which is similar to Platform 1 ($72M) and 2 ($50M), went a lot further from a cost per aircraft. This would support the assumption that military certification is cheaper than FAA. Platform 3 has also actually fielded whereas the other two have not, which aligns with the military certification also being faster. With Platform 1 being an MCDA with more military certification than Platform 2, but Platform 3 being cheapest would suggest that maybe military certification is only cheaper when applied to MSA. Based on some of the unexpected findings these assumptions are further challenged.

An unexpected finding is that Platform 3 was deemed nonreportable to the TAA so the airworthiness process stayed in the PMO chain of command and did not have 3rd party reviewers, while Platform 1 received a high enough risk for TAA involvement. This suggests that time savings could have been more that it was an internal military certification versus a full TAA military certification. Platform 3 also had no prime contractor and much of the airworthiness work calculations, data collection and planning were done by the PMO and its engineers. Since they are part of the PMO the work they are doing is not calculated into the total contract cost. This work done by the Platform 3 EN team is typically done by the contractors, like for the two MCDA. Therefore, Platform 3's cost may also be more comparable to that of the FAA hybrid

certifications. Platform 3 also was initially a requirement from Air National Guard and was applied as a form fit function replacement versus the MCDAs having an Air Force requirement which has dictated colors of money and had an official development portion of the contract. This is a combination of disconnects between policies and interpretation of requirements.

4.3.3 – PMs, ENs, PMs v ENs

Table 8 shows the comparison between each of the three PMs interviewed. Table 9 shows the comparison between each of the three ENs interviewed. Table 10 shows the comparison between the PMs and the ENs. This gave a basis of the experience and mindset of how specific personnel type looked at their certification approach and if there were any overlaps between them.

Table 9: PMs Similarities & Differences Table

PMs			
Similarities	Differences		
	IP1	IP2	IP3
1st Aircraft SPO (< 3 yrs in aircraft systems)	Observed a lot of subjectivity with TAA	Felt path was relatively easy / Didn't think TAA was really involved	Thought it had been done through TAA
Wish for better understanding of AW processes	small increments of progress, constant changes of what was agreed upon	Did not think there was much adjusting from plan except w/ lithium battery	Thought there were some unneccesary tests but relatively easy
Need strong communication with stakeholders, decision makers (ie FAA, MCO, TAA, DOE)	Time constraint lead to certification path/Upfront assumptions made the Seam of safe carriage more doable	AF policy dictates full use of FAA certification especially for passenger aircraft, so that's waaht was pursued	Mil aircraft easy install

Table 8: ENs Similarities & Differences Table

ENs			
Similarities	Differences		
	IE1	IE2	IE3
20+ years of Aircraft systems experience	Government Support Contractor	Government Civilian	
Considered Mil GPS a noncomplex modification	Both worked Commercial sector and for military on MCDA and MSP		Only worked in Fighter/attack aircraft (MSPs)
Strong role in developing AW plans	Safe carriage w/ mil funcitonality approved would be faster fielding with risk approval, but would have preferred Limitied approval similar path to Platform 2	Limited FAA certification: Full FAA approval w/ military statement of functionality/ To try to use risk as means for quicker certification leadership will deny saying if FAA wont accept why should I	Pushed for nonreportable modification keeping certification at DOE level for military certification. No TAA involvement.
IE1&2: Believe it impossible for Full FAA certification with no military involvement	Military equipment was not built to FAA standards and specs causing some difficulties in certification.		Military cert so standards and specs mostly
Military only certification would not be cheaper because PMOs lack manning for Military only certification efforts on MCDAs	Most of calculations and deliverables done through contractor and FAA		Much of the calculations came to ENs in PMO to do.
Strong communication with Stakeholders is key and that it be early and throughout.	Installed on all aircraft waiting on risk approval	Everything on track but waiting for flight test	Successfully operating capability in field
Common issues with defining requirements versus safety critical functions and what needed to be a certification criteria	This was the wrong path	The right path	The only path
	2 major plan adjustments and countless compliance adjustments	always making adjustments but minor, except lithium battery certification needed separate effort	no major changes throuhgout process

Table 10: PMs v ENs Similarities & Differences Table

PMs v ENs		
Similarities	Differences	
	IPs	IE's
Platform 2 personnel were on same page of their paths taken	First Aircraft systems experience	20+ years of aircraft experience each
Strong communication with stakeholders is important early and often	Focused on schedule and contract details	Focus on meeting MACC criterion and meeting compliances
	Almost no understanding of certification path/ IP1 most effort into learning though constrained by time	All strong understanding of paths and difficulties
	Have not seen a finished product of the aw certification process prior to start of effort	Have seen AW certification process start to finish

Most of the similarities between the PMs were expected findings. They all wanted a better understanding of the airworthiness processes. This is what prompted the need for a PM guidance sheet. They also all believed in the importance of stakeholder communication. Some expected differences were that IP1 would face more scheduling conflicts since dealing with such a small operational fleet, while IP2 only had to worry about being ready in time for the full aircraft flight tests, and the large fleet from IP3 provided more test bird opportunities although operational. Schedule seems to be a stronger factor for IP1.

The majority of the PM comparison brought forth unexpected findings. The first was that this was their first aircraft project and time dealing with airworthiness certification. Having less experience than the ENs was expected, however, it was unexpected that in all three cases the PMs had no prior work with airworthiness. They all said they wanted to know more but IP1 seemed to be the only one who really tried to learn the process and participate in stakeholder meetings while IP2 and IP3 left certification in the hands of the ENs. IP2 was unaware of TAA involvement in their limited FAA certification process although they help evaluate compliance of the letter of functionality for the military specific aspects that the FAA cannot approve.

The ENs were all expected to have some experience and they each had 20+ years specific in aircraft systems. Both IE1 and IE2 with combinations of commercial sector, other MCDA platform, as well as MSA platform experience. IE3's experience was all within fighter/attack MSA platforms. All stressed the importance of communication with the stakeholders. They all found that it was hard to define certain items as critical safety items versus a requirement, and further how they could meet the compliances for these requirements. This was especially more difficult on the MCDA side as IE1 and IE2 had to make military equipment match standards that tied to an FAA standard.

Both IE1 and IE2 did not think it would be possible for a full FAA certification without any military approvals of certain aspects, which explains by both pushed for a hybrid approach somewhere along the AW "seam". But what was unexpected is that they both said it would not be possible for a full military certification approach to take place either. For the MCDA so much of the AW work falls on the contractor and the FAA while in the MSA the IE3 talks about how a lot of the AW work had to be done within the PMO, which brings up the concept of personnel. It was also found that IE1 would have preferred a limited FAA approach mirroring closer to Platform 2's approach. There may be a correlation with the fact that IE1 was a government support contractor versus a government civilian in regards to the power of IE1's opinion. It was also interesting that IE3 did not say the nonreportable AW certification was the right path but the only path.

How do the PMs and ENs stack up together? As expected, they all thought communication was key and more of it up front is key. The PMs had more focus on their schedule and funding especially IP1 and IP3 versus the engineers who were more focused on the technical requirements of the MACC and or FAA process.

Unexpectedly, IP2 and IE2 were the only informants to say they were on the right path. Within Platform 1, IP1 said the safe carriage approach was the right path, because of the cost and schedule pressures and that was the path ultimately taken, but spoke negatively about the path having a lot of subjectivity and disconnects among stakeholders along the way. IE1, regardless of cost and schedule pressures, said safe carriage was the wrong approach. For Platform 3, IP3 said their path was the right path while IE3 said it was the only path. IE3's perspective comes from the understanding that MSA follow the military only airworthiness process and that's it. There is the option of reporting or not reporting to the TAA, but from IE3's perspective that wasn't really changing the path. The only other path that could be available is to get a prime contractor and hand over some of the calculation work to their personnel, but would ultimately still be meeting all the same criteria in the MACC. Since IP3 also admitted to not really being involved in the AW process it seems this was more of a blind agreement since the engineers were accomplishing project.

4.3.4 – Platform 1&2 Personnel v TAA

The last comparison is between the MCDA personnel and the TAA representative (Table 11). Here we see how perspectives from the PMO were similar and different from the military airworthiness office perspective. There was only one TAA representative interviewed, IT1, to represent both MCDA platforms. Since Platform 3 was nonreportable there was no TAA representation for that platform's AW certification path.

Table 11: Platform 1&2 Personnel v TAA Similarities & Differences

Platform 1&2 Personnel v TAA		
Similarities	Differences	
	IP1/IE1 & IP2/IE2	IT1
Advice: Strong Communication with all Stakeholders early and often	PMO decide the Airworthiness certification path	Aide to MCDA platforms in AW decision making
Understood that since MCDA a pursuit of FAA certification was the starting point	Platform 1 (IP1&IE1) thought TAA dictated safe carriage approach with IRT for risk assessment w/ future pursuit of Full FAA certification	Platform 1 should have attempted Limited Approval from start
An MTC or an MFR will be obtained encompassing the STCs	PMs <3yrs aircraft systems, ENs >30 yrs aircraft systems	12 yrs aircraft systems, 3 yrs with TAA focus on MCDA
Lithium battery concerns for safety critical function risk	Platform 1 thought UON time constraint made this not doable; Platform 2 (IP1&IE2) pursued FAA to max extent possible	Use FAA to max extent possible
	Have to think about other programmatic concepts along with airworthiness and flight safety	Only focused on airworthiness criteria and safety
	Platform 1 has cert basis for safe carriage and had to complete MACC criteria to show compliances and mitigated risk approval for cert basis; Platform 2 EN agrees to multiple small adjustments, while PM saying not from the PMO perspective	Platform 1 has no certification basis from TAA perspective; Platform 2 has multiple AW plan revisions but is normal necessity

It was expected that the IT1 would have a good amount of experience in aircraft systems particular with MCDA aircraft. IT1 had been with TAA for three years so was fairly new to the TAA role when the MCDAs were going in. IT1 agreed with the PMO about the importance of strong communication upfront in with the stakeholders. The role of the IT1 is guidance to the PMO while the PMO settles on the actual path of the Airworthiness certification path. IT1 focuses on the system integration and how that aligns with the FAA certification process and military airworthiness process to leave the smallest gap in the AW "seam" providing the highest level of airworthiness. The PMOs have to take into consideration other programmatic requirements along with the focus on the most gap-free airworthiness certification path. All parties tracked the certification complications caused by the lithium battery and all thought best to drop the battery from the existing certification paths. It was understood that after the Platform 1's safe carriage STC and risk acceptance occurred they would only fly with an MFR versus an MTC since there was risk being accepted whereas Platform 2 would fly with an actual MTC which means you have no registered AW risk when flying.

It was expected the paths chosen would be viewed differently, but it was unexpected the lack of understanding of each other's viewpoints. IP1 and IE1 took the safe carriage approach and an IRT from the TAA to do risk assessments along different testing stages. IT1 did not believe this was the right approach for Platform 1 to take, but agreed to the IRT. From IT1's perspective the TAA team advised against a safe carriage approach saying they would not be able to fully certify functionality on the military side due to lack of data and doesn't recognize the existing FAA certification as a cert basis to build off of for their process. This is where understanding the integration of the systems becomes vital. But what is unexpected is that the PMO for Platform 1, as will be seen in quotes in section 4.4 Resulting Decision Factors, make it seem that the TAA and other outside stakeholders were forcing the PMO's hand to the safe carriage STC with risk assessment as the only option. Therefore, the PMO saw the TAA as an approver of the AW certification path, instead of instead of an advisory role to it. On the other hand, the IT1 and Platform 2 personnel seem to be on the same page in every step of the program. Platform 2 being part of a much bigger project and not constrained by operations seemed to have better communication amongst the stakeholders.

4.4 Resulting Decision Factors

The first factor observed was Policy. This came straight from the existing AF policy directive, AFPD 62-6 stating "the Air Force shall obtain and maintain Federal Aviation Administration type certification to the maximum extent practical" (SAF/AQ & Roper, 2019). The MSA did not have to abide by this policy and so their only real option was a military certification path. For both MCDA platforms in this research, this policy was at the forefront of their decision making. But to what extent were they able to use the FAA, that came from additional decision factors. There were six other factors that influenced AW decisions found in the data set: Cost,

Schedule, Performance, Personnel, Level of Integration, and Disconnects. These six could all be observed in multiple occasions through the Similarities & Differences tables from the subsections above. In this section all seven decision factors are identified as well in specific quotes that clearly show how they were considered, the quotes along with the Similarities & Differences tables also showed whether these are viable factors to consider.

The philosophy dictated in Policy is for MCDA to pursue FAA certification to the max extent possible. Table 12 makes it clear that this is what the programs believe as IP2 states, as well as what is advised by the TAA with IT1, explaining the benefit of continuing certification along the original standards of the FAA since the original aircraft held FAA certification. IE3 states that since Platform 3 is a MSA it does not follow this policy.

Table 12: Decision Factors - Policy Quotes

Decision Factors	Quotes
Policy	The reason for pushing for that certification level [limited FAA approval] is basically, that's what policy dictates this... This is primarily a **commercial derivative passenger carrying airplanes** so, that's what the **Air Force DoD policy [states].** - IP2
	You know it's our policy to do **FAA to the maximum extent practical** and I think you know some of the rationale behind that is that. You know the the **base aircraft was certified [with a] test set of of rules or airworthiness standards**. You know the **FAA airworthiness standards** and, two it's important **for safety** to ensure that, as much as possible, you ensure that same **the same set of standards are used to assess all modifications because there's interdependencies** between each of the different requirements. - IT1
	It was a military only… So we **never go through the FAA in a military platform** - IE3

There is an existing assumption that military certification is usually cheaper and faster because it can accept risk. This assumption may have played a role as the outcomes of different decision factors, particularly for Platform 1. The next three decision factors are the three common programmatic measures: cost, schedule and performance.

In Table 13, IP1 for Platform 1 talks to the Cost of the safe carriage approach being ~$72M but if pursuing the full FAA certification an extra $20M would be applied, but to go for a full military certification was around $40M which is clearly more expensive than if doing the full FAA certification. So, from a cost perspective the safe carriage seemed most reasonable. For Platform 2 cost was not much of a factor for this modification as the estimate a very high level ball park estimate. This is due to it being part of a much bigger program scope. Lastly from the MSA perspective totaled ~$60M for a much larger fleet so in this instance the assumption would seem to hold true but it's because the base aircraft has always been military certified. IT1's quote under policy, although is in reference to FAA standards being maintained, would have that same affect with original military aircraft to maintain their standard. We see Platform 2's high level estimate for limited FAA certification being lower than Platform 1's safe carriage estimate, because limited follows the existing FAA standard to a higher level.

Table 13: Decision Factors - Cost Quotes

Decision Factors	Quotes
Cost	The effort **[safe-carriage STC w/ TAA IRT team]** was approximately **$72 million**, both RDT&E and production funds. The follow on [Phase II - **Full FAA Certification**] Government costs estimate is approximately **$20 million**. Also, if we saw a **full TAA certification** and forewent the FAA certification. Uh, the kind of ballpark figure was postdated it about **$40 million** for the TAA to do there. - IP1
	So the grand total **[for limited FAA approval STC]** was somewhere in neighborhood, about 47, you know **49 million**, but again, that is a **very high level**. A ballpark figure without a lot of fidelity and at that would just kind of our best guess. -IE2
	I'm gonna say right about that **35-$40 million** threshold is about where we were at with that program... There was for that development stage, I believe we Cut about, I want to say somewhere about that fifteen **$20 million** worth in. In charges to that, the. National Guard Air National Guard. Build the program as being **a form fit function replacement and a commercial off the shelf.** - IP3

Schedule also, seemed to play the strongest role as a decision factor in Platform 1 (Table 14). When this requirement came out Platform 1 was pressed for time to not only complete the effort, due to the 2-yr timeline of the UON, but to also get their contract awarded. This rushed the discussions that went into airworthiness certification and may have prompted the wrong decision. Platform 2 recognized that if TAA had to recertify all the aspects of the airplane, which is ultimately what would need to occur for a military airworthiness path that more time would be wasted. Taking these quotes and comparing to what was seen in the similarities and differences tables Platform 1 busted the 2-yr schedule, but will soon fly operationally with risk, Platform 2, based on how smooth it has gone, if it was not tied to a bigger scoped project would be close to certification and Platform 3 just started flying operationally. All three platforms started within a couple years of each other and in the grand scheme of Air Force modifications the results of their timelines negate schedule as a reasonable decision factor.

Table 14: Decision Factors - Schedule Quotes

Decision Factors	Quotes
Schedule	We initiated this as a, uh, **urgent operational need**, and so the time frame was supposed to be a **two year time frame**. - IE1
	Are assumptions going into the effort was that you know we would do all the testing as if we were gaining full FAA certification. However, we didn't have the time due to a **UON or the urgent operational need** status. Uh, so we were seeking, ultimately full testing, as if we were gaining full FAA certification in hopes that the TA would take that testing and be the final approval... it was more the **documentation piece through the FAA** that would have dragged out the period of performance. **So we sought the safe carriage** with then ultimately the TAA signed up to do an independent review team to help assign airworthiness **risks**. - IP1
	..don't have to recertify the airplane for all through the TAA to all the things that have already been FAA certified. - IP2

The last programmatic measure is Performance (Table 15). The ENs from both MCDA platforms talked about the capability of Mil GPS being similar to the commercial GPS works so the technicalities of the installation were not overly complex. The aspects outside of the FAA were the anti-jam and anti-spoof criteria. The complexity of the installation and what aspects of

the capabilities FAA certification can cover are the two primary aspects of how performance is a factor. IE1 wanted to pursue a limited FAA certification because of the results of this factor, but it seems cost and schedule trumped the performance factor, and reduced the certification to safe carriage.

Table 15: Decision Factors - Performance Quotes

Decision Factors	Quotes
Performance	The modification was not too **extensive** of a modification. It basically added two antennas to the crown of the aircraft and 2 military GPS units. Uh, that were providing signal to the aircraft cockpit...**military developed system had specific military purposes**... FAA looks at functions and it does not have certification rules for military functions such as carrying bombs or jamming and and things like that. And in our case the jamming, the **anti jam anti spoof kind of things were not functions normally dealt with by the FAA**. - IE1
	[Mil GPS is] an alternative positioning source. So we haven't gotten rid of the commercial eggies, commercial GPS is used in the aircraft…this is really a civil aircraft function as a military aircraft. -IE2

Levels of Integration was something highly stressed by IT1 (Table 16). The points made are similar to those of performance but focused more on the interdependencies of when you connect the mil GPS system what other systems is it interfacing with and are those interfaces something that will be recognizable to the FAA standards for certification. Notice that IP3 for says the functionality of the aircraft was not being modified but when seeing IE2s's concern about military equipment not being produced with the FAA in mind, those interfaces the mil GPS box will have with a commercial cockpit could look much different than how it interfaces with a military cockpit. This is the most direct decision factor as it relates to the definition of airworthiness and obtaining a safe aircraft to fly.

Table 16: Decision Factors - Level of Integration Quotes

Decision Factors	Quotes
Level of Integration	The modification was not too extensive of a modification. It basically added two antennas to the crown of the aircraft and 2 military GPS units. Uh, that were **providing signal to the aircraft cockpit**. - IE1
	So the overall **functionality of the aircraft was not being modified**. Uh, and so the risk level and the certifications were fairly **easy**. -IP3
	They **[military equipment designers] don't go** with the idea of trying to concern themselves with **the FAA process.** - IE2
	… two it's important **for safety** to ensure that, as much as possible, you ensure that same the **same set of standards** are used to assess all modifications because t**here's interdependencies between each of the different requirements**… So as we certify [the] integration of that GPS system into the aircraft. You know it's going to have **tentacles essentially back into the aircraft avionics** and we won't have data for that, and so you know ultimately the **lack of data you know results in uncertainty**. - IT1
	The **FAA doesn't have criteria to address anti jam or SASM,** so they rely on us to to utilize our military criteria for that. And we assess it and issue them a **statement of functionality** to support their [program's] **compliance findings**. - IT1

The Personnel factor was interesting and unexpected (Table 17). Outside of policy dictating FAA certification and looking at the levels of integration, IE2 simply presented that their PMO is not properly manned for a full military certification, as a lot of the work that the contractors and FAA do would then come to the government. The MCDA programs both also had a prime contractor unlike the MSA, Platform 3. IE3 talks about how the engineering team has to do a lot of calculations and handling of test documentation, that the MCDAs are not doing.

Table 17: Decision Factors - Personnel

Decision Factors	Quotes
Personnel	We **don't have the personnel** to do what would be necessary in my mind to do it [military only certification]… it becomes an issue of of the way the Air Force **structure the program office**. - IE2
	our personnel and we have to do the calculations to go about doing it and we have to have all the documentation in place to make sure just that is done and we've done proper testing. -IE3

Finally, Disconnects, which often come from miscommunication, is the final decision factor. This is more of an indirect decision factor, because one cannot really know in the moment that they are basing a decision on a disconnect. These interviews conducted were able to expose some of these disconnects. In Table 18, IE1 indicates that the PMO was told by the

TAA that the safe carriage with IRT team risk assessment was the only way they could do it, meanwhile IT1 thought limited FAA certification would have been the right path for Platform 1. There was a clear disconnect due to a lack of communication that occurred. IE3 essentially states the opposite of the assumption that military certification is fast and cheap. IE3 also states how the Air Force is always pushing for faster and cheaper and combats that saying you can't be faster and cheaper and do certification right. IE2 also combats the assumption of military certification being faster, saying that based on who is approving the risk you may be held to the same standard as FAA, which ties in to IT1's view on the assumption. In general, the FAA and TAA certifications are looking for the same type of tests and levels of rigor for similar requirements. IT1 does say that risk can be used if compliance isn't met but that should not be what a program strives for. Theys should strive to be in compliance, to be safe, to be airworthy.

Table 18: Decision Factors - Disconnects Quotes

Decision Factors	Quotes
Disconnects	Now we're not going to let you do it that way. **You need to do it this way** and so we revamped our plan and and we did it. We went forward with **the only path that the [TAA] said, you know we could follow**. - IE1
	My perspective is that they, both, Uh, we should have soughtt full or limited FAA approval for all aspects of that modification. - IT1
	It's [military AW process] not something that happens very quickly and and because it's such **a long process and a costly process** to acquire all the documentation. Uhm, you it is **very difficult to field anything in expedited manner.** The Air Force is pushing us to do things faster, better, cheaper, you know, and it's like you can't have both ways. -IE3
	The FAA is not gonna accept it. What makes you think I'm gonna accept it? [In regards mil AW Decision Authority] - IE2
	I've **often seen that military certification being identified as much cheaper than FAA certification,** because there is the option to not show full compliance and and they get that **risk accepted and move on** right? But in the **FAA world you have to show full compliance**, which means you have to do all the analysis, the test that the FAA is going to require...You know mil cert doesn't mean no cert right? ... generally speaking, FA and military certification, they're gonna, ultimately, **drive the same type and level of work** - IT1

The decision factors observed Policy, Cost, Schedule, Performance, Levels of Integration, and Disconnects, do not hold equal value from person to person or platform to platform but in comparing all the points of view, the one that should hold the most weight is the level of integration, and to best understand this knowledge of your system as well as knowledge

of the airworthiness processes themselves so when communications begin there will be less disconnects.

4.5 Guidance for Program Managers

The program managers hold the responsibility for their programs and so when an airworthiness decision is made it ultimately comes back to him or her. That is why when it was observed that all three PMs had no prior airworthiness knowledge this deliverable became an essential piece of contribution to MCDA decision factors research. The ENs had a strong knowledge of the airworthiness process but disconnects still occurred and so the PMs need to be more knowledgeable as well.

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Appendix D: PM Guidance Sheet, a full example of the guidance created for PMs can be found. The guidance has 4 main topics: Know Your Platform/Modification, Understand Airworthiness, Decision Factors, and Assumption Fallacy.

The first topic, Know Your Platform/Modification, lays out high level your platform and mission and right away starts to reference items in the next topic.

The second topic of the guidance is to state what knowledge must be read and learned to understand airworthiness. From the literature it is clear that a PM must read and understand the AFPD 62-6, have access to the list of AW bulletins from the TAA offering guidance MCDA certifications, and should have a copy of FAA order 8110.101A to know the connection between the FAA and TAA certification and the roles of the FAA and MCO. Every PM before making any AW decision should also take AIR 116 – Introduction to AF Airworthiness Certification. This basic knowledge will allow for PMs to have much more intelligent conversations with their EN counterparts as well as the FAA and TAA and all stakeholders on the subject. Lastly on the back or page 2 of the guidance is a copy of Figure 5 from AWB-360 showing the levels of FAA approval and the AW seam of where military certification is needed. Once all the knowledge is absorbed this figure creates a good mindset for how a PM's program fits into the AW certification puzzle.

Next, this guidance lays out the common decision factors in the order of most importance as a PM looks to build their AW certification path.

1. Level of Integration – Where does the new system touch and how does it affect the existing system

2. Disconnects – Know the platform and AW processes and communicate with stakeholders well before Contract Award or Acquisition Strategy occurs.

3. Performance – The capability of the system, the mission of the aircraft

4. Policy – What is the furthest FAA can certify on the system

5. Personnel – Is your office structured for a certain certification level (most MCDAs would not be able to handle the workload of a military certification)

6. Cost – Similar work would have to be executed for military cert or Full FAA. Refrain from work that would overlap causing double payment.

7. Schedule – No path is significantly faster than the other. Shortcuts such as risk approvals lead to more disconnects ending in negligible time savings.

Cost and Schedule are at the bottom of the list because these two decision factors were ranked much higher for Platform 1 than Platform 2 in execution, which led to the most disconnects as the program progressed while also not meeting their time constraint.

Finally, the known assumptions about military certification being cheaper and faster due to the ability to accept risk, is listed on the sheet but as a warning to not get caught in its fallacy.

4.6 Summary

Through a series of seven interviews with PMs and ENs from three platforms and one member of the TAA an analysis was conducted to observe what major decision factors took place for their AW certification path. There were seven major decision factors observed through the interview comparisons: Level of Integration, Disconnects, Performance, Policy, Personnel, Cost, and Schedule. The decision factors are listed by importance based on the analysis. The interview comparisons in the Similarities & Differences Table along with quotes suggests that Platform 1 would have been better off potentially following the same certification as Platform 2, which is significant because it showed that programmatic constraints like cost and schedule were

high in priority when coming to that certification path. The lack of aircraft experience and AW knowledge amongst all three PMs, is what led to the Guidance for PMs in

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Appendix D: PM Guidance Sheet. This guidance along with an emphasis of early and often communication with stakeholders will better prepare PMs and their teams in the future as they navigate their way to the best AW certification path.

V. Conclusions and Recommendations

5.1 Summary of Research

This research looked to bring clarity to MCDA platforms as they pursue the airworthiness certification paths for their programs. Policy dictates that MCDAs pursue FAA certification to the max extent possible. The phrase "Max extent possible" leaves room for subjectivity. This research provides clarity into see what decision factors went into the programs AW certification path, how these decision factors influence one another and finally where there could be improvement to airworthiness certification. An analysis of comparative case studies through interviews of two different MCDA platforms and one MSA platform was conducted to help find answers to these questions. Below are the three research questions and how they were answered.

5.1.1 Research Question 1

What factors are key in the choice of an AW certification path for aircraft modifications? -- The research showed 7 major decision factors that played into how they chose to pursue AW certification. Those decision factors were: Level of Integration, Disconnects, Performance, Policy, Personnel, Cost, and Schedule. This order was developed by examining the platforms based on what worked and what didn't work, along the AW certification path.

The platforms did not display all of these factors equally. Platform 1 had a stronger focus on Cost and Schedule versus the other factors (Level of Integration and Policy). Platform 1 ran into more issues than Platform 2; ultimately leading to negligible timeline and cost savings in comparison to Platform 2. The primary focus should be the Level of Integration of the design itself and how it best integrates with the existing system; knowing the touch points for the max level FAA is able to certify.

To avoid Disconnects, communication and knowledge sharing among the stakeholders must occur early and often. A focus of this communication must be the AW certification touch points. The third factor, Performance, ties into the first two factors (integration and disconnects), but considers the question of, 'do these capabilities reflect solely military purpose or are there commercial elements?' Mil GPS, at its core, is a GPS; it has commercial and military requirements and is a good candidate for FAA certification. As a counter example, a new missile system has no commercial equivalent requirements. Policy, the is ranked after the first three technical factors, it provides a starting point.

The bottom tier of the lists are things that are difficult to control; in some instances they are constraints that guide decisions (operating within constraints/"it is what it is"). Personnel recognizes the capabilities of the manning within the PMO. Based on this research MCDA PMOs are not sufficiently manned for the workload of military certification, whereas Platform 3, the MSA, had the capability for in house analysis and certification. In contrast, the contractor and FAA possess much of those capabilities for MCDA systems. The final two factors are Cost and Schedule, although still decision, they should not take a high priority. Why these two are ranked so low is better answered under the second research question.

5.1.2 Research Question 2

How do these decision factors influence each other in the final airworthiness certification path and its execution? -- A common assumption is that military certification is cheaper and shorter, because of its ability for risk acceptance if compliance cannot be met. This assumption creates a disconnect to the policy of pursuing FAA certification, since the Air Force is constantly pushing for faster and cheaper options. This assumption of military certification would encourage PMOs to break policy and focus on Cost and Schedule. This was the case in Platform

1. The programmatic decision factors of Cost and Schedule were taken at higher value than the technical decision factors such as Level of Integration, causing more Disconnects as their rushed timeline took away from the more in-depth communication that needed to take place. Platform 2 focusing more on the level of integration and clearer communication to avoid disconnects have had a much smoother execution. Platform 3 was also very smooth as a full military certification but because their basis as an MSA allowed for clean integration. The cost and schedule savings hoping to be gained ended up being negligible for Platform 1 in comparison to Platform 2 and 3. The technical understanding of the integration ties closest to what airworthiness certification is supposed to do and that is to provide an aircraft that is safe to fly with the technology capabilities on board. To understand that integration not only do the engineers need to understand that (which all studied did) but the PMs need to understand it as well as they are ultimately responsible for the project.

5.1.3 Research Question 3

What can be done to improve AW certification path decisions? -- The two key takeaways from the research that can directly impact how a program selects their AW certification path is the need for better flow of communication and to address the lack of airworthiness knowledge of the program managers.

There were major disconnects for Platform 1 feeling that they were forced into the safe-carriage approach with risk assessment from the TAA where the TAA believed they should have done a limited FAA approval approach with statement of functionality for the military components like Platform 2. The prime contractor not being the OEM and integrator of the GPS system also seemed to be a contributor of miscommunication between the FAA and Platform 1. Therefore, more extensive conversations between the primary stakeholders surrounding

airworthiness decisions need to take place prior to Acquisition Strategies and Contract Award. Designated meetings between the TAA, FAA/MCO, and OEM of the aircraft and makers of the modification with the PMO's engineers and program managers need to occur prior to award. If a time constraint is being pressured, push back on it, because when sacrificing the airworthiness quality ends up not saving any time as we saw in the data.

The program managers end up holding the weight of whatever path is chosen and so that is why the PMs need to have prior AW knowledge before making a decision. In all three platforms this was the PMs first aircraft system and first time doing an AW certification. Therefore, to equip PMs with the right knowledge a guidance sheet in

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Appendix D: PM Guidance Sheet was created. This guidance will educate PMs of the existing AW processes, show them the importance of knowing their platform and modification, the AW seam between the FAA and TAA, guide them through the common decision factors that go into an AW certification decision, as well as warn against the certain fallacies that exist and lessons learned from prior platforms.

5.2 Study Limitations

This research focused on a small subset of all the MCDA in the Air Force. It was scoped specifically to a Mil GPS modification and three platforms that underwent that modification all around the same time. This was due to the familiarity with the modification and availability to contacts. This scope is representative other communication and navigation modification on MCDA. Many other PMOs working unrepresented modifications on MCDA can still use the thought processes here as it applies to a mindset for navigating the AW "seam". These constraints narrowed the focus to specifically where to use a limited FAA approval vs safe carriage FAA approval or to go full military certification. There are other levels of FAA certification that could have been pursued. An increase in platforms would also add to the validity of the data findings.

5.3 Recommendations for Future Research

If given more time a broader spectrum of MCDAs could be included in the comparative analysis, with different modifications. If more programs are able to participate in the interviews a repository of continuity among multiple platforms categorized by modification types and then certification type based on the AW seam. This could be something then all aircraft program

management offices could have access to in order to find continuity and lessons learned from other programs.

Another approach would be to pursue more quantitative data analysis into the actual costs and schedule relationship. The estimates received in interviews were not exact. A quantitative analysis among programs to determine exact dollar amounts and length of specific AW tasks could provide fidelity to the whether the assumption of military certification is cheaper is false. Also, this would be insightful to the differences within the different FAA AW seam certifications. No literature was found tracking this quantitative data which is part of what led to a qualitative case study data collection through interviews in this research.

This further research will help develop a more objective understanding of the airworthiness certification process and add validity to the decision factors already found in this research.

5.4 Significance of Research

Even though the scope of the research was small, the findings are significant. For all three platforms including the member of the TAA, nothing was stressed more than the importance of communication early in the project with all stakeholders to the airworthiness process. To be an educated stakeholder in that meeting, a PM should not enter those meetings blind and so the PM guidance is crucial to bring their knowledge of airworthiness and the processes to a level that can intelligently talk through the #1 decision factor Level of Integration. By better understanding the Level of Integration they can more properly assess the programmatic decision factors, and not fall victim to the fallacy of cost and schedule savings associated with

military certification. This research hopes to help program managers and their team make a more sound and objective airworthiness certification path decision.

24 March 2022

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24 March 2022

Appendix A: Interview Script

Good Morning/Afternoon Sir/Ma'am.

Thank you for taking the time to do this interview with me. My research is examining which factors are important to the selection of an airworthiness certification basis. Many program offices have pursued FAA or TAA airworthiness certification or some combination of both.

I am collecting information from multiple program offices, including management and engineering, as well as the Technical Airworthiness Authority. I want to better understand the choices made and processes followed to better aid future programs in their decision making.

I will be recording this interview to allow for a smoother discussion and better data capture. Your personal information, duty title, and specific program will not be released outside of the research team nor used in the final paper or results; they will only help me organize the data. All recordings will be deleted once my thesis is complete. All retained data will be anonymous.

There will be 20 questions in the interview:

To begin I would like to start with background on yourself and your relation to the program.
Second, we will go into what the program is, its purpose and the modification at hand.
Third, I will ask questions directly tied to the Airworthiness process and decisions made for the certification approach.
Finally, a few questions reflecting on the decisions made and where to go from here.

About the Interviewee

1. What is your name, position or title, and the program office you work in?
2. How long have you worked in AC systems?
3. What modifications and platforms have you worked on? What is the most recent? When was it?
4. What is your role in the modification?

The Program

5. What is the modification we are talking about today? (Size, Functionality, Time, ACAT level, Dollar Amount, etc)
6. Was the original design of this aircraft for the military, or is it a Commercial Derivative Aircraft?
7. How long has the Air Force been utilizing the aircraft?

Airworthiness Certification

8. What level of Airworthiness certification did you seek to accomplish through the FAA? How much did you seek to accomplish through the TAA?
9. Why did you strive for that certification level?
10. What were the benefits or drivers of this path?

11. What were the costs of this path?
12. Did you achieve the Airworthiness certification from the FAA and TAA that you wanted? Were the benefits sought achieved?
13. What were the major setbacks encountered or biggest moments of tension in the certification path?
14. Did you make multiple adjustments to the initial AW plan or Criteria Basis through the process? Did you meet all standards or able to show compliance in every area?
15. What risks do you currently carry?
16. Are you flying today on a Military Type Certificate (MTC), Military Flight Release (MFR), or Supplemental Type Certificate (STC)?

Reflections

17. What documents and communications did you find most helpful in establishing the AW certification?
18. Was the path your program took the right path and why?
19. What is something you wish you had or knew up front when going for the AW certification? Any future recommendations?
20. Who or what other programs would be of good value for me to pursue in an interview for more data collection?

Thank you so much for your time. Once I have established the first round of interviews and certain trends in the data, I may look to come back with some follow-ups. Would you be open to reconvene after the New Year for a second interview?

Thank you, have a great day!

24 March 2022

Appendix B: Interview Matrix – Raw Data (Anonymized)

Platform 1: IE1 & IP1 (pg. 1/3)

AW Certification Interview Matrix			*About the Interviewee*				*The Program*		
Derek Dennis	1/3/2021		Q1	Q2	Q3	Q4	Q5	Q6	Q7
			What is your name, position or title, and the program office you work in?	How long have you worked in AC systems?	What modifications and platforms have you worked on? What is the most recent? When was it?	What is your role in the modification?	What is the modification we are talking about today? (Size, Time functionality, ACAT level, Dollar Amount, etc)	Was the original design of this aircraft for the military, or is it a Commercial Derivative Aircraft?	How long has the Air Force been utilizing the aircraft?
Date	Code Name	Finding ->	Position Type	Experience	Experience	Position	Type of mod	AC type	Time of use
20211110	IE1		My name is _____. Ah, I am the **airworthiness lead** for the _____ program.	I've worked in aircraft systems my whole career **since 1987**. I've worked in this particular program office for **four years now**.	For military aircraft I've worked on the **F4, the F16, the F117, F22. E8 I put a radome on the E4B. And now the ___.** I'm also on **FAA designated engineering Representative DER** and I've worked on multiple FAA certified aircraft. The majority of them being. Beechcraft series, the B100B200V300 and Cessna Aircraft, as well as a couple of Fairchild. Uh, aircraft, S8227 in particular... Yes. Yep, **I am still working ___ and I am also an active DER** on the side and I have four or five projects. Installing antennas on Beechcraft three fifties B3. Textron, I guess owns them now.	In the for the ___ program, I am the **airworthiness lead** and so I am the lead for all **airworthiness plans and documentation** required to attain...Fight release whether that BFA or STC or TA military. And I also work as the **structural subject matter expert** for finding compliance for structural aspects of the modifications. The modification we're **discussing is adding a military GPS system to the Bombardier BBD 700, which is a commercial business jet by Bombardiere, also known as the Global 6000.**	The the the modification was **not too extensive modification.** It basically added **two antennas to the crown of the aircraft and 2 military GPS units.** Uh, that were providing **signal to the aircraft cockpit**. Uh, is the original goal of the program. We initiated this as a, uh, **urgent operational need**, and so the time frame was supposed to be a two year time frame. And it kept [ACAT] level. I don't actually recall, but the basic contract was for **around $70 million**.	Yeah, the the basic aircraft is the Bombardier business jet to **BD700** is this designation. It's also known as the global 6000 aircraft. It's a business jet by Bombardiere so that aircraft was, you know, converted to a military as a commercial military, **commercial derivative aircraft**, and so the basic certification of the aircraft is FAA.	The the Air Force had been flying it for about **13 years now**, but it was really I. I think the 11 designation came in and and 2010 so it's about 11 years as a as in **11 designated aircraft.**
20211110	IP1		So I am _____, my current duty title is an AG or the Aerial Gateway Network **branch deputy**. And I oversee multiple aerial network programs currently. However, like for for the purpose of this interview, everything would be based off my baking experience. Uh, on the platform of the ____. To assist with the FAA stuff not there is some. Some FAA work that we can kind of go into when we get there. I'm on my current effort efforts. But for the most part, most of the knowledge will come from the Bacon program office...I think you [mean] the **aircraft IPT lead**.	It was **three years**. (*So it was all with the ____ ?*) It was, Yep.	Yeah, so for bacon, uh, I Started in the program of July of 2018, I finished with _____ in September of 21. Uh, and the modifications that were most in depth with the FAA and Leonor TA was **the mill GPS slash identify friend or foe or IFF Mode 5** installation on ___ fleet.	So again, **PM**, not the day-to-day PM but oversight PM too. A captain and then a GS-12 PM who was the lead day-to-day program managers for the overall effort.	Sure, so the the models **mill GPS IFF mode 5** installation on the [____] fleet. Uhm, it's a **small fleet**. Only ultimately **3 aircraft.** In the end there. Uh, for the program itself ended up getting split into two different phases, so the first phase. Uh, initially was supposed to be from start to finish, however we hit snags with the TA and their ascential seam between **the FAA and the TA, and who covered what They take completely different approaches to the final approval, and we could not.** We are assumptions going into the effort was that you know we would do all the testing as if we were gaining full FAA certification. However, **we didn't have the time due to a UON or the urgent operational need status**. Uh, so we were seeking, ultimately full testing, as if we were gaining full FAA certification in hopes that the TA would take that testing and be the final approval which was then. Not the agreed upon approach from the TA after already going into ASP. Uhm, approval and getting underway with the you on work. Even though we completed the testing with the FAA, we then had to do a follow on effort for full FAA certification. Uh, that ended up almost **doubling. Uh, for the cost**	So it was a **commercial derivative aircraft, With a military modification.**	Uh, 21 approximately **13 years**. The fleet has been in service.

Platform 1: IE1 & IP1 (pg. 2/3)

24 March 2022

AW Certification Interview Matrix			*Airworthiness Certification*								
Derek Dennis	1/3/2021		Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16
			What level of Airworthiness certification did you seek to accomplish through the FAA? How much did you seek to accomplish through the TAA?	Why did you strive for that certification level?	What were the benefits or drivers of this path?	What were the costs of this path?	Did you achieve the Airworthiness certification from the FAA and TAA that you wanted? Were the benefits sought achieved?	What were the major setbacks encountered or biggest moments of tension in the certification path?	Did you make multiple adjustments to the initial AW plan or Criteria Basis through the process? Did you meet all standards or able to show compliance in every area?	What risks do you currently carry?	Are you flying today on a Military Type Certificate (MTC), Military Flight Release (MFR), or Supplemental Type Certificate (STC)?
Date	**Code Name**	**Finding ->**	Certification Path	Factors for Cert Path	Benefits	Costs	Success rate	Setbacks / Difficulties	# of adjustments	Risk types	Flying Cert
20211110	IE1		The the program office had an initial plan, a proposed plan to get a **safe carriage STC certification of the FAA and then military certification for the functionality** of the military GPS system because they are military functions that are very **difficult for the FAA to certify.** That was our ingoing **airworthiness plan**. Submitted to the TAA office at Wright, Patterson, and They they kind of basically did not accept that plan and proposed **instead for us to utilize a independent review team or independent airworthiness assessment in the short term. Whilst we sought full FAA certification of the the mill GPS system** and so that. The second way is the way that we moved forward with this program.	Well. [TAA] was the final authority and so we had to basically do it. Their way up because we were seeking their approval of the year where or where they understand, they said. N**ow we're not going to let you do it that way. You need to do it this way** and so we revamped our plan and and we did it. **We went forward with the only path that the [TAA] said, you know we could follow.**	The benefits were for **an urgent operational need program and independent review team**. Assessment risk assessment and approval. It could have been **theoretically the fastest way to get the system approved for operations in theater whilst working.** The much longer process of a full FAA STC of the capability. So that's the benefits of the you know the plan that we were told to follow the the other plan is it also or the other part of that is it also **keeps all the certification of the aircraft in the original certification authorities** certification basis as an F. So it's **an FAA certified airplane and the mill GPS system would be fully FAA certified.** If we could obtain that, and so that's those are the two. You know reasons that that that path was which was given to us. … **That is a general Air Force, a philosophy for commercial derivative aircraft, for any aircraft to Keep their certification, uh of modifications done under the same authority that the basic aircraft** is is was certified and On a big picture, it **definitely makes sense because there are a lot of aspects of the military certification processes versus FAA certification process**	The costs of that are **pretty large** because, uh, when you, particularly in the case of our modification, we we're **taking military developed system and putting it onto a commercial certified airplane** and and that **military developed system had specific military purposes that would work extremely hard and or expensive and time consuming for the FAA to to certify** and. And that's so those are the drawbacks of that. Where the FAA, There's not, you know, like **FAA looks at functions and it does not have certification rules for military functions such as carrying bombs or jamming and and things like that.** And in our case the the jamming, they anti jam anti spoof kind of things were. Not functions normally dealt with by the FAA, so. Difficult and expensive, inexpensive for them to certify and we. **We actually haven't come, Got there yet we the contract for that has not been LED because it came in a much more expensive than the funds we had available**. And then we still don't have the appropriate funding to attain or try to attain that the full FAA certification of	The answer to that is **no**. We we have not received FAA certification of the mill GPS system or choose the top level goal and there's cost in cost. Mostly **constant funding issues** that you know haven't really enabled us to fully go down that path, but we haven't attained that and we did not obtain the Military certification that we wanted, yet either 'cause **we do not have military approval to operate mill GPS** for navigation of our airplanes and the **Independent review team process that we utilized came in with such a high level of risk that that risk has not been accepted by the Air Force** Uh, and [has] to go all the way up to the **PEO level,** which is General 'S'. For us to operate that system. and and **that's a very long and arduous process**. And we haven't got there yet, so so we **haven't retained either level of certification that the the program is seeking yet**…Exactly, yeah and yeah, I, I think we're we're kind of, Yep. What we're **seeing both of the downsides as opposed to the benefits of the of this chosen path**.	The biggest set back on for the FAA. **The full FA STC path is funding availability and Viability of actually obtaining FAA certification** of those malfunctions, the **Biggest setbacks on the in the military certification side were the independent review teams.** Uhm, **elevation of of risk w**e the program office and our contractors even even the FAA, the **BOMBARDIERE contractors assessed the risk at much lower than the the military independent review team** from Wright Patterson Air Force Base. We came in with a medium level risk for operations. And but the airworthiness authorities independent review team at Wright Patterson, came in with a serious level risk, and so that risk has still not been accepted. Because the higher level rest of higher difficulty it is to gain acceptance.	**Yes, we did.** Like we said, we proposed a different path and or guided into the the airworthiness path. You know, for the partial FAA with AARTHY and then seeking full FAA path. And so we revised to that. The **independent review team process does not entail a certification per say. I mean a certification basis**, so it doesn't define strictly define a certification basis, and so it's a little Gray. Or in that department. Though our **program did do a full. A military MIL Handbook 516 MACC certification basis, and compliance findings** and and we we had, you know, a good. I think was 35 non compliance is found. And **we assess those.** Still add that **medium level risk** where the **independent review team took a much more macro. Look at everything and. I I think causing it to be a much more conservative assessment and hot, much higher level of risk**… We met the standards we **we met both the FAA standards for the safe carriage STC**. You know that portion that we attained and we did. Do a **full compliance finding a for the military certification** side of the House. We weren't compliant with everything. We did a fault. We did the full process though. Uh, and so we you know you you C compliance and everything and and if you don't then you **define your non compliances and you assess your risk in the military process** and and that is what we did. There was just a elevation of risk from the IRT side that made it a higher level risk.	The, uh, the program has **four serious level risks,** UM? And and so that I have not been accepted yet, and we are continuing to seek to get those risks coordinated and accepted. And we hope in the next couple of months as other priorities are quieting down, we will have the time and energy to push that through the system and and and at least get it before general she meant to for him to make a decision on whether he it is he will accept that. Risk so that the you know ___ can utilize them. Their most GPS capabilities which are currently installed and just not operating… Yeah there are. **A number of lower level risks, non compliance risk**. But the this the the higher level risk roll those lower ones into them. So yeah, but basically you just you look at the highest level risks… There is no higher rest and never has been one that it was discussed as being a possibility, but **they there was never an assessed high**. Nothing. I'd have to go go back on that, I'm I'm not not not 100%. **When we provided all our mitigations and ask for a risk assessment for operations of the system, it came in at the serious level.** So it might have been. It might actually be in a high level before we did all our flight testing and all our integration work and all that and then. But but the assessed with all the work we've done was for the serious level.	We are flying the **mill GPS system under the safe carriage STC**, meaning it's just being safely carried and not being utilized, not operating as a navigation system for the ___ and. We are still **seeking risk acceptance in a military flight release for operations of the mill GPS system for navigation in the aircraft** and. Come as we said, we need to get that risk accepted before we can gain the military flight release. Uh, that it would not, uh? BB8 we will not be able **to put that system underneath the military type certificate until we attain the full FAA certification that was part of the airworthiness plan.Uh, we agreed to with the [TAA].**
20211110	IP1		So for the, UM, the effort that was awarded in on contract, we sought a **safe carriage STC through the FAA**. OK, and with utilizing that we thought for, t**hen the operational use to be approved through the TA.**	Uh, ultimately we **didn't have the time for the full FAA certification** due to the requirement being deemed the urgent operational need, so we didn't have the duration to do the full testing. The testing in and of itself was **approximately 12 to 18 months. That would have added to the timeline that we just didn't have.** In order to feel their requirement. So in effort of reaching that UON. Uh, we didn't have the documentation time. I guess I should say, not necessarily the testing time, **it was more the documentation piece through the FAA** that would have dragged out the period of performance. So we sought the **safe carriage with then ultimately the TAA signed up to do an independent review team** to help assign airworthiness risks. In order for us to utilize the capability in the field.	Benefits. So I'm not sure there was a benefit because it was **not an easy process** the [TAA] is, in my opinion, **a very subjective process**. Uh, and felt like the every time we had brought up our our **plan are risks for assessment** or you know our our testing artifacts there. It was their **interpretation of how they felt we met** or didn't meet certain criteria each time going back to the TAA. Uh, things that **were agreed to previously seemed to shift slightly** and kind of had maybe more time to think about things. So then there was a different kind of dynamic that would set even the month after, as opposed to progressively, you know, having an approval and then moving forward from there. We seem to kind of **go back and forth**. More so than continuing that forward momentum. Again, the **differences between how the FAA certifies things and the TA certifies things really was not as easy**. I think as the team initially anticipated based on upfront discussions with, you know leadership in the TAAs office. Uh, which then kind of resulted in much more of a zigzag. A pattern of how we obtained any of that as far as the FAA went, I thought that they. Seemed pretty	So first phase one, I believe we were up to. To, uh, approximately **$78 million** a month for **the safe carriage STC with. Uh, IRT approval TAA IRT approval.** The **follow on** Government costs estimate is approximately **$20 million.** However, the proposal initially sought was at **$54 million to finish out full FAA certification.** Also, if we **saw a full TAA certification** and forewent the FAA certification. Uh, the kind of ballpark figure was postdated it **about $40 million for the TAA to do there.** A final approval also and that would go back from start to finish and kind of wood. Uh, we undo the FAA testing if you will. I'm not sure. (*What about non financial costs?*) Let's say **schedule certainly took a hit up we**. Spent a lot of time **going back and forth and not being able to proceed with being able to use the operational capability**. If you will come here, we are in **November of 21 when the when the contract was awarded in September of. 18 and still unable to use the avionic use** especially now a bacon program. Office has jumped up. I think we just compare. They just completed their third. Uh,	We did a complete the **FAA safe carriages STC with the help of the TAA**. So not necessarily what we wanted and initially against that was our Plan B. The UM, which we were able to to seek? UM, if we were able **to turn the capability on, which is in the process of being worked through the wickets, ultimately**. Uhm, due to the airworthiness assessment, there is a package being staffed with the C3IN **PEO for A signature** to be able to accept that airworthiness risk and be able to turn the capability on, so hopefully by **the new Year** we will at least be able to turn the. **Turn the capability on for an avionics suite capability.**	**All of it**. Uhm again, I guess I would go back to the **TAA and they're more subjective approach to how they sign off on.** Uhm, the approval. There's many different functionals within the TA understandably, but they just view things quite significantly different than the FAA. So going down that FAA path where all modifications to date with the Bacon fleet have been all FAA. OK, I think that's probably **the biggest part of tension, and trying to align both entities to kind of meet that common goal and ultimately get the capability to the field in the fastest time possible.** Uhm, major setbacks. We had a lot of **scheduling conflicts.** Biggest was we lost an aircraft in the middle of the effort. Going into the first installation. Uh, aircraft that actually went down was supposed to be the first install.Uhm, if I remember correctly and it just threw up kind of the whole schedule off because the contractor had been prepared for a certain aircraft and that's not initially that went in first.Uh, the schedule was also tide to a multitude of other things to take the most advantage of the aircraft downtime, which coincidentally two of the four initially needed a major inspection completed, so we had to work the schedule around that, which then tied into also.Testing from the FAA perspective and the perspective and just finding.Uhm, the best. Uh, we use of time essentially for both in snow and testing, and there was a period set in there that we were grounded. Uhm, on multiple occasions actually even once the aircraft unfortunately went down. There were other instances across the fleet that ended up grounding us. Additionally, I think for a total of almost four and a half to five months, the entire	Uh, but there **were multiple adjustments**, more so based on once the **TAA had their review time,** we. We made **many adjustments based on their assessments** of where we were and **what they needed to see in order to get a achievable airworthiness risk assessment**. We had to **add scope to the contract, ultimately to buy down a lot of that airworthiness risk that they felt that was acceptable for them to approve**. One of the biggest ones was the F Met the failure modes and effects testing. **FAA doesn't look at necessarily a lot of the Information within that kind of scope from the military side of the House. So we had to amend the contract or ECP the contract to add that scope in so that the contractor could then prove where. Uhm, what we were missing from from the eyes of the TAA.** Uh, I would say from a financial standpoint it was probably close to just under. Uh, I just under **$10 million in added scope that was derived from a TAA perspective**. That yeah, wasn't initially planned for and our airworthiness plan for certification criteria. As far as [standards], I guess from **a safe carriage standpoint. Yes, we were able to achieve** that and ultimately able to achieve A airworthiness designation from the TAA so that we could move forward and having the [PEO] sign off on that risk as opposed to having to go to SAF/AQ up with the way that it was deemed. And I always get these ones confused. It was deemed as a serious and a high risk,	I actually can't remember all. Of the risks up. I would have to go back and double check up. On what is still being carried in what was deemed to be able to move forward. But ultimately, **overall it was an airworthy serious**. Thank high risk.4. Yeah, for the PEO to sign, but as far as what actually was constituted in those, I can't remember off the top of my head right now.	Technically, we're not flying. Well, I guess we're flying with the **supplemental type certificate for Safe Carriage only**, so the capability is not utilized right now. How, however, once the PEO signs off on the airworthiness, we will be flying on an MTC, or both. Both MF Rs in MTC's. Between the fleet and the nuances of the fleet, **we will have a variation of actually all three of those.**

Platform 1: IE1 & IP1 (pg. 3/3)

AW Certification Interview Matrix			*Reflections*			
Derek Dennis	1/3/2021		**Q17**	**Q18**	**Q19**	**Q20**
			What documents and communications did you find most helpful in establishing the AW certification?	Was the path your program took the right path and why?	What is something you wish you had or knew up front when going for the AW certification? Any future recommendations?	Who or what other programs would be of good value for me to pursue in an interview for more data collection?
Date	**Code Name**	**Finding ->**	Known knowledge	Correct decision	Lack of Knowledge	Contacts for Me
20211110	IE1		Yep, yeah, the air, the **air worthiness plan.** Was a critical tool. You know we didn't get the the the path that we had proposed. Uh, accepted and so we **had to revise that plan.** And and that that's a critical part of it, as well as the. If A is what they call a **project specific certification plan,** which is essentially a net worth in a certain plan. Uhm, for that specific modification or installation and and both of those are very critical. And and we're great tools. Who the? **Mil Handbook 516. Mack certification basic basis** matrix is is also a a key tool and document to trying to push things through that. That military starts side of the house.	Yeah, and i**n my opinion it was not the right path.** And and we are still, you know, not able to fly the system because we didn't choose the the right path. The and it was not the right path because. **And FAA certification of military functioning system, it's just not viable and it's not feasible it it's it's**. **It's desirable from a high level philosophical philosophy, but. Uhm for military functions Uh, specifically military developed systems with military functions trying to seek FAA certification is not realistic in that** in that some.Yeah, that that was the the biggest problem…A military certification with a mill. **A Mac I think is. The only viable method, and it would still end up it still may end up with some you know non compliance is at risk,** but the those risks would be. Much more well analyzed and thought out and understood. Uhm van, the overarching IRT process that was used. They they Uh, you know? Effectively they are. They almost didn't understand that the. The Bombardiere business jet uses GPS for longitudinal position only. And it has all or if that's the only thing that it it it would. It would be the sole source for all the other position data has multiple other sources that are constantly.Checked against each other and so vertical, you know, ground above ground and all those things have multiple sensors going on and and though the. And in the military utilization of GPS, is	If we had done a little **more research on the FAA's ability to certify military functions** and E and the. The FAA's.Uh, continuing stance on that, and you know, they're they're. They're even getting more strict with it now where our aircraft has an FAA asked for the ARC 210 in the cockpit, you know that that radio we have in the cockpit and that was the last FAA STC issued for R210 cockpit since then. They said we're not doing those that that radio because that radio. Oh, really shouldn't be certified under the FAA because it has 2 broad abandoned you and unless you modify the radio to not allow it to use its full band of frequencies you're creating you, you have non compliance is and so it it does not comply with FAA rules because. Uh, and in less you you know put, you know, do basically software limitations in the system. You know you you add, ban, ban chopping, or band limitations because. The the radio itself you can dial any frequency you want and you can stomp on glideslope frequency or some important. Uh, navigation for status frequencies in.So yeah, if we had known a little bit more about that that history in that, that general trend within the FAA, **I think we could have made up a stronger case to maintain the original path that we had recommended and and and seeking FA just safe carriage by the FAA and functional. Certification by the Air Force.**…Yes, yeah yeah as	Certainly there are. A number of other airplane other platforms also pursuing mill GPS systems and like one of them they tend is using the same military GPS system. And that's but that's you know, military system on a military aircraft. But then you also have the the _____ is. Is trying to incorporate the same mill GPS and that's more of an apples to apples with our program because it's a commercial derivative aircraft that is incorporating a military system into it and the ____ has is is. Yeah, if you haven't approached him I I think you should because it it has more military function in systems incorporated on it than the ____ like the ____ has self defense. In other you know anti jam kind of things like that that it has to have because it's it's a VIP transfer…The biggest example of that is the the IFF system that **APX 119 IFF** system that we incorporated.Handles both civil and military modes and and so, uh, civil…Yeah, the Honeywell guys would would be able to even if even if they can't give you too much, they can give you their marketing spielo. Yeah, we've got this guy on all these platforms and then you can find them to find somebody in that platform.
20211110	IP1		I think the **countless meetings t**hat we had, both with **the MCO and TAA**. Trying **to dive into what was deemed acceptable**, how we would go through **the whole process** in that, you know we had that **Seam approach that didn't necessarily work out in our favor, but we were still able to obtain. Are close to obtaining all the certifications necessary for the fleet**. And I guess just not necessarily the documentation. Uh, from my perspective, but more of the communications across the board and getting e**verybody all on the same page, all in the same call to try to talk through the multiple different functions areas that were concerning to whether it be the MCO the TAA** and kind of having that common ground to be able to talk through a lot of the conversations to be able to get everybody on the same page to get to the end goal of field in that capability.	No. Uh, **I think it was the right path because again it was a UON.** We needed to field the capability as soon as we could. Then at the time, with the information that was provided for the team to be able to conquer this task, and I think that **Seam approach was the appropriate way.** Again, based on upfront dialogue with TAA leadership, they all or I should say the individual had agreed that if put in that same scenario would have kind of conquered the the task as we had. Unfortunately, when it came down to brass tacks, that wasn't necessarily the way that. Happened, but the team was able to still move forward and find some sort of delineation between the two approving authorities. TAA and FAA to be able to field the capability. So yeah, I guess given that the information that we had at the time we were able to move forward didn't [meet] the timeline. But I think that ultimately will give the. The the pilots that capability that they need to be able to. Complete their missions.	**All of it**. **I guess we were going off of information that we had thinking that we were down the right path at the TA would ultimately kind of sign off on all of the testing and all of the work that we had planned to do in the strategy leading up to getting the effort awarded.** So I guess. Having **better insight or I don't really know how to even say that either, but like ultimately. Have accurate information going into the effort.** I think the team would have put maybe taken a different approach had we, you know, had information that differed from what we were given initially. So yeah, I guess again I think the **whole subjectivity of TAA**. Again, in my opinion, subjective. Uh, I think, Probably be personally would have **liked to known how nonstandard their processes are** on how they **come up with derived airworthiness requirements** and how they feel it falls into a certain category vice. Uh, maybe some sort of metric that kind of puts it in there. Granted, it's off of a metric, but it's all kind of up to the fields in again, in my opinion of where they think it falls as opposed to some sort of **quantitative metric that says no kidding. It's in this category**, not based on, well, you didn't do all the nuts and bolts, but you did 98% so, but it's still not good enough for us. We're gonna move you somewhere else and far as the category scheme. So I think combination of the subjectivity and then	I know that the aerial networks division is having a lot of struggles with the FAA right now based on UMT phase or the temporary frequency authorizations. I don't know if that would be an area to kind of look into. And it's actually that it would comes down to is that the Air Force doesn't do everything that. Kind of falls in line with their process, especially in the most layman terms, so they're not willing to kind of play at the moment and not authorizing any of those frequency allocations. Uh, I don't know **Stephen Icso**. Maybe a good person. I know he also has the bacon experience as a reservist, but also has all all of **HNAG** pretty much portfolio in kind of dealing with the nuances there from or at least knowledgeable on what's happening with the FAA, and at least from a network perspective. And getting all the R. Uh, sorry. End of day, all the frequency allocations sorted out for different Air Force platforms to be able to test and or utilize. For a plethora of, but at least from the network perspective, H and AG may be able to, uh. Trying to think of other programs. I know the **AWACS** grew up. They were just going through, but I think they're got cancelled so that wouldn't be a good one. I'm not 100% sure I can think about that one more two and get back to you with anybody else or other programs if that's acceptable? … Asian J and I was having a similar

Platform 2 – IE2 and IP2 (pg. 1/3)

AW Certification Interview Matrix			*About the Interviewee*				*The Program*		
Derek Dennis	**1/3/2021**		**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**
			What is your name, position or title, and the program office you work in?	How long have you worked in AC systems?	What modifications and platforms have you worked on? What is the most recent? When was it?	What is your role in the modification?	What is the modification we are talking about today? (Size, Time functionality, ACAT level, Dollar Amount, etc)	Was the original design of this aircraft for the military, or is it a Commercial Derivative Aircraft?	How long has the Air Force been utilizing the aircraft?
Date	**Code Name**	**Finding ->**	Position Type	Experience	Experience	Position	Type of mod	AC type	Time of use
20211118	IE2		Yes, my name is _____. I am, uh and **avionics engineer** for the Air Force government employee. I'm. Presently, **the lead flight, quite deck avionics engineer** for the _____ be on the Air Force side. Uh, and I work in the program offices AFL AFL CMC slash _____ guess?	So I've only been working for the government directly for about **12 years** or so. I've actually worked in **industry for about 24 years** before I came to the government. So I've worked in the airlines I've worked at that as a contractor, work special OPS. Uh, years ago, back in the 80s. Worked well actually. I guess at this point I I would say I'll get someone to neighborhood of about **30 years of experience in avionics**. I've got about **37 years as an engineer overall**. Most of that was in avionics.	I worked on the. Multiple platforms UM? Probably somewhere neighborhood **18 different, 18 or 20 different aircraft**. So I've I've worked in the in the commercial side of the fence I've worked on Douglas DC-8 DC 10s. Uhm, MD 87's a **Boeing 7273747576777.** I've worked the **King Air 200 of work, the Airbus A300** Before's and I've worked with the. The military of dumb stuff I've worked with. The **MH 53** day helicopter. The inmates **60 G helicopters** that's a payable on Paybox special OPS. **T38** upgrades J Pats aircraft **C32** a **C40B** and **C-27** J the light Attack support aircraft. Which I believe is a uh. I forget I forget the Desi. It's eight almost 829. I can't remember what the. Actual name was anymore, but. Uh, and also **F16 simulator trainers** and. The horse in the Air Force. Now right now I'm working on _____**. Uh,** _____ is now designated_____. The new _____	But the mil GPS my my my vacation I'm responsible again like it's just somebody on the **lead. Flight deck engineer** and I had a pretty h**eavy hand in the determining factors of how we're going to move forward as far as the design for the.** _____. How we're going to apply military GPS because at the time they were doing it. They were looking at just putting a box and as it's cheaper, cheaper by itself and then they were just. But they were saying they put like a a small three ATI display in the flight deck instrument panel. Uh, we chose to make it in the war. Uh, we had they just system for the flight crew, so we've actually done a lot more to that. It's a very. It's a fairly. It's a. It's a fairly decent integration for this aircraft, so my **responsibility is everything pretty much start to finish from the design aspect.** Working with Boeing, working with the manufacturer Honeywell. Been involved with with all the design reviews and things like that and, uh. Also involved with this certification aspect of it working on both with the FAA and at every time they originally were, you know when we were trying to push the idea of going down to the **FAA certification route, Boeing was pushing back and wanted to mill certification so the initial thought was ever do milk certification.**	We integrated this system with the aircraft such that it **interfaces with the flight management computers**, which is the, which in this case is the **green aircraft equipment.** And what we're doing is we're allowing them to **switch between the military GPS.** In this case, it's a. It's an **embedded GPS INS**. It's a H**oneywell H-764**. It does have a a GPS card in it. It's an INS with GPS and the GPS card is a force 524 echo **trimble card** which has the capability of S Pass which we are not using. We're not using the S fast capability. We are using the mil GPS aspect of it, yes, but the S passes really **civil function** which the. Air Force Airworthiness Office does not want us to be doing so **we're interfacing with the flight management computer and we're also feeding information from the flight management computer to other places within the aircraft** so. , you know, looking at a block diagram here, they kind of give a basic description we've got In our system we have we're using. The **CRPA antenna**, but seven elements CRPA, intent of within AEW electronic unit for the for the antenna for each of the GPS is we're feeding information from the **GPS to mission communication**	Well, so the aircraft that we're using as a as **a Boeing 747 Dash 8 I**. That's in a reality that wasn't going to be the case. It was gonna be a. We were actually getting trying to get **something off the production line** and I guess what happened was is that. ThatBoeing had a couple of fairly new at that. I'm fairly new 747s that the Russians I've had. I guess the Russians for the airlines had and they defaulted. So we ended up picking up those two airplanes. Suppose we 'cause we gotta get DA lot of it, which I I you know I don't know, you're not you're talking to the wrong person where I think we got it right. Good deal out of it but that's that's that was the that was what they thought was anyway so they so that's what we got. W**e got 747 dash 8** I's **so it's a purely commercial aircraft.** And we're transforming it into a US Air Force commercial built derivative aircraft.	**This aircraft has never been used.** This aircraft is brand new. Uh, it **set out in the desert out at the out in California.** Uh, and I was after a few times I've seen it up close and personal, but on the aircraft several times and this is **before we send it down to San Antonio for modification but but that's that it's been around.** I mean, like I said. I think I wanna say, oh, geez, I can't remember the year. I can't remember the time frames anymore. So let's say roughly 2016 or so, or something like that. I had to go. I had to go check records to find out when we actually purchased those aircraft, but. They've been in our possession for a few years, but you know, like I said, they they sat out there. They're being upkept by Boeing, and then they were **sent out to San Antonio where they're being modified as we speak right now.** *("They havent flown any op hrs?")* No, **absolutely not**.
20211130	IP2		_____ and the **avionics IPT lead** for the ____ replacement program. So I work in AFLCMC/____	Ive worked in ____ program office since **April of 2019**. I have worked in ____for about **twenty months**. As a **major aircraft program, I've only worked on ____**	In my time at AFLCMC, prior to that I worked in **simulators** for the most part supporting **C-5** and **KC-10**. Ive worked on the anfar ERP program for the C-5. and worked on KC-10, of course, that was primarily training systems.	I think my major role in the the this modification is is working on both the **the flight deck. And the mission communication system avionics.** Making sure that we have a, uh, a **solid design that the contractor is is working their their timelines now need to get to production, but eventually two certification.** Uh, **hopefully mostly F FAA certification**. Uh, so that we can continue. Yeah, we can field this thing on. Somewhat on time. Uh, and I won't get into the schedule details.	Basically, modifying **two 747 800 aircraft**._____ **transports**. So it's it's a small fleet size only and only two aircraft, **but the modification is. There's a significant**. It's about a, uh, **a cat, one D $3.9 billion effort.** It's actually been been ongoing for a number of years, and it's probably not going to now d**eliver until about 2025**. So, Uh, **about nine years at total.** I believe in in a making from the in inception to a final delivery…Ah, just a mill GPS portion is is not not that much. it's tough to say. With that, with that dollar amount is **we really don't have that. Broken out because it is a firm fixed price contract**. We don't have the level of insight into various efforts that you might have on some other other contracts. Let's just put it that way. Its hard to say, if I had to I guess I would say less than uh, **$10 Million**. For the effort by I'm like I said I really have no no way of knowing since **we don't have a work breakdown structure and pricing that's broken out on that level of detail.** *("And so the functionality. How would you describe it?")* For the **mill GPS portion.** It's, it's basically, uh, an **alternative. Positioning source**. So we haven't gotten rid of the. Our commercial eggies, commercial GPS is used	I would say if you looked at question 6, see you original design obviously was a. This was a **commercial airplane.** So it it is a **commercial derivative Air Force aircraft**.	**This particular version of the aircraft I** I **don't think has been fielded before within the Air Force, 'cause it's a 747-8**. But in general we have both Air Force has been using 747s in various roles. Probably for about 30 years. The first is, you know, Air Force One and naoc and and a couple of other other systems throughout the Air Force. To date, I can't say that we've been using any 747-8s, in any other under role, but 747 is in general for for quite awhile.

Platform 2 – IE2 and IP2 (pg. 2/3)

AW Certification Interview Matrix			*Airworthiness Certification*								
Derek Dennis	1/3/2021		Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16
			What level of Airworthiness certification did you seek to accomplish through the FAA? How much did you seek to accomplish through the TAA?	Why did you strive for that certification level?	What were the benefits or drivers of this path?	What were the costs of this path?	Did you achieve the Airworthiness certification from the FAA and TAA that you wanted? Were the benefits sought achieved?	What were the major setbacks encountered or biggest moments of tension in the certification path?	Did you make multiple adjustments to the initial AW plan or Criteria Basis through the process? Did you meet all standards or able to show compliance in every area?	What risks do you currently carry?	Are you flying today on a Military Type Certificate (MTC), Military Flight Release (MFR), or Supplemental Type Certificate (STC)?
Date	Code Name	Finding ->	Certification Path	Factors for Cert Path	Benefits	Costs	Success rate	Setbacks / Difficulties	# of adjustments	Risk types	Flying Cert
20211118	IE2		The path that this program office took was First and foremost, we take the the FQDN **AFI** in the in the in **the direction we're given from the Air Force. Pretty serious, especially on a passenger carrying aircraft**, which is where your what this is. **To get as much FAA certification to the maximum extent practicable** and that's what we're trying to do on everything. Now I also will tell you that **Programmatics gets in the way.** So what happens is there's times when we want to get other things FAA certified, and because of the fact that you want fixed **firm fixed price contract,** what happens is that they're they're they're. **There tends to be some horse trading going on.** So, and there's things like that that occurred, and so there's certain things we couldn't get that we wanted to get from FAA perspective. And then in in, in, in in reality, we started looking at it. It's it's not a real bad thing, but. The thing that we got the trade off that we got was. We got them to buy into the idea of going forward and **getting FAA certification of full FAA certification with the mill GPS. And when I say full on talking about it from the way**	Again for the FAA. For for number reasons, one first of all, that's the that's the edict that's pretty much **handed down to us** from the **commercial derivative perspective.** It because **we're passenger aircraft. It lends itself very well to what we're doing.** In it, because the **FAA was able to to at least they're telling us they were able**, they're able to do these. Did the GPS spot certification and not just **the GPS, but the interfacing that we have with all the different elements** within the GPS like the Egypt with **transponder and everything else**. Because they could cover all that. Did we decide hey, that's a better path to go down and and and what that comes down to? Also is. Is **manpower in the program office as well?** If you take a good look at program office in the past? You know they have. **They've basically have cut down the the staffing. In my opinion, if you're going to do a true certification effort on this type for this particular system, you're going to have more people involved. You got that more engineers involved on the on the Air Force side** and you're gonna have to **have more control over what's going on with the design melt elements within Boeing,** and	Well, like I said, I think I think it it helps us from the standpoint there and **we don't have the personnel to do what would be necessary in my mind to do it**. Proper certification from the program office standpoint. it becomes an issue of of the way the **Air Force structure the program office** anymore and so. Uh, you've got the personnel you got time, cost and schedule. If it works to the benefit it can, it can help you in those areas. Again, like I said, we're we're at it's it's. It remains to be seen because **we're not far enough down that path in my mind to be able to say whether or not there's not gonna be a hiccup or a problem. So far things look OK,** but that doesn't mean anything. If this were not the endpoint yet.	Well, you've already seen you've already seen the. But as the numbers I kind of rattled off to you about the the way the system is integrated. We could have took this. We **could take the easy path I guess, and just to meet the requirement though in a GPS receiver** on the aircraft with a little three ATI display and it made it be a Federated system. Again, it goes back to. In our minds, we wanted to make and **it's system that was useful to the flight crews**. And it's something that they could use for, you know, the purpose of their conops. As a worldwide aircraft like you know, being able to fly anywhere in the world anytime. But far as their costs are in the big, to me the **big cost is really the money.** If there's a drawback to what we're doing, it's the money because of. If you're doing this, if you were doing, I **think that modification efforts on the Air Force side versus what I've seen on the commercial side is is almost like night and day. Because if I do this, if I did a a an effort on the on the on the on the commercial side. I believe that you're probably looking at a cost that's way, way much**	At this point in time, what **we can say is that the plans have been approved and accepted by the FAA, and that we have gotten our airworthiness cert plan through the Air Force**. That's as good as I can tell you, because everything is in process… Well, that's hard to say right now because the **schedule keeps slipping to the right**. Uh, so I'm not even to be honest with you. I'm not even sure what this _____. He's as we're speaking. They're changing the schedule. So I think originally originally we were supposed to have the plane out. Dash 2020 24 into **2024. I think it was. I think now they're talking about 18 months or better out from that**. And so, uh? *("That's because you're it's all this like you're doing so many other things to the aircraft is.")* Oh yeah, yeah, it it. **It's it's certainly isn't because of this this this modification,** it's it's. It's a bunch of other stuff. Uh, **we got we got a whole host of issues going on.** But I think originally you know we were looking to have this sort. You know, let's put this with the **FAA. Gives you five years**. OK, **they give you 5 years before they they can actually pull the rug out from underneath you.** When it comes to certification now you could get an extension I guess on it. And of course you're gonna have to probably do a lot of of of **proven to them. Things are still. Where they're**	Uh, for this well for this particular for this particular **modification, nothing yet**. I'm always keeping my eyes open. There's always been a **few hiccups come along**, but we've been able to get things moving resolved. Whatever up to this point, so hope, hope, and pray to God. It stays that way. But there's another things, for example with like the class to EFB. We ran into situations right now where I'm facing right now. White paper as we speak to go to the FAA to go argue some points on that particular thing because they're they're putting us in a situation where they're wanting us to put **this system into DAL level D that everybody else in the industry is using a down level E,** and nobody makes equipment for **DAL level D hardly**. So, and it's not going to work for our conops, so they're putting us in an undo situation and undue stress situation **where I can't get equipment to do my job. But yet you're telling me I gotta get it certified that level, so we're gonna have a little chat about this,** because because **the interpretation of the policy holder is driving us to do these things, which everybody else in industry scratching their head saying.** I think he's nuts. So we've got to figure out how to get this resolved. So that is a major hiccup, because if we don't do, if we cannot get this. If we cannot get this taken care of, we're going to go down the path of those certifications. We've got to do that right now. We believe it or not, because the fact that we're looking at FMC position data up through that to the to the basically through the to the EFB. The ENV guys are going to look at this and they're gonna, they're they the potential for trying to turn this into something. **We're**	**Yeah, so there's there's always that going on.** There's there's no matter how you slice it, the there are elements of of. With Boeing develops the sort by now. Keep in mind when we talk about FAA cert plans here Sure. Boeing develops a cert plans. **Typically we don't get a lot of insight now. We did on some things. We got to see some of the preliminaries, things that they were doing and and that was good because I asked a lot of questions and I was looking for some stuff, making sure they were doing certain things.** Matter of fact, **I myself personally went directly to the FAA, MCO and I and I and I went when it came to the GPS.** Especially I wrote about I wrote a I don't know three or four five page paper and I said look, I'm a derp and they know it 'cause we they know me for years. I said look if I was doing this myself. This is exactly what I expect to be done. OK for all the interfacing for the Egypt words. A transponder, all these other things. Here's what I expect you going up from the navigation perspective, here's why. Expect you going from ADSB perspective. Here's here's exactly what I expect. We're going out and I'm telling. **I'm asking you guys this, because you guys have the insight to a cert plan. I don't. I'm just trying to let you know As the Air Force as a program office, I'm asking you to let me know if these people are not doing what we asked them to do, because if you're not, I'm going back to Boeing and we're gonna have a chat** because there's there's certain	Well, the risk on that is of course, **if if they can't get it fixed certification. We got a major problem.I don't even know if we can get it. I don't even know if we get military certification**. **Because we would have to go back and and had to deal probably to deal with the contracts** on what? Because you're going to have to go back and get the data necessary and we're gonna have to go back and re establish ourselves with the Hanscom GPM's and TPM's **they get 'cause we register going down that path.** And once we once we determine where it could do the we're gonna get certification that that was basically nixed no longer no longer matter. Fact, **everything from our perspective at this point in time is being FAA certified that would be related to. Anything from the Hanscom perspective so.** Everything is is is being FAA certified in so. We basically don't lead to apply anything from that perspective, and we've talked. We've had discussions with them and they know where we're at right now, so there's so there's EN. They're all familiar with, you know where we're at so.	Well, **the goal is his together as a full of MTC,** that's what we're shooting for it, so that's what that's what I'm sticking with. *("So it will be an MTC? Overall, but you're still receiving it STC within that.)* Right, right, yes yes. So so so **the way it works basically is is that.** You, I think the way they started this aircraft was it started out. I want to say this started out with attack another where it came out as a **green aircraft totally FAA certified.** So we start out there as attack. We move on to what we're doing. **It's now MACC modifying the aircraft so. We are, you know, the ultimate goal from the Air Force perspective is always getting a military military type certification**. **Whether you're getting STC's or not, it doesn't matter because in the end it is under the jurisdiction. This whole thing is really under the diction of the military, and the military has ownership of this. So when it's all said and done, it's a military type certification. The STC efforts just get rolled up into that and that's taken into account when you when you lay out the baseline for your MACC.** You're talking about with applicable, what's not and what's not applicable AETC to the Mac is because it was based on 14 CFR part 25 or whatever from standard word is that it's covered through the FAA certification. So from our standpoint. Uh, we
20211130	IP2		Now we're seeking **maximum certification through the FAA.** On the on the on. The **EGIs in particular.** But I gotta check my notes here real quick, but I'm, I'm believe right now. Uh, we're just going to certify them as provisions only under the FAA. At least that's the plan at this point. We're gonna do some **additional testing because of the because of the batteries.** Uh, to see **if possibly they can be certified.** Uh, with the batteries in in place and let me just check something there real quick. I I'm sorry the the I misspoke so right now our **our certification approach is to certify the the EGIs with mil GPS. But basically removes the lithium batteries from the STC. Type design.** The bottom line is that the EGIs can can have the batteries inserted at at a different time, but for uh will have to do a little bit of a work around on on the. Spin up cycle of the EGIs to allow them to to operate without the lithium batteries. But that and then go through the FAA process that way, so we will certify it within mill GPS. Uh, in the aircraft, just without the without the lithium batteries installed at the time of	The reason for pushing for that certification level is. Basically, that's what **policy dictates this**. Yeah, no, that's what policy dictates that you know this is a. This is primarily a **commercial derivative passenger carrying airplanes** so. That's that's what the. This Air Force DoD policy. Ultimately.	Uh, if you really go to to to question 10, what's the benefit or the benefit of doing that? You know, **sticking with that policy is we don't have to recertify the airplane for all through the TA to all the things that have already been FAA certified so.** And and I obviously that's a significant. Portion of the airplane. And looking at the **the system that we're looking at, you know essentially the whole flight deck. It is a. FAA certified flight deck**. We're we're making some changes to it that have to be reviewed and and possibly certified differently, but **if we had to go back and and recertify the whole flight deck Ah, a new. This would be a much more involved process** and and are, you know it would drive no significant impact too. Flight test. Ah, I I can't. **I really can't imagine trying to go down a a total military certification process.** Uh, on this system. **The MCS the the mission communication system. That's really not, you know, part of what we're talking about.** That's that's another furball. But for for the purposes of the for purposes of the. **Mil GPS Certifying everything under the under the FAA as much as possible is is. I think the most realistic**	I don't have the the the actual costs of this effort like I talked about before. We don't have a. Hey, uh, under a **firm fixed price contract.** We don't have a **dedicated work breakdown structure and and various costs for**. Sub efforts within the **work breakdown structure where we might be able to pull this out.** *("What about like nonfinancial costs")* Like I said, _____ can probably talk to you more about working with the TAA. We've talked a little bit about the FAA. I think our **biggest challenges has been the the lithium batteries. We didn't have to deal with that issue. Then uh, let should almost be a slam dunk**. Getting a certified with the with the alternative input from the the mill GPS. The the lithium batteries have created a little bit of issue, so we're doing **additional testing**. Are **on our own outside of the contractor.** to examine the viability of of retaining the lithium batteries in a system so this is where we got to look at. Kind of two paths. Well, I told you earlier about taking the batteries out and certifying it without the batteries in place is basically the the Boeing	Well. **Yeah, and that's still a work in progress unfortunately.** So **Boeing has yet to submit all their certification**. **All their certification paperwork. Uh, for the avionics systems to the FAA**. I have to check on the check on the EGI itself. And then see how that's being certified. Come because of the the the the lithium batteries. **There are about 16 certification plans that are being held up.** Overall, the aircraft, by and large is is being certified. So through the FAA process so. Rough number is there's about **70 certification plans in total. Pardon me. The vast majority of those. Are are already through the FAA process and and have been accepted.** Uh, I have. I'll have to check with _____ and get back to you on, particularly on the EGI and where that stands. And that's probably the other engineer, you ought to, talked here.	So I I think the the **batteries are probably the the biggest set back.** Yeah so far but. Hi there, **it's not driving us off the timeline.** At least not the current timeline. And we put a plan in place to to deal with it. Woods with alternatives… Uh, we talked kind of about the the major set back and it really hasn't been all that major. I think we've been able to to to work through the process with the FAA.	But how we made major adjustments to the airworthiness plan? **Not from from our perspective. the objective is is still. To Certified under the FAA to the the maximum extent possible.** The current cert plan is is now bend basically through the process and and is published. Could there be some changes to it in the future? I think if there could be They will largely be. Uh, **to increase the FAA certification or decrease the amount of FAA certification down the road**. Uh, and take things back from the from the mill certification process. That is what I'm understanding, anyway… So Can we show compliance in every area? No. Obviously there are. There are s**ome systems in in this this aircraft that are are because of the nature of the systems or just outside FAA's purview**. But as far as this system goes, **I I think we will be able to show compliance.** In most areas and following this D LT278 testing. Uh, we should be able to show compliance in all areas for the EGI. *("So to follow on that..Is is that something that you're saying you're going like compliance testing that is? Like the FAA just checkboxes, even though they're they don't have specific tests for that and models.")* No, we we we still have, **we still have the full gamut of AIMS testing. To go through this as part of this effort, so, Uh, you know from that from that perspective. Uh, It's not going to be just a check box from the FAA per standpoint.** Aims testing is is a. I'm I'm not gonna say a separate effort, but it's it's	**We're not carrying any risk in our our current risk of you for. For Mil GPS,** you know, should we be? Honestly, I don't think so. At this point, **we're not showing any significant risks there.** Just trying to see if I could find it. Update briefing on. On where we are. So so right now where? Where were Boeing is tracking or? It looks like by January of 22. We should be pretty much. Through that process. *("And so did you have to have any sort of risk assessment done by the ETA on GPS. Or was it all with that?")* yeah, to my. **To my knowledge this is all through the through the FAA.** Size so. Uh, functional tests and the end to end system development. Right now low GPS is is was completed pretty much in August of this year. Their Boeing is looking at the. At their system spec verification. But that's the part that. so they're still working on and expected me completing around January of next year. On spec verification, with the with the existing load GPS… **Flight tests wont start until somewhere around 23**. **Aircraft worn power on is is right now looking at June 22. Uh and 1st Flight won't be until around November of 22.** Uh, and then. Our our primary testing flight deck type testing is is in block. 20 which is actually on the second aircraft. And that won't be until sometime in 23 according to the current schedules sometime around June, July will start Block 20 testing. So second, aircraft power on is not until.	Yeah, Jected Vista flying in **STC.** Uh, uh, as far as as far as mill GPS goes. My my understanding or someone flying on an STC. So Yeah, could that be subject to change. I think it would probably not be driven by Mil GPS if if that's where we end up. So right now. **We've been targeting all these things to to be under under an STC.** Three or four first flight. Even the other areas where we're having problems with the lithium batteries.

Platform 2 – IE2 and IP2 (pg. 3/3)

AW Certification Interview Matrix			*Reflections*			
Derek Dennis	**1/3/2021**		**Q17**	**Q18**	**Q19**	**Q20**
			What documents and communications did you find most helpful in establishing the AW certification?	Was the path your program took the right path and why?	What is something you wish you had or knew up front when going for the AW certification? Any future recommendations?	Who or what other programs would be of good value for me to pursue in an interview for more data collection?
Date	**Code Name**	**Finding ->**	Known knowledge	Correct decision	Lack of Knowledge	Contacts for Me
20211118	IE2		So I would say that what was very very helpful for me personally was I had set up a **series of meetings. Early on in the program were like I said, I'd pull people from the FAA. The Air Force Airworthiness Office, Hanscom. Boeing of course. And program office** and trying to think who will. Who will I brought into the broad in a number of elements and we and I and I I devised a plan of what the discussion should be about, because I've done you like it. Started doing this for a long time, so there's certain things I forgot to pack. The presidents airlift 'cause they're **the users they were involved in this conversation as well**. To try to make sure that. We we get the most complete, thorough look at how to put the system on the aircraft and how to get it certified. In other words, I was looking at this. I was looking. I was keeping an open mind. I was looking at it from standpoint. **How would I go down the path of getting FAA certification? How would I go down the path of getting mill certification and and and try to? Uh, come up with. All the inputs that I gotta get based on all the information that we know about. In trying to make it a, you know a a smart decision so that 'cause this was all really in in the process of how do we get to the point of coming up with**	I believe it's **the right path. It wasn't the right path. I wouldn't be sticking with it**. This this path is is beneficial to the program Office for number reasons. Like I said before, if you to do the job right, in my opinion, we'd have to get. **We'd have to staff up with a number of people, and I'm not just talking hot buys, I'm talking people know what the crap they're doing with these types of systems.** Yeah, and the interfacing and things like get for us to be able to move forward in a proper manner so. And **the problem that I'm seeing right now in the air forces we seem to be kind of short staffed in a lot of areas, seeing eyes, one of them and and so that would be a difficult thing for us to do.** From from the standpoint of my my like I said my biggest negative in my the biggest negative thing to me **personally is effectively went firm fixed price contract because it even though I have a good relationship with Boeing even though we talked to each other, there is a lot of details in there that I'm not getting and I don't know what's going on and if it was, if if if that was not present for.** So I mean, that's something that. Perspective. Uh, is it happen? Is it's? It's an application thing, so I mean, I've I've, I've got quite a bit, but not again. The type of engineer I am. I wanna know every aspect, every detail to make sure everything is being covered properly. **'cause I don't want surprises at**	Boy, what which there's there's times I wish you'd asked me that question well caught on it man, 'cause there's there's some **there's a white paper I want to put it out on this because there's things that we've learned that this needs to be everybody needs to be aware of and KC-46 taught us some stuff too.** Uh, Teams, what did things that's going on right now is is we're. We're part of the learning process and statement of functionality so. So I guess. **When you're doing certifications, I think we need we need to have a good understanding up front.** What elements will be will will be ethics or apartment? **We have been certified right up front because that will make a big indicate that will tell you right away and hopefully what kind of data you should be seeking after.** But there's that, but there's this other little problem. It's a nagging problem, and this is probably all face. Every time, is that? When you go down a path, let's say you've established the path you're moving down that path and all of a sudden they run into a hiccup. Wait deep into the to the bowels of the situation and all of a sudden you guys switch gears. Or let's say that you were doing the mill certification and all of a sudden so they they have to come back to it because th**ey've changed something in design and now it opens up the map again and all of a sudden. Other**	Ill give you 3 names: OK, one guy one get it and give you the PM or a VIPTPM. His name is **_____.** [_____, _____ PM,]. Another another individual I think would be very beneficial from a technical perspective, and he's my boss and he and I.We working together for years on this program is **Mark Phillips**. And he's he's avionics lead [EN] for the entire aircraft he's got. He's got the whole aircraft. I'm just. I'm just the flight deck lead that reports to him.the last person I would mention would be Raimon is his name is **Raymond** Rd Regas we we just calling Ray Array Modrej Regas **Rodriguez** is a He is our lead airworthiness person on the program. And he and I were posed together for a number of years on this program, so he knows. Very much very. He's got a very very good hand on what's going on from the Edward is perspective. Overall, for the entire aircraft as well as you know what I'm dealing with. And he also worked at the ENY office for a number of years as an airborne this person so. He can give you the insight from from sitting in on that side of the fence. Uh, as well as you know, working with us in the program office. *("And then how about from the perspective of maybe a different program office?")* Well then I would suggest you gonna talk to uh. OK, so I know I know two commercial group group people or groups like that. Or kind of fresh on the mind. **KC**
20211130	IP2		That's that's probably a question that's that's better asked of ____, I don't know if you have an interview scheduled with him, but he can probably help you more in that then. They're not then I can. As far as how we got to the certification. Ah, **I'm only tangentially involved in that.**	I I think it's **I think it's the right path.** There's as far as where we're going number one because that's you know what **the guidance requires**. But more importantly. **They would be redundant to. To to try to serve recertify the whole the whole system under under the FAA even, or I'm just under under under the military certification aspect** because. Even though we have to do some additional work to do too. Get the mill GPS certified under an FAA process. Ah, **if we went the other way. Anything that that system touches. There within the avionics architecture or the OR the aircraft. Could then be.Question. By the military side and and we would have to go back and and recertify.** I don't know, uh? The the flight management system other than the electrical power system. Other systems within within the airplane that already that already have a certification. On them, ah, if we open it up to the to the mill side. So I think for that reason and not having to do. **Duplicative and and additional work.** Or to get to a certification. Is this is the right thing to do for the for the aircraft?	I guess personally I **I wish I knew a little bit more about how. Now the FAA. Deals with the whole certification process**. And we've had **pretty good. I think communication with the MCO, the military Certification Office of the FAA.** Those guys have been really supportive. maybe a little bit more clear understanding about roles and responsibilities and it it's not. It's not just in in this system 'cause so I think we were pretty solid where we are right now with it. Within those GPS. So I'm I'm looking at just the whole all the other systems. Uh, across the prosody aircraft. How we interface with the FAA? And and work the certification process with them is. And **this is new to me and I'm I'm learning it.** Ah, and just how how that needs to work and A and, you know, with the **various roles and responsibilities are. This is important. We're running into some some situations where certain individuals. Within the FAR. So I say stonewalling some of the things that, uh, that we're that we're trying to do not in the system so much, but on but on others and. Yeah, the the politics inside the. Processes.** So it would be helpful to to know you know where they are. Would I I should say I'm not expressing this way. **It would be helpful to know how to to work the the. Huh, regulatory structure within the FAA**? Maybe that's the best way of putting it. For instance, **we have a. We**	That's a good question. I don't know if **KC 10s** gone down this road at all. Or not. I'd have to go back in. Come back and ask. From how they **C5** would be helpful and I would, I kind of presumed that you've talked to some of the other. **Our commercial derivative aircraft. Have you talked to C32s or 37s at all**? *("No, I haven't so far done").* I think I have the the name of the **commercial derivative engineer in the commercial derivative aircraft out at tinker.** Let me see if I can pull that up for you. *("I spoke with _____".)* Yeah that sounds right. Yeah that's the same name I have... We're we're pretty much even on the testing portion.Uh, for for the system are our guys have that at all. Pretty much in place right now. Well, right now I'm I'm not seeing any huge, huge risk right now. They're they're. They're talking about being able to test in California or some Maryland. Ah, Texas Washington, and it looks like a Montana. So right now I'd I'd say we're we're looking pretty good in. and that part Just to see if there's anything else that. They have been here for that or any kind of risks. No, it's honestly I'm. Uh, I think where we are in the integration process and and being able to. Then they get the test is. Is looking pretty good or or suppliers and then a good job of. of keeping us ahead of the game. **Overall, we've had really great avionics program management. I**

Platform 3: IE3 & IP3 (pg. 1/3)

AW Certification Interview Matrix			*About the Interviewee*				*The Program*		
Derek Dennis	1/3/2021		Q1	Q2	Q3	Q4	Q5	Q6	Q7
			What is your name, position or title, and the program office you work in?	How long have you worked in AC systems?	What modifications and platforms have you worked on? What is the most recent? When was it?	What is your role in the modification?	What is the modification we are talking about today? (Size, Time functionality, ACAT level, Dollar Amount, etc)	Was the original design of this aircraft for the military, or is it a Commercial Derivative Aircraft?	How long has the Air Force been utilizing the aircraft?
Date	**Code Name**	**Finding ->**	Position Type	Experience	Experience	Position	Type of mod	AC type	Time of use
20211213	IE3		OK, my name is _____. I'm the **A10 avionics section chief** for the A10 SPO. Yes, uh two how long have you been working in aircraft systems? It's not just tense, but.	OK yeah, I've been working since 2000 for about **21 years on aircraft systems**. Prior to that I was a TPS developer for avionics Sr using Lru's. So basically **developing software that tests the avionics** off of multiple different platform aircraft. But we the way at the SPO we only include aircraft systems as a system as as a whole experience when you're actually working within a SPO. Or avionics. Business or about that let me shut this up OK. And so, so that's so it's just the 21 years.	OK, so I've been on the program that back on the **A-10 program for the last three year.** It's almost three years now, pushing on three years I've we've worked a ton of modifications. We did a a second guess, we call it or, but it's a Ethernet, a second **Ethernet switch** that we put on the aircraft we are currently working on, and if **C Circuit Card assembly** that that is an integrated flight and fire control computer. Sir crowd assembly that we're changing. It's **a form fit function replacement** out of the commodities group, but we're implementing it to improve diminishing parts abilities. We're doing the same thing on **RR Central** computer. We call it kick you 2.8 and and that's also for DMS issues. We are doing a major modification for **3D audio**. We're putting a 3D audio system to improve situational awareness. Uh, we within the Coms that are coming into the pilot we are working on a high resolution display where we're replacing the	Yeah, so uh, as **the section chief, my job is to review, approve, mentor my team through the modification processes**, whether it be a T2 temporary mod that we implement to validate the technology AT1 where there's an urgent need out into the field that would need to be deployed quickly, or a permanent modification where we're deploying and fielding that mod across across all of our aircraft. And in addition, **airworthiness certification. Ah, where I'm reviewing and and helping them get through the CERT basis** write ups that we need as where as well as the error in this c**ertification through the Director of engineering and and OP**. If needed the cert basis. **My job is really to determine if changes are reportable or not reportable.** Well, uh, we brief it. To RROSE team art where we call Systems engineering area as well as our Chief engineer, which then migrates to our Director of Engineering and we'll talk more about that. But I'm involved in that whole process as we go through in order to attain obtain an error word in this certification and or airborne disapproval. So that's kind of my role. *("home real quick. What is JRP like? What does that acronym stand for?")* It's a, it's a anti jamming GPS system. It's assassin based system. Uhm,	Yeah, so the way we we pretty much did it. A guard, uh, it let me rephrase it. This particular mod w**as funded by the guard under and degree of funds**. It was about **$20 million contract.** What I would say a medium A Capt 2 program. The purpose of it was to support **GPS anti jamming initiatives** that were being out there. It requires a select availability, anti spoofing module or sasm GPS. Receiver with Beamsteering digital antenna electronics. That's the daed interface, and then we combine that with our controlled reception pattern antenna or our CRPA antenna. So it's the the taking our current Iggy. **Installing this, this new GPS receiver in it and then putting a CRPA antenna in in in**. You, uh, interface with the DAY in order to make the whole system now function and provide us this jamming resistant GPS capability. *(**"OK, so you already had an EGI installed. You're just switching up the GPS card that was in it.")*** **Correct and and the ofp software within it to work with the new GPS receiver.** And DAE 'cause it Iggy interfaces with the DAE ibda interfaces with the CRPA antenna. So and so that that connection we needed to have some upgraded. Oh FPS in the EGI to be	It was a **military only**. It was actually **designed and and sourced by the Army** and then the Air Force stole it from a man and that I mean you could tell by the the the **30 millimeter gun we have in the center to be a tank killer.** That was really what they were going for. The Air Force then i**n about 1976 March of 76 I believe it was took over** and and and crafted from him and and has been managing it since then.	Yep, 19 about **1976** is when it game online.
20211124	IP3		So my name is Yep, so my name is _____. My position title was **acquisition program manager**. I worked in the A-10. In a program office in **the avionics section**. I left. There are approximately a year ago, so actually a little more October 2020 is when I left and then	**I was there for approximately 2 years.** So that was **my only experience in aircraft systems**. Prior to that I had worked. Yeah on GSD, which is a. Nick Intercontinental ballistic **nuclear missile** program in their program offices and prior to that I worked for a **test range**.	So modifications platforms that I've worked on and there was the **A10 platform**. Of course then **GBSC** would be the next biggest platform I was involved in the process of standing up that program. We had not been declared at that point in time A in the FYDP that we were a green lighted type program. I'm trying to think the technical terms, but that's a running outside of my head at the moment. Uh, so I worked on that initial acquisition, getting it ready for. Or uh, milestone A and then moving on milestone beef. So and then that was prior to the, UM, working fo**r A-10**. Uh, so that throughout the **2017** time frame is when I was working for them for a few years and then prior to that I worked for the Utah Test and training range, which. Uh, I oversaw a lot of different types of test components and things like that. Uh, related to a lot of different programs across the DoD, working with other test ranges, such as the net are vanilla test and	So I was the **program manager** over a modification. Uh, to **digital beam steering** and upgrade the **GPS NAV navigation unit on the attack.**	No, uh, so the program was named the **Anti Jam EGI**. A big E stands for embedded guidance and TfL unit. It's kind of. They bury acronyms in acronyms. I'll leave it at that. Uh, so for question #5, what is the modification we were talking about today? It was a**t Anti Jam EGI**. The size of the program we're going to purchase somewhere around. **281 air operational aircraft**, and then there were some extra. I think we're right into the low 300 standard, 10 units or so, but we were doing that as a retrofit. **Updating the current EGI by adding some new components,** Society of it, and then adding a. Uh, and the EGI was made by Honeywell, the. Uh, we were adding a **digital beam steering unit** that was made by Lockheed Martin. That particular unit controlled a **CRPA** which is a **controlled reception pattern array antenna**. Basically it's an antenna that has seven different antennas built into one unit and then. We, uh, digital beam steering unit controls the way that that antenna looks to move itself around. Interference created by jamming or other interferences. So that's kind of the functionality, uh, account level on that particular program. It was **funded through**	Yeah, **military aircraft**. It never had any commercial type purpose.	Uh, if my memory serves me correctly. Uh IOC for the aircraft was around 1971 or so **early 70s**. Uh, so it's been in use now for about **50 years**. And continuing forward.

Platform 3: IE3 & IP3 (pg. 2/3)

AW Certification Interview Matrix			*Airworthiness Certification*								
Derek Dennis	1/3/2021		Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16
			What level of Airworthiness certification did you seek to accomplish through the FAA? How much did you seek to accomplish through the TAA?	Why did you strive for that certification level?	What were the benefits or drivers of this path?	What were the costs of this path?	Did you achieve the Airworthiness certification from the FAA and TAA that you wanted? Were the benefits sought achieved?	What were the major setbacks encountered or biggest moments of tension in the certification path?	Did you make multiple adjustments to the initial AW plan or Criteria Basis through the process? Did you meet all standards or able to show compliance in every area?	What risks do you currently carry?	Are you flying today on a Military Type Certificate (MTC), Military Flight Release (MFR), or Supplemental Type Certificate (STC)?
Date	Code Name	Finding ->	Certification Path	Factors for Cert Path	Benefits	Costs	Success rate	Setbacks / Difficulties	# of adjustments	Risk types	Flying Cert
20211213	IE3		So we never go through the **FAA in a military platform.** We always go go through **our director of engineering and to our Technical airworthiness authority when it is reportable** and and so we always go through the eat what we call the EN process as as we go through so the TAA is where it's at for us. We work with in the Air Force EN processes that are outlined in **62601** as well as **MIL Handbook 516C**.	Well, it's it's well one. It's **mandate mandated right for us to go through it.** Uhm, it you know? You **all modification changes based on the AFI require it**. The **determination is based on the impacts of the airframe of critical functions within within the aircraft.** They're either **reportable or non reportable and delegated, and it's delegated to our chief engineer. If it is non reportable.** So basically what we have to do is get in there, **discuss with in our own team and look at our airworthiness criteria.** There's, uh, some people caught. Used to be called a **MACC**. Now we have a **cert basis** and and **airworthiness certification.** Basically there **check lists of hundreds of questions** that we go through just to check ourselves to **determine what we think is the impact of this mod on the on the airframe and at what level do we need to report it?** And we go through that entire checklist and then we determine, Oh yes, this is, you know **non reportable.** We try to s**ell that to our OSS**. Any team as well as **our chief engineer.** Once we get concurrent. In all agreement there, then we moved on **forward over to the Director of Engineering and we try to sell it to him**. Here. **He actually makes the**	Yeah it it it sure and **ensures the system is safe to fly**. **No cyber escapes exist**. It's installed in core and **in accordance with our system engineering processes**. Uh, uh, the modifications since the modification changes the way we navigate the system, and I'm talking specifically the JRG program and we received data from the satellites, we needed to **ensure that no critical safety issues** were affected during that process, and that **MACC Airworthiness process allows us to go through those mechanisms and and basically double check ourselves.**	Sure, you know to me after every modification that we do about, I believe AETC about **1/4 of our costs are linked to airworthiness and the documentation that we have to generate to validate compliance.** I mean, we have to look at things like the EMIM set EMC, both EMI from a SRU LRU perspective. But then also the EMI from the platform perspective. What is this particular modification going to do? To our weapons system and other other systems that are on our weapon system, what is what is other web? Uh, modifications that currently exist on the platform gonna do to this modification. We have to look at, you know, for a hero and hemp testing, what is it going to affect our ordinance? Is it going to affect our, you know, radiance on **our personnel and we have to do the calculations to go about doing it and we have to have all the documentation in place to make sure just that is done and we've done proper testing.** To ensure that it's safe to fly all of the Iru's need to go through qualification testing from the vendor and we have to analyze that	**Yes, we were able to do it. We were able to fly it. It's been a now a proven technology both in contested areas as well as across state lines and and so it.** It's a. It's a great modification. We part of that question is where we where, where do we see benefits and that is now. **We can actually go into a contested. Warfighting area with a lot more confidence that our GPS system is going to be accurate** because a lot of **our weapons are based on accurate GPS data and our lot of our flight controls and paths which are doing are are based on that**. So we're much more confident going into a wartime threat area threaded area then we ever were before before of this mod was installed.	There was, I think, t**wo major misunderstandings, one with was with my program manager of the program who almost had a hidden agenda up to go to M code.** I think he was talking with the ACC folks. **ACC folks wanted to go to M code Garden Reserve or pushing this as an based system. The the program manager. Took it upon themselves to challenge engineering on whether this was a COTS product or not, and whether it could. It could be installed on the COTS product and bottom line. We were able to go go through and prove that yes, it was falls within the the COTS environment and normal integration that it was a TRL level 7 or higher capable component and could be funded properly under angry of funds.** And the program was able to continue, unfortunately that. The issue that we had with our **program manager pushed us back about 8 months in ability to field** and and and. Prior to **that some of the things he was working on behind the scenes without engineering knowing probably pushed us back a year maybe a year and a half ago**. Getting this modification out there Unfort and it was unfortunate that was the that was the biggest problem we had once. Once that was resolved, we've been able to go through. And and and get through pretty quickly. **The other is the determining within our own engineering team what is considered a critical safety item in what is not considered a critical safety item. That's one of the big challenges. I think there is a lot of. Uh, either misinterpretation or lack of understanding of of what is a CSI and what is the requirement.** So we had some internal fights on it. **We finally came to the agreement that it this was not a**	yeah, I think yeah**, yeah you you strive to meet compliance on everyone.** But as you go through your internal reviews, both internally to the avionics team as well as the OSS knee team and the chief engineer and Director of Engineering, and **you're going through that process. Yes, you do make you make adjustments as you go through to ensure that the data that you have is accurate and being represented accurately to the to the upper chain upper management.** *("And then once you've like, started to do tests and stuff in the lab, and do you still have to go back and make more changes or?")* It depends. It depends on the cost of the programming. **Most of our programs we have a contractor that is the integrator. In this particular case it was. Lockheed Martin was the integrator and Honeywell, the supporting them as a subcontractor to the EGI.** There are things when you get in there that we would like **to get fixed that are at a scope of the contract** and so you have to look at those at each time. And say alright, **does this meet your overall requirements of the contract and. If it doesn't, is it something that is gonna kill your airworthiness compliance? If it is something that they say is a high risk and you you just don't want to carry that risk onto the aircraft, then you go strive to make a a contract change in order to get that capability or that requirement added to the program.** Uhm and and then after that, if if not and you say hey, that's not	And this one, and correct me if I'm wrong. Uh ____, or or ____ but I **don't think on JRG we're carrying any risks.**	We're currently on **an MFR** know at MTC. Sorry we will be getting the **MFR once we start the getting ready for the production.** Contracted fielding onto the aircraft. So_____ it would be the opposite. So we should be yeah for Jigar D, But if it's a JRD only, we'd be **final on MFR and then later. It's dependent on what the DOE.** Uhm, his call on whether or not we**. Just fly on AMFR, continue to fly on MFR, or does he want us to have an MTC for this modification?** I think we only have about. Four or five temps that have ever been issued for the A10. I'll typically. DoD would just issue in MFRs and which would be basically just, uh, modificata mate and **amendment to our baseline MTC**. That's what I understand. _____the youth. Correct me if I'm wrong. Yep no, I think you're right. Thanks____. Appreciate it. *("But if you're noat carrying any risk why would it still stay as an MFR and not just be an MTC?")* Well, so I mean with the transition to another DOE, his requirements have changed as drastically. **A MTC how I was explained it to buy the latest DOE. Is any modification to the aircraft? Previously it was you'll issue and MTC only if it's a major a major modification to the 810 baseline MTC.** *("So I guess that can be dependent based on your leadership then?")* Yeah____, correct me if I'm wrong. Is is there
20211124	IP3		So the overall functionality of the aircraft was not being modified. Uh, and so **the risk level and the certifications were fairly. Easy,** I didn't really have a direct part handling those out with the engineering shop and the A10 because it's been on the slaughtering house for more times. Have can count over the last decade or so. Has been a hasn't done a major modification to the aircraft that required any of these type of certifications in a very very long time. Uh, in the avionics section, having said that, **so most of it was TAA and then there was the.** FAA component that we have to certify the navigation system itself for airworthiness, so the actual piggy and that process had not been done. In, uh, at my departure from the program office, that was something that they were still. The Yeah, the **FAA really has no basis in it because it's a military aircraft.** The only folks that we really had to deal with. Yes, uh, Were the **folks at Hanscom and I'm trying to remember the office name those folks have to certify the actual GPS that it could navigate the way that it said, and so they signed off.** Uh, when all	As far as why we went that route. Pretty much that was **decided by the chief engineer and engineering team.** Uh, they basically decided that this was and I'm trying to remember the names of the mods. Did they do? And the names that they give those. But they **basically decided that it was this type of mod and because of that it would have to go up to**. Uh, I'm trying to remember the name of the person that signed off. Uh, at **Air Force Sustainment Center**. But they it was basically the the **chief engineers boss**. Uh, at the best I can say at. Warner Robins model Rusty 'cause I'm not used to dealing with these these folks anymore and it's been a moment, but at any rate they he was the **signature or authority on the mod and making sure that we were we were doing everything in compliance.** Uh, and so the idea was behind the mod. Basically he give us the **approval to do the first couple of aircraft for test and then once we prove in those particular aircraft for test**, uh, we'd already done a lot of lab work. Uh, and testing of the components to make sure that they met specifications that were required by the program. Uh, and then it would come over	The the drivers. For the path were the typical, uh? **Engineering community.** They were the ones who advised on that my job is the **program manager was mainly to check the process and make sure that they were making the process.** Meaning **the timelines** that they needed to on the program and. And **ensuring that we were getting through that to make our test events and things like that once we got to that stage. To keep the program on schedule.**	The costs of that path. Uh, compared to other paths, **it was just mainly time**. **There were a lot of briefings** that we had to submit to 1st our Chief engineer getting his buy in and prepping that, and then once we got beyond that because of the type of modification it had to go up to. Uh, and then next, uh, the Sustainment Center's chief engineer, and so we had to get on his calendar, be prepared for briefing him so that and then on top of that, we also had to brief the. The program. The system program manager, the SPM, over everything, so we also had to brief first so there were a lot of briefings involved and **trying to get timing with all those people were probably the most difficult.** Uh, challenges and hurdles. Uh, and **then also making sure that we had everything back from the contractor.** A-10 is very unique in the fact that **there is no prime contractor like there is in other program**. Office is a lot of times. For example, if I was on F35 or F16. Uh, any of those types? I have a dedicated prime contractor workforce that I can get a run to and say for those particular. Birds	Uh, last I had heard and this is about six months ago since **I've reached out to any of those folks, they were still working through those processes. They had finished all of the testing.** Uh, but they were on track to to get that. **And they they were expecting to to receive those benefits**. Uh, some of the contracting processes and things like that and. And **Depot availability or hampering the program as far as timeliness of being able to achieve.** Uh, as you're probably well aware with the GPS realm, especially beam steering. Uh anti jamming type things. There were a number of programs that. Were G wants and had been funded as such and **so they receive priority over A-10** so. The the life of being the little guy on there that showed impulse, so to speak.	I think in that particular program. Some of the major setbacks and **problems that we faced were actually in the test realm. Being able to get test time.** Came up with the FAA for a GPS champ system. Uh, the **they had a NAV fest where they purposely do jamming and things like that, uh, I believe its yearly and it's at White Sands missile range** and getting that block it. I'm getting the. Getting flights and things like that. Trying to make that event. Uh, and having you know, only a couple of shots without its own. Individual program that would go out to test and have to use the range and set all those types of parameters up. **Getting that FAA time to do the type of testing we needed was very difficult, so that was that was some of the biggest setbacks that we faced.** Uh, especially when we ran into some **technical problems because nobody had ever integrated at the EGI, the UM. This Lockheed Martin anti jamming being steering device together.** There were some major technical problems that delayed us and so. Ah, there we had some significant setbacks, and the FAA was not the. It's difficult in and of themselves to to get that kind of time. Uh, and then trying to get arranged to do it. *("The FAA you were having to prove navigation while being jammed?")* Uh, so that wasn't for the FAA. That was a program requirement. Uh, we needed to prove the operational. Uh, you know applicability of this system. Are we able to actually? Navigate in a jammed environment, and so **the FAA controls all the airspace, even if it's military or space.** And when you're operating in type of jammed system and so out at White Sands missile range, or Wismer, they actually have jammers that they	So we hadn't finished when I left the program. Going completely through that airworthiness process we had. Basically, we're in that process, uh, and? **We because we had such a limited scope, the ability to meet the criteria was fairly easy, but sometimes the criteria drove a lot of extra unnecessary tests.** Uh, and when you're on a jet that becomes very expensive quickly.	Ah, that I'm unfamiliar with as far as what risks do they currently carry? Uh, uh, the the whole program risk in the reason the program existed was to deal with the risk of. Uh, **jamming in a denied GPS environment and I would say that the program as a whole successfully mitigated that risk.** But as far as what risks we currently carry on unaware? *("Did they ever end up getting a test flight?")* They did go out to White Sands and and we're able to do stuff. **We had done plenty of test flights with the onboard**. Uh, once the EGI is self was certified by the uh. DAG had to be the Lockheed Martin box. Had to be. The circle had already been, but they had to be certified as airworthy. It's, uh, by device manufacturers hunting well Maki and so once we had those and then approved modification. A program through the chief engineer and his boss. Then at that point time we were doing quite a bit of testing. First on the ground and then once we. Got fairly mature enough because we're using that as our hardware in the loop lab because of the lack of the 309 speed ability to do that. Then we were able to actually take and put it in the air. **The nice thing is that as far as risk mitigation, if there was a problem it was like will shut down the system and and flip the breaker and we're done, you know? Uh, so as far as, uh, a safety concern, there was very little that they were worried about because**	I would have to look into that question because **I don't remember.** What type of certificate? And I remember that we had a discussion about that. They they did the modification package and then that was what went up through. I've got 1067 stuck in my head that I don't think that that's correct, so I'm pretty sure 1067 something else... I'm trying to think of the modification. There's an A&B and that's why I know that it's wrong. I'm like the name of that. Well, we're still number of things that are, you know, hiding from yesteryear in there. *("My assumption would be an MFR since the program isnt done yet because that's usually what they give you a bum like when you're still testing or like if you're operating on risk")* Right. *("And then military type certificate is 1. Use checked all the boxes and then you're not really holding any risk when you're flying operationally anymore").* It sounds correct, but it's been so long that. I'm trying to remember the different types of modification types. Does that was part of that process that they? Then we went through. But that was we went through that process. Oh goodness. 2 1/2 years ago or more? I think so. It's been a long time since that that process kicked off. So it's it's been a minute.

Platform 3: IE3 & IP3 (pg. 3/3)

AW Certification Interview Matrix			*Reflections*			
Derek Dennis	**1/3/2021**		**Q17**	**Q18**	**Q19**	**Q20**
			What documents and communications did you find most helpful in establishing the AW certification?	Was the path your program took the right path and why?	What is something you wish you had or knew up front when going for the AW certification? Any future recommendations?	Who or what other programs would be of good value for me to pursue in an interview for more data collection?
Date	**Code Name**	**Finding ->**	Known knowledge	Correct decision	Lack of Knowledge	Contacts for Me
20211213	IE3		So for us, the **UM MIL handbook, 15 C MIL Handbook 4461, four 64 and MIL standard, I should say four 61464 and 882 from system safety perspective are the big the best guidance** that we have that give us some concrete answers or clarifications to the questions we have. **We utilize the 516 and in looking at the Mac. Assert basis airworthiness certification checklists** to actually help direct us the best we can. Again, they're a good stepping stone and guidance, **but there's a lot of misinterpretation. End or a different interpretation**, depending on who you talk with as you go through the chain. And but that's the best that we have. And so we utilized those plus **personal experience and guidance from our Chief engineer.**	Well, it's **I wouldn't necessarily say it's the right path. It's the only path.** I mean, we don't have a choice. **This is the path that the Air Force has said is the best way to go about doing it, and we follow our processes.**	Uh, **better clear definition of what is reportable and not reportable as well as what is a critical safety item in what is not a critical safety item.** I think there is just a lot of misunderstanding in those **two areas that lead you down paths of maybe obtaining additional. Uhm qualification Aurora documentation to prove that your system is not going to be detrimental in any way, shape or form.** *("Any future recommendations?")* Yeah, **I mean you know the whole process. I understand why the Air Force has done it and but it is a long process. It's not. It's not something that happens very quickly and and because it's such a long process and a costly process to acquire all the documentation. Uhm, you it is very difficult to field anything in expedited manner.** But on the other side **they are forces pushing us to do things faster, better, cheaper, you know, and it's like you can't have both ways.** You either want us to do acquisition in an expedited. Means and maybe you would have less documentation. You would need it to fulfill that or you want us to go through and **slow the process down, which this does, and ensure that every everything is checked so that the pilots that are flying these new modifications are are safe.** So you can't have both worlds now with the **new digital engineering processes that we're talking about, maybe there should be some**	The **F16**, I mean they are our sister platform that is out there. We actually inherit most of our modifications after they implement them with the with the exception of this particular one, but they would definitely be good to do it. T**hey're a little different perspective on it because they have an integrator prime integrator on their platform**. Lockheed Martin that is always with them. But it but and and one of the things I'd like to say on here too is I get frustrated with this. The whole process when F16 integrates something and is able to get through. **My director of engineering and without having to do maybe a major cyber cyber security analysis. And then when we implement the same modification onto our platform now all of a sudden I have this in dense, discuss, intense discussions.** That I have to have with everybody throughout the chain, and to include the DOE on what my cyber vulnerabilities are. Or you know what my impact to my aircraft is is like it was just implemented. **The F16. It's flying on the F16 and now I've just adapted it and now I've got to go through this additional stuff. You think that there would be a means by which we could streamline implementation of things from platform to platform** to make it easier as the second and third and 4th person go through the process. I'm inheriting a lot of the documentation and stuff
20211124	IP3		A man that was **more of a question for the engineers.** The engineers were really the ones that stablished the path. Uh, but **they had a matrix that for airworthiness that they had to do, and I remember this massive matrix and it it covered everything and then we had to tailor that matrix.** Uh, once that matrix was a tailored, then it had to be agreed upon by because of the type. Uh, modification had to be agreed upon by the local. Uh, **the program chief engineer, then it also had to go up to the next chief engineer. Uh, for Air Force Sustainment center uh. They call it life Cycle Sustainment Center**, but anyways, so yeah, that was the, uh, the process involved. *("So did the TA have to say anything with the matrix?")* I think they were the 88 in that case, or had that authority And I was not as involved. That was really something that the .**The chief engineer.**Uh, **and his staff** shepherd. We had a guy. Uh, there was another engineer that wasn't the engineer on the program, but he. His job was pretty much everything cyber and TAA related, so everything got submitted over to him and he worked at the hardest part was getting it through the process and now was **a long and lengthy process with a lot of turn time for reviews. So that was that was kind of the the**	And I would say that it was the **the correct path.** The UM. We had the **right people doing the right jobs, considering the low risk that really helped us,** but. Uh, getting the system **certified for. For GPS navigation, that was probably the most difficult part of the. Uh, modification process**, and that was a requirement of the modification processes that met those requirements up to a certain level, and that was another matrix that was. Extremely difficult.	I think it would have been helpful to know. I think it would have been helpful to know. Uh, I had come from GSD. As I said previously and as a result of **coming from a non aircraft world the way that we certify things versus the airworthiness process was very different.** As a program manager, you are struggling too. To juggle a number of factors, **so it was literally a little bit of trial by fire.** Here and in other program offices that are seeking airworthiness certification, they wouldn't even had to deal with what I was doing because I was really doing not only the job program manager for the SPO, but I was also program manager of integration, which would normally be a prime contractor. Normally, the prime contractor would generate all of these documents and and and do all this. Work, but that wasn't the way it was in in 10 minutes from what I understand, we are the complete one off in the Air Force. **Everybody else on a major aircraft has a prime, so all of that. All of those pieces fell to me, and when you don't have somebody that's been in a job very long. Uh, there's no one to go to to go. How do you do this? It say, hey? This is what you've got to do.** Go figure it out so **a little bit more understanding of how to get through that process, but also all the different processes that we were going to have to get through.** Uh, I understood, of course, at that	Uhm, related to what I talked about? Uh, **Albert**. Uh, uh, his name is **Leah She Sung** View or I can't really say that very well, but I did send you his contact information. Uh, he's a good contact over there little hard to understand first, but. Uh, after they moved him to sit next to me. So that I can keep it better tab on what he was doing. They, uh, you know I got a little bit more accustomed to what you're saying, great guy and I'm trying to remember the name of the guy that did.Certification. Let's see if I can find it really quick. I can see his his face in my head, but I can't seem to think of it off the top of my. Head here. *("Do you remember who your Chief Engineer was?")* Yeah so Oh, a good engineer just to talk to in general. His name is _____. Cool, uh he he's worked for F22 and some other programs and then he came to A-10. So it was the chief engineer's name was seeing if I can find him **Christian**. Their information when you've when you're used to. So I. When I used to deal with him every day, it was easy. And now I have a full different group of people that I work with, and so it's a very different experience. You can look up their their supervisors names and all of that kind of stuff. When you went, you actually find their contact card in Outlook, so that's what I'm doing really quickly. For insulation, oh **Michael Hackett** That is the chief

TAA Representative for Platform 1 & 2: IT1 (pg. 1/3)

AW Certification Interview Matrix			*About the Interviewee*				*The Program*		
Derek Dennis	1/3/2021		Q1	Q2	Q3	Q4	Q5	Q6	Q7
			What is your name, position or title, and the program office you work in?	How long have you worked in AC systems?	What modifications and platforms have you worked on? What is the most recent? When was it?	What is your role in the modification?	What is the modification we are talking about today? (Size, Time functionality, ACAT level, Dollar Amount, etc)	Was the original design of this aircraft for the military, or is it a Commercial Derivative Aircraft?	How long has the Air Force been utilizing the aircraft?
Date	**Code Name**	**Finding ->**	Position Type	Experience	Experience	Position	Type of mod	AC type	Time of use
20211215	IT1		Yep, so my name is _____. I'm the **technical expert for commercial derivative aircraft within the Air Force Airworthiness Office**, so I supported the efforts for the ___ and _____ efforts that came through our office.	So I've worked in **aircraft systems for about 12 years.** I've been in the **airworthiness office for the last three years** and the position of commercial derivative tech expert and then prior to that I I did **risk management for for the Airworthiness Office** before coming to there were in this office. I was a **lead engineer in Big Safari** for several different aircraft programs to include commercial derivative aircraft. Was various, you know, organic Air Force developed aircraft.	Yeah, so I mean, I guess from the. Airworthiness office in general. You know it's all, UM, **commercial derivative aircraft that that come through the office and are assessed by the TA.** So I would include the ____ **in _____.** I'm also the the **delegated technical airworthiness authority for several. Uh, other CDA programs**? Specifically some **FMS programs** that are acquiring CDA, so includes, you know, triple some recent projects are **777** modifications to that, some **Airbus 321** and **319**. Some other **part 23 certified aircraft.** So like some **King Air 350's PC12 C208** and then in the program office I was **lead engineer for a commercial derivative**. Testbed aircraft that we had which was a **Dornier 328**, as well as other I guess, classified CDA aircraft. So then for as far as military side I was a lead engineer for **MQ one and MQ 9 tests aircraft** that we managed...So some of the modifications so recently. Well,	So my role is **to advise the programs.** Uh, hum through the the airworthiness process, ensuring that they develop or assisting them in developing their **airworthiness strategy**. Essentially guiding helping guide them through. The the airworthiness process **from the TAA office perspective** it's urine they comply with in Air Force policy as well as. Uh, you know, helping them develop their different airworthiness products so their plans, their **certification basis and their compliance reports.**	It it it? Yes, so I think I think this this I mean. Obviously it's the **mill GPS system.** I would say the programmes probably I would defer to them for this specific, you know details. To comment on there.	Yeah, so both. **Both aircraft were originally commercial.** Uh, you know, FAA certified aircraft. From our perspective, we treat them as **a military CDA aircraft.** You know, because they're they're **essentially the the basis for the aircraft was certified by the FAA.**	I guess I would have to d**efer to the. I would defer to the programs** on that I. I I don't recall the exact date that they were placed in service obviously _____. It is still in in development.

TAA Representative for Platform 1 & 2: IT1 (pg. 2/3)

AW Certification Interview Matrix			*Airworthiness Certification*								
Derek Dennis	1/3/2021		Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16
			What level of Airworthiness certification did you seek to accomplish through the FAA? How much did you seek to accomplish through the TAA?	Why did you strive for that certification level?	What were the benefits or drivers of this path?	What were the costs of this path?	Did you achieve the Airworthiness certification from the FAA and TAA that you wanted? Were the benefits sought achieved?	What were the major setbacks encountered or biggest moments of tension in the certification path?	Did you make multiple adjustments to the initial AW plan or Criteria Basis through the process? Did you meet all standards or able to show compliance in every area?	What risks do you currently carry?	Are you flying today on a Military Type Certificate (MTC), Military Flight Release (MFR), or Supplemental Type Certificate (STC)?
Date	**Code Name**	**Finding ->**	Certification Path	Factors for Cert Path	Benefits	Costs	Success rate	Setbacks / Difficulties	# of adjustments	Risk types	Flying Cert
20211215	IT1		*("From your perspective, I guess what levels of airworthiness certification? Should the program offices seek through the FAA and how much should they have come to you guy?")* So speaking directly to each of the programs. **Uh, modification the the mill GPS. My perspective is that they. Both. Uh, we should have. Sot full or full or limited FAA approval for the for all aspects of of that modification** I know ____. you know they're they're current plan is **to pursue a limited FAA approval and and I think that's it's appropriate and it complies with Air Force policy.** Uh, I I think ____**. They they currently. Uh, you know, did not pursue that path initially. Uh, I I think yeah it would have been. Uh, most appropriate to, from my perspective, two seek FAA limited approval for that mail. GPS on the ___.** But you know, I know they had an **interim approach in in doing a risk based assessment,** which we've which we've done for them, so I I guess for this one are you are you. Are you familiar with our **Airworthiness Bulletin 360 and the FAA order 81, ten, 101**? *("Uh and add ONS. So what wos the original plan? I guess from*	So yeah, so you know, we you **know it's our policy to do FA to the maximum extent practical** and I think you know some of the rationale behind that is that. Uh, you know the **the base aircraft was certified. Test set of of rules or airworthiness standards. You know the FAA worthiness standards and. Two and it's important for safety to ensure that. As much as possible, you ensure that same the same set of standards are used to assess** all modifications because there's **interdependencies between each of the different requirements.** Uh, and the set of FAA requirements and a set of military requirements are different and they both have their own **interdependencies**, and so when you **start mixing them, there's a potential to have you know gaps essentially in coverage,** and then an overall reduced level of safety so. You know, anytime you have things that you know **are highly integrated into the green aircraft system or you know are critical systems, it's important to ensure that you know you maintain that consistency with the ordinance standards to ensure that you know that same level of safety that they're their original aircraft was originally**	So so the the limited. Uhm FAA certification. I mean the the **benefits is of that is really, you know that that's ensuring that you know all. You know, aspects of that modifications design are included in the FAA type certification.** You know there are other. Uh, locals reduce. I guess you could say reduce levels of approval so you know **safe carriage or provisions, only that that could have been sought, but in in that case you know the FAA wouldn't have been addressing the integration and operations of those systems with all the aircraft systems,** and so you know that that's, uh, that's since the GPS systems that critical system, right? And it ties into the aircraft avionics. You know that that's a case where you would. If we did it secret **FA limited approval, you would have a a mixing of far requirements and Muhammad 516 requirements.** Uh, which you know could **create potential gaps. Another issue is when you do have integrated systems. That you know, specially some sit well. In this case you know you have integrated system. We don't have access to all of the. The data for the the FAA certified portion of the**	Yeah, so I think as far as cost I think. But in general I I think I think generally speaking, **FA and military certification, they're gonna. Ultimately, drive the same type and level of work right?** We both have our standards that that you have to meet right? And and the general **type of work that you're gonna have to do to show compliance. It is is generally the same.** I you know, I think I think the cost. Yeah, I often we would C diff Alex when I was in the programs we would often see a big cost difference. Uhm, in mill versus FAA certification because the contractors essentially viewed Mill Cert as no service, right? So the FA in their system you either meet their requirements or you don't, or you don't get a type certification in the Air Force we have. **You know we have our requirements and if you don't meet it there's always the option to get accessor risk and get that risk accepted.** By the appropriate authority, and if that you know PMPO or SA signs off on the risk. Uh, they get their airworthiness approval, so there's always that. **I guess what we call risk relief valve that that**	You know, in the **___ case that they they have a an approval for this system**? **You know, with a a serious level risk.** It's not the you know, they still **have more work to do to get full FAA certification** and mitigate that risk, and then for for **____ you know they're still going through their. Their cert basis was recently approved** and they're still, you know in development and you know, **having haven't got sent the first flight yet.`**	So I guess some. From the **___ perspective I I think. Uh, you know, I think they did a lot of good work in. Establishing there. Essentially, the airworthiness seem for the mill GPS and defining. Uh, you know the scope of that statement of functionality that would support the limited approval.** Uh, yeah, I think. Yeah, I I know there was a lot of you know work put into that, but I I think that's all that was all goodness as it you know, Sedgley sets what the you know requirements are from our perspective tissue. That statement of functionality. So you know, **setting those you know those expectations and requirements up front you know will. Uh, yeah I think serve them well, you know going forward when it comes to the compliance review phase.** Uh, you know, I think, uh, yeah, I I think for the **___. I think you know a lot of the the challenges came from from you know essentially at trying to apply. Hey, you know R. Military. Uh, you know or or assess the system from the through the lens of our military** where this requirements, you know, assessing a system you know. System integration on TI **aircraft that was essentially intended to be FAA certified**, right? So **I think I think those are some of the you know, probably a lot of the challenges came from that. It's just the lack of data and the fact that you know the methods to show compliance on the. You know, on a CD A you know if it were being face or to fight or different than you know what. Uh, uh, you know would be required for a mill certification and I I think I I'm sure I'm not sure if you're there at the time. You know there's a lot of discussion on, you know, safety critical functions and threat analysis and**	So I I think in in general. Yeah, I I, I think, uh. I'm trying to recall there there in this show airworthiness plan. So I know, you know. I **I know ___ they we've had multiple revisions of their plan.** Uh to to **accommodate and sensually. We're fine. Different aspects of the certification effort.** And and you know it is. **It is expected that you know you develop an airworthiness plan early in the process, or you know the program is life cycle and that that plan is refined.** You know, in maintaining current throughout the entire program, so I **I think making adjustments to the the plan is is essential to ensuring a successful, you know certification effort right to. To account for different, you know it, you know either refinements or you know changes or new things that you that you learn right**...Yeah, oh right OK so. So I guess for ____. They have not been gone through their compliance review yet and then for **___ they did a nonstandard assessment, so they they really don't have a certification basis. Established and so yeah, it it was really a risk assessment of instead of that system.** *("So where there's still compliance is that we're having to be met within the risk assessment.I know they're still like made a Mac and like we're falling that criteria.")* From **from our perspective. There is no certification basis, so you know it's really a a risk assessment. Of the design based on the data that is available so. I guess in some aspects I think that. You know they probably**	Did you say risks carried on on either aircraft? So **___ doesn't have any risks, at least airworthiness risk that they're carrying, right? 'cause they're still in development.** I know the **__ has risks. Uh, yeah, for for see fit. I believe risks associated with safety critical functions risk associated with the lithium battery I I would have to defer to the program where or pull up the V assessment that we did.** Right, yeah, they're the right here where this assessment would establish all the risks that are applicable. *("OK, and and so because they're going through a risk assessment.Like to ensure flight I guess.That is why those risks are being held. Even though like ____ is also having that looking battery.Situation I guess not to use the same word.")* **I guess the way our system or process works is that risks are assessed. You know, during a compliance or in their worthiness assessment, right?** So the **program may be carrying, you know, tracking different risks that need to be mitigated, but those aren't risks that need to be accepted until you go to flight because you know our our process or policy doesn't require risks. Be formally accepted until you expose you know people or assets to to that risk right where the environment** so. Yeah, so you know ___ you know while they may, they may be tracking I. I assume they're tracking, you know various risks, you know. Those	Yeah, so in result they will all be flying under either an MTC, UM, **a military type certificate or military flight release. So all all Air Force owned aircraft will. You are required to have an Air Force airworthiness approval and MFR or an MTC.** if you pursue, you know for CDA. If you get FAA type certification, you know we will leverage that type certificate as well as **supplemental type certificate as you know as a basis for issuing R approvals but will always issue. Uhm, in Air Force approval. On top of everything.** *("So* the limited FAA With a statement of functionality, that's an STC that then gets pulled under your MTC for the entire aircraft") Correct, Yep, Yep. And you know, as part of that. You know for a CD as part of issuing that MTC or MFR. **You know we will leverage that STC, but we also ensure that the clan, therefore this usage, is consistent with. Uh, you know that configuration usage in an environment that was assessed under the STC,** so we're not, you know. Come. And are we going to we we always like? Are we going to be using it different? Did we change any of the configuration or we're putting it in a different environment? **And if there are those those deltas, then those are gaps that that we either need assess on the military side or drive back into the the FAA STC.** *("So this is going to be.I'm*

TAA Representative for Platform 1 & 2: IT1 (pg. 3/3)

AW Certification Interview Matrix			*Reflections*			
Derek Dennis	1/3/2021		Q17	Q18	Q19	Q20
			What documents and communications did you find most helpful in establishing the AW certification?	Was the path your program took the right path and why?	What is something you wish you had or knew up front when going for the AW certification? Any future recommendations?	Who or what other programs would be of good value for me to pursue in an interview for more data collection?
Date	**Code Name**	**Finding ->**	Known knowledge	Correct decision	Lack of Knowledge	Contacts for Me
20211215	IT1		So in general, you know the initially that **airworthiness plan is a key product that we used to establish the entire airworthiness effort**. **So you know having that you know our requirement is that that's approved before contract award**. Uh, and **updated throughout the program**. Uh, yeah. So I think that you know, I understand there's, you know a lot of different types of programs submit that may not not all be practice always practical, but you know having that error in this plan established and approved early on since that really he goes the the driver to defining what the overall certification approach would be either male sort right or FA or some combination of the two. So and and you know that will inform you know like the contractors plan for certification, you know. **So having that approved early on is key. To establishing certification,** another thing is ensuring you know after that plan set stablished **you know anything that's on the military side of the seem you know where stablishing that serve basis certification basis early on right and ideally before SGR so that you're feeding those. You know, this TA approved airworthiness requirements into your system. You know your programs requirements,** right? And then you know,	I **I think uh ____ took the right path. Uh, you know seeking FAA approval? Limited approval.** You know, I think that was appropriate, given that it **is a system that ties into the UM. You know the aircraft avionics and it's a critical system. I think keeping that all in the FAA site is is appropriate.** I think. I **think the ____. I, I think it could have been better if you know FAA certification was planned from the start.** But you know, I think I think we've found a way to to do, you know, do the airworthiness assessment you know to meet the programs requirement**. So I think in general you know deviating from that and having to go back and. You know, get an FAA type certification. You know after the fact you know, sometimes maybe he's a little bit, is more work than you know. Planning it in front.**	Well, one thing I guess. That would have been better is if we could have. Driven, or, you know, **influence the airworthiness, planning maybe earlier on.** In that program I guess I I don't, I yeah, I I think you know being able to have earlier involvement through that and worthiness plan. Or you know, maybe even initial you know, **pre airworthiness planned. You know, we probably would have, you know, been beneficial.** *("And so I, I guess that kind of becomes a future recommendation, but are there any other future recommendations as far as how they get started and come? Understanding your requirements and. Why not?")* I, I guess that really would be my main recommendation is that. **Driving airworthiness planning early on. Because that's you know, you know, I think. I think that's really the time to set the. You know, set up program up for success, right? Ensuring you know all the stakeholders have come. You know have have bought in, you know on their approach early on. Uhm, in in the program and I think having a TA established airworthiness seem. Uh, you know before you you know, say go to RFP,** right? I think **I think that's key because then that informs the contractor did right, and. Yeah, you know they they plan for the right search strategy.** So yeah, I think having that plan and this seemed to find early	I, I think if this were to be, you know, picked up again in the future, I think it would be interesting to to know to kind of do some **other case studies of. Other systems that are that have that are, I guess you could say more military specific.** Uh, so things like you know Air refueling. I think that would be a really interesting study to see to do, you know to look at? Uh, you know what is the appropriate seeing there and is you know using? Yeah, and and maybe even kind of backtracking and looking at it from a. I, I think sometimes when I think I think it'd be interesting to see how. Wow, **what's practical? You know just from the start of the Air Force. I guess more of a a new aircraft. So are we going to go down the CDA path or we're going to go down the the military path and just from from the start?** 'cause I I think I think. Yeah, I think that could be really interesting to see. Kind of the trace it 'cause I think. **I think once you are once you have a CDA aircraft I think. I think you know. I think it's. There's there's less trace base I think in you know FAA or military.** I think those are pretty. Yeah, I, I think I think kind of stepping back and you know, maybe more of a ham acquiring your new tanker. Do we develop it? **You know what is it that aircraft role and you know mission and does that you know what are the factors that should be considered?** In in that role you know the aircraft

Appendix C: Key Code Phrases Matrix (Anonymized Data)

Platform 1: IE1 & IP1 (pg. 1/3)

V Certification Interview Key Code Phra			*About the Interviewee*				*The Program*		
Derek Dennis	1/3/2021		Q1	Q2	Q3	Q4	Q5	Q6	Q7
			What is your name, position or title, and the program office you work in?	How long have you worked in AC systems?	What modifications and platforms have you worked on? What is the most recent? When was it?	What is your role in the modification?	What is the modification we are talking about today? (Size, Time functionality, ACAT level, Dollar Amount, etc)	Was the original design of this aircraft for the military, or is it a Commercial Derivative Aircraft?	How long has the Air Force been utilizing the aircraft?
Date	**Code Name**	**Finding ->**	Position Type	Experience	Experience	Position	Type of mod	AC type	Time of use
20211110	IE1		EN - Airworthiness Engineer	34yrs EN AW experience	7 platforms: 4 Mil (fighters), 3 MCDA; 7+ platforms: Civil Aircraft	AW lead in develop AW plan and Compliance documentation	non-complex modification; Touches cockpit avionics; affects Outer Mode Line (OML); 2 antennae 2 mil GPS boxes, 2 DAE; $70Mil ~ ACATIII; UON	CDA w/ mil reqt	13 yrs flying w/ military
20211110	IP1		PM - IPT Lead	3yrs PM AW experience	1 platform: MCDA	PM above day to day PM, aircraft IPT lead	small fleet (x3); Mil GPS /IFF Mode 5; Time constrained 2yr UON; $72M ~ACATIII; Full FAA Cert Double $$ for cert portion; safe carriage STC w/ military risk to operate pending approval	CDA w/ mil reqt	13 yrs flying w/ military

Platform 1: IE1 & IP1 (pg. 2/3)

/ Certification Interview Key Code Phra			*Airworthiness Certification*								
Derek Dennis	1/3/2021		Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16
			What level of Airworthiness certification did you seek to accomplish through the FAA? How much did you seek to accomplish through the TAA?	Why did you strive for that certification level?	What were the benefits or drivers of this path?	What were the costs of this path?	Did you achieve the Airworthiness certification from the FAA and TAA that you wanted? Were the benefits sought achieved?	What were the major setbacks encountered or biggest moments of tension in the certification path?	Did you make multiple adjustments to the initial AW plan or Criteria Basis through the process? Did you meet all standards or able to show compliance in every area?	What risks do you currently carry?	Are you flying today on a Military Type Certificate (MTC), Military Flight Release (MFR), or Supplemental Type Certificate (STC)?
Date	**Code Name**	**Finding ->**	Certification Path	Factors for Cert Path	Benefits	Costs	Success rate	Setbacks / Difficulties	# of adjustments	Risk types	Flying Cert
20211110	IE1		Initial: Safe Carriage STC/ w mil functionality approved through TAA (too difficult for FAA to certify); TAA proposed Indepent Review Team while Safe Carriage with pursuit to Full FAA certification	The TAA told us we had to change gears.	Safe Carriage / TAA IRT = Faster fielding through Risk assessment. Path to obtain full FAA cert. Follows AF philosophy of: commercial derivative aircraft, have all modifications done under the same authority of the basic aircraft. Mil Cert process and	Military requirements (Mil GPS) do not align with FAA functions cert rules of their cert path. Would be $$$ for FAA to certify. Have not succeeded in Full FAA cert. Funding unavailable. "It cannot be done." Will need hybrid cert similar to IFF Install which was	NO, not achieved. Have seen all downsides and no benefit yet. TAA set too high of risk, Still need PEO approval. Funding issues for Full FAA.	Funding for a Full FAA cert, and whether FAA had ability to certify. Military: IRT assessed risk level higher than PMO or Ctr assessment of risk.	Multiple adjustments: 2 plan adjustments, Countless Compliance adjustments for TAA MACC. PMO said Medium risk and TAA said High mitigate to serious.	4 serious level risks, number of lower risks of due to noncompliances.	MilGPS flies under Safe Carriage STC. Once risk acceptance by PEO will have MFR. MTC obtained once a Full STC is accomplished.
20211110	IP1		Initial: Safe Carriage STC (FAA) w/ mil functionality approved through TAA plan	Time constraint due to UON. FAA full certification would take too long. Therefore Safe Carriage STC(FAA) w/ TAA IRT assign AW risks.	No benefit: Not easy and Subjective process with the TAA. What was previously agreed upon would change. Cycles of little progress. Difference between FAA and TAA certification. MCO (FAA) more straight forward and TAA.	~$78 Mil - safe carriage STC w/ TAA IRT risk assessment. +$20 mil for Full FAA effort (Goc Estimate) $54 mil (contractor proposed). Full TAA was estimated at $40Mil. Schedule slips due to back and forths. Busted 2 yr time to fly	No, not fully achieved. Safe Carriage achieved. Risk approval awaits PEO signature.	All of it was difficult and setbacks. TAA subjectiveness. TAA views things very different than FAA. Everything prior is FAA certified and so trying to have FAA and TAA align (SEAM) brought tension. Program Operational Schedule Conflicts	Multiple adjustments. Additional contract scope for FAA and ctr to meet tests for TAA to bring down risk level. (+$10mil). Met safe carriage STC std, but need PEO approval for operation.	Overall AW risk was Serious	Safe carriage STC. Once approved we will fly on MFR and MTC potentially combination of all three.

Platform 1: IE1 & IP1 (pg. 3/3)

V Certification Interview Key Code Phra			*Reflections*			
Derek Dennis	**1/3/2021**		**Q17**	**Q18**	**Q19**	**Q20**
			What documents and communications did you find most helpful in establishing the AW certification?	Was the path your program took the right path and why?	What is something you wish you had or knew up front when going for the AW certification? Any future recommendations?	Who or what other programs would be of good value for me to pursue in an interview for more data collection?
Date	**Code Name**	**Finding ->**	Known knowledge	Correct decision	Lack of Knowledge	Contacts for Me
20211110	IE1		The AW plan. Project Specific Certification Plan (PSCP). Mil Hdbk 516. MACC matrix.	Not the right path, we still cant fly. FAA certifying the military reqts is not feasible. Sounds good from philophical perspective but not realistic perspective. MACC is only viable method and you would still have noncompliance. A better understanding of the AC is	Needed more research into the FAAs ability to certify military functions. Don't mix! When going for as much original cert possible stop at military function and let mil do the rest, because mil will get involved eventually anyway.	____, IFF
20211110	IP1		Countless meetings with MCO and TAA to get everyone on the same page.	Yes because of trying to meet the UON. Upfront impressions made Seam method more doable.	Have accurate information before going into the mod. Better understanding of how the TAA aw process works. Seems like there is a quantitative metric missing from TAA process. Don't mix FAA and TAA, go one way or the other.	HNAG. AWACS (HBS)

Platform 2: IE2 & IP2 (pg. 1/3)

V Certification Interview Key Code Phra			*About the Interviewee*				*The Program*		
Derek Dennis	**1/3/2021**		**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**
			What is your name, position or title, and the program office you work in?	How long have you worked in AC systems?	What modifications and platforms have you worked on? What is the most recent? When was it?	What is your role in the modification?	What is the modification we are talking about today? (Size, Time functionality, ACAT level, Dollar Amount, etc)	Was the original design of this aircraft for the military, or is it a Commercial Derivative Aircraft?	How long has the Air Force been utilizing the aircraft?
Date	**Code Name**	**Finding ->**	Position Type	Experience	Experience	Position	Type of mod	AC type	Time of use
20211118	IE2		EN - Avionics Engineer	30 yrs avionics experience	18-20 platforms: 2 heli, 3 mil, 10+ Com, 5+ MCDA	8-9 yrs with program. Lead Flight Deck EN, heavy hand in aircraft mod design and aw path. Negotiating with Contractor, FAA and TAA.	small fleet: 2 aircraft; this portion would be ACAT III ~$50M includes Mil GPS, box level ~$8M, Integration/testing efforts the remaining $42 Mil connecting to FMS, IFF transponders and auto pilot. Start 2015/16; Mil GPS FAA Cert so TSO 196 instead of MSO 145	CDA w/ mil reqt	purchased in 2016. maintained on ground. 0 flight hours.
20211130	IP2		PM - Avionics IPT Lead	20 mos about 2yrs	1 platform: 1 MCDA // 2 simulator programs 1 mil, 1 MCDA	Make sure a solid design is executed from the contractor. And all occurs relatively on time. 2 certifications hopefully mostly FAA	small fleet: 2 aircraft VIP transport;platform - ACAT I ~$3.9 Billion; Deliver 2025, about 9 yrs total; FFP contract; Mil GPS breakout maybe ~$10M; Mil GPS system in addition to civil GPS system (redudant systems). Lithium battery in EGI cause wrinkle for FAA cert	CDA w/ mil reqt	This particular model 0 hrs. but others like it have been utilized for ~30yrs

Platform 2: IE2 & IP2 (pg. 2/3)

/ Certification Interview Key Code Phra			*Airworthiness Certification*								
Derek Dennis	1/3/2021		Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16
			What level of Airworthiness certification did you seek to accomplish through the FAA? How much did you seek to accomplish through the TAA?	Why did you strive for that certification level?	What were the benefits or drivers of this path?	What were the costs of this path?	Did you achieve the Airworthiness certification from the FAA and TAA that you wanted? Were the benefits sought achieved?	What were the major setbacks encountered or biggest moments of tension in the certification path?	Did you make multiple adjustments to the initial AW plan or Criteria Basis through the process? Did you meet all standards or able to show compliance in every area?	What risks do you currently carry?	Are you flying today on a Military Type Certificate (MTC), Military Flight Release (MFR), or Supplemental Type Certificate (STC)?
Date	Code Name	Finding ->	Certification Path	Factors for Cert Path	Benefits	Costs	Success rate	Setbacks / Difficulties	# of adjustments	Risk types	Flying Cert
20211118	IE2		limited FAA certification: Full FAA cert with statement of functionality on military side.	Passenger commercial derivative aircraft is pushed for FAA cert. Early talks FAA said they could certify all major integration aspects. Have good relationships with Ctrs. FAA well established. Mil Airworthiness would mimic alot of same tests. Military mission but is still a civil aircraft. Learned from other program horror stories. Potential cost, time, schedule reasons. Not military path because of lack of organic manpower, access to data, would need more control over ctrs.	Not right personnel to do organically. Cost schedule savings. Right now everything is OK.	Since military mod more expensive than commercial mods. Military equipment creators don't build to FAA specs DO178 (SW) DO 254 (HW), DALs meaning extra analyses, and compliances needed. Ctr often try to push tasks to mil cert for risk acceptance. Extra push on ctrs needed. EN stance if FAA wont certify why should I? Hard to get good data from ctr. Either FAA or Military dont have much experience can be harder to convince something has met compliance. Tough to make sure everything that should be on contract is on contract. FAA TAA pick your poison.	In progress. Approved and accepted AW plans with FAA and AF. Big aircraft platform schedule has 18 mo slip from 2024 to late 2025 2026. Cost: FAA gives 5 yr and can pull rug from under you. 18-20 flight deck STCs.	Nothing with this exact mod. EFBs had issues - FAA wants DAL level D when all industry builds at DAL level E of device. Disagreement on essential non-essential. Interpretation of policy. Q14: "Boeing decided to do was was basically dust their hands off and say and we can't mess with this stuff. It's too. It's too much of a pain. It's it's impossible. They're never going to pass the test blah blah blah"	Always adjustments. Not much insight, without pushing for it. Had direct comms with FAA, MCO, and Ctr. lithium battery - had separate effort for certification. Looked into alternate battery HW.	If FAA cert is not accomplished then unable to get mil cert. everyone on board with FAA cert and no real other plan.	Eventually Full MTC, STC for mod rolls up into MTC. Military has ownership.
20211130	IP2		Maximum FAA certification possible. Full FAA certification minus Lithium batteries. No mention of TAA involvement. Additional testing for those to see if certification is possible	AF Policy dictates it. Especially for commercial passenger air vehicle.	Not having to do a brand new certification. Certification focused only on mil gps system and its integration. Policy pushes us to not need to certify things already FAA certified. To recertify flght deck for military would be much more involved. Cant really imagine it. Ctr created a SIL of MCS and Flight Deck.	No WBS for effort-lack insight. Lithium batteries driving additionl work for certification. Contract struggles for additionals work.	Work in Progress. Ctr needs to submit cert paperwork still for FAA. Lithium battery issues. 16 cert plans held up.	battery issue of no certification path. Been addressed as extra effort. Not influenced timeline.	"Not from our perspective." potential for adjustments of how much testing with FAA vs Mil.	No significant risks. FAA hold the risks. Integration process locked down.	Eventually STC

Platform 2: IE2 & IP2 (pg. 3/3)

/ Certification Interview Key Code Phra			*Reflections*			
Derek Dennis	**1/3/2021**		**Q17**	**Q18**	**Q19**	**Q20**
			What documents and communications did you find most helpful in establishing the AW certification?	Was the path your program took the right path and why?	What is something you wish you had or knew up front when going for the AW certification? Any future recommendations?	Who or what other programs would be of good value for me to pursue in an interview for more data collection?
Date	**Code Name**	**Finding ->**	Known knowledge	Correct decision	Lack of Knowledge	Contacts for Me
20211118	IE2		Up front discussions with all stakeholders directly. FAA, TAA PMO, Users, Hanscom Mil GPS, all technical folks. Look down both paths extensively.	Yes. Would not continue if not. Could not staff necessary team for military certification. AF as whole Short staffed. Only wrong is being FFP. A lot of information we don't receive.	Need tp know as much up front as possible. Certain design changes cause to go back to drawing board. Know what type of information is needed to show compliance. Understand how FAA works and how TAA works. Try to learn from other program offices and their mistakes. Know with FAA cert, not much insight for PMO as far as data except in ways of manuals and diagrams. know what is a critical safety function and any levels of thread anlaysis needed. Thread analysis are expensive and time intensive. 1. Can this be done through FAA? 2. Is that the path we want to take? Easier as a passenger aircraft.	_____,_____. KC-46, MH-139 Helicopter CDA-Joseph Salom. C32 E4B blue and white aircraft. Matt Smearcheck TAA_____. Brian Welch TAA.
20211130	IP2		only tangentially involved.	Yes. Guidance requires it. If going military a lot of redundant work would be done on systems already FAA certified, versus just looking at new system.	Wish I knew the FAA process more. Really understand the FAA process, and make sure the contractor understands and bids a contract representative of what needs to be done. Have strong communication with FAA and MCO	KC 10, C32, C37. The CDA office at Tinker.

Platform 3: IE3 & IP3 (pg. 1/3)

V Certification Interview Key Code Phra			*About the Interviewee*				*The Program*		
Derek Dennis	1/3/2021		Q1	Q2	Q3	Q4	Q5	Q6	Q7
			What is your name, position or title, and the program office you work in?	How long have you worked in AC systems?	What modifications and platforms have you worked on? What is the most recent? When was it?	What is your role in the modification?	What is the modification we are talking about today? (Size, Time functionality, ACAT level, Dollar Amount, etc)	Was the original design of this aircraft for the military, or is it a Commercial Derivative Aircraft?	How long has the Air Force been utilizing the aircraft?
Date	**Code Name**	**Finding ->**	Position Type	Experience	Experience	Position	Type of mod	AC type	Time of use
20211213	IE3		EN - Avionics Section Chief	21 yrs ac systems	5 platforms: Mil attack/fighter	Section Chief to help determine if a mod should be reportable or not to the TAA and help build airworthiness package and design criteria to present up to DOE and OP	$20 M Guard & Reserve Funds; Funding issuers fears of platform shutdown. Same GPS box new GPS card, add DAE and new antennae. Downselect 2014, Real program start 2019 to present. At least 139 Guard fleet.	military aircraft	1976
20211124	IP3		PM - Acq avionics section	2 yrs experience	1 platform: mil, Worked in test centers, and ICBM	Program manager over digital beam stearing and upgraded the Nav to combat attack. From 10: Make sure we meet timeline.	Development ~$20M Guard & Reserve Funds. Full fleet 281 Addtl $35-40M for full production. Deemed formfit function replacement, but DAE really made it a development program. Never serviced in ac.	military aircraft	early 70s, ~50yrs old

Platform 3: IE3 & IP3 (pg. 2/3)

/ Certification Interview Key Code Phra			*Airworthiness Certification*								
Derek Dennis	**1/3/2021**		**Q8**	**Q9**	**Q10**	**Q11**	**Q12**	**Q13**	**Q14**	**Q15**	**Q16**
			What level of Airworthiness certification did you seek to accomplish through the FAA? How much did you seek to accomplish through the TAA?	Why did you strive for that certification level?	What were the benefits or drivers of this path?	What were the costs of this path?	Did you achieve the Airworthiness certification from the FAA and TAA that you wanted? Were the benefits sought achieved?	What were the major setbacks encountered or biggest moments of tension in the certification path?	Did you make multiple adjustments to the initial AW plan or Criteria Basis through the process? Did you meet all standards or able to show compliance in every area?	What risks do you currently carry?	Are you flying today on a Military Type Certificate (MTC), Military Flight Release (MFR), or Supplemental Type Certificate (STC)?
Date	**Code Name**	**Finding ->**	Certification Path	Factors for Cert Path	Benefits	Costs	Success rate	Setbacks / Difficulties	# of adjustments	Risk types	Flying Cert
20211213	IE3		No FAA for mil aircraft. EN process military certification thru DOE and TAA if reportable. Follow 62601 and Mil Hdbk 516C.	Mandated military certification. Report up to DOE to determine if reportable or not. Knew we would not be reportable. No TAA involvement. AW decision delegated from DOE to CE. Most mods are nonreportable.	MACC process ensures safe to fly. Multiple checks ensure no critical safety of flight issues. In accordance w/ SE processes.	A lot of the work comes on the PMO to prove things out. Personnel doing calculations themselves. 1/4 cost of program directly related to AW work, but 100% of effort prove that it is airworthy. Good SE process but a lot of work and can be more focused on process and whether or not is best design.	Yes. Successful GPS in jammed enviroments in the field.	2 major setbacks: PM/ACC pushing for Mcode w/o EN support. Tech unavailable. Cause program delays. // Distinguishing between critical safety item and requirements. Being "last aircraft in the inventory" targeted for M-code. "Always get the scraps"	Didn't have to change anything. Just some minor talking between EGI and DAE adjustments. AW stayed the same. If issue contract adjustments or risk anlysis would be used	No risks.	MFR as ammendment to MTC. Flying cert is dependent on DOE. Old DOE said MFR, except for large mods then issue new MTC. New DOE wants new MTC for every mod.
20211124	IP3		Risk level low and certification fairly easy. Not certifying whole aircraft. Most done through TAA. No basis for FAA, although FAA like requirements. Sign offs from AF Mil GPS office. Large matrix for certifying.	Engineering team decided. Submission up to CE boss at AFSC (DOE). Authorizing a couple aircraft for install and flight test. Any changes would be addressed and then signed as permanent mod.	Drivers: Engineering Community	Time, multiple layers of briefings up to chain to get go ahead. Lacked a prime contractor, more coordination fell on PM in PMO of mulitple silo contracts integrating on same system. A-10 lab testing lacked so more push for flight testing. Small program in fighter attack world, lacked support.	At least finished flight testing, on track for fielding.	Test scheduling time. AntiJam opportunities slim. Still need coordination with FAA. Technical difficulty between EGI and DAE.	No adjustments. Small scope fairly easy. Some unneccessary tests.	Reason for reqt, combat jamming environment, was successful. No real risks. Plenty of test flights. Flight risk mitigation flip breaker on aircraft revert to LOS.	Can't remember. Doesn't really know the certificate names/meanings.

Platform 3: IE3 & IP3 (pg. 3/3)

/ Certification Interview Key Code Phra			*Reflections*			
Derek Dennis	**1/3/2021**		**Q17**	**Q18**	**Q19**	**Q20**
			What documents and communications did you find most helpful in establishing the AW certification?	Was the path your program took the right path and why?	What is something you wish you had or knew up front when going for the AW certification? Any future recommendations?	Who or what other programs would be of good value for me to pursue in an interview for more data collection?
Date	**Code Name**	**Finding ->**	Known knowledge	Correct decision	Lack of Knowledge	Contacts for Me
20211213	IE3		MIL handbook 15C MIL Handbook 461, 464 and 882 from system safety perspective are the big the best guidance. Mil hdbk 516 MACC to build AW checklists. Experience and guidance from CE.	Not right. The only path. Required by AF as the best process.	"better clear definition of what is reportable and not reportable as well as what is a critical safety item in what is not a critical safety item." misunderstandings lead to extra work that may be unneccesary. The process is long and cannot be rushed. Rushing would have less documentation and could impact safety. Digital Engineering could be future path of going fast and still doing due diligence for the AW cert. Q11:"What you don't know is what's gonna kill you." "And make sure you know what the heck you're talking about when you're doing these modifications." Q20: PMs know the technology but dont try and be an engineer. Trust the EN team and understand the process takes time.	F-16, our sister platform. Do most the same mods (except Mil GPS) after them but receive extra scrutiny when going for reviews. They also have a Prime Contractor.
20211124	IP3		Engineering question. (PM lack of knowledge). Had a matrix to track AW that had to be approved up EN chain of command.	Yes. Low risk effort and properly manned to do the work. Certification is hard work.	not aircraft background so no knowledge of AW processes, led to trial by fire. Make sure there is a prime contractor on effort. Too much for PMO to track.	A-10 additional contacts: Le Shi Sueng (Albert); Christian; Michael Hackett (CE); ____ (EN); Pamela Lee (Division Chief, PM); Jaclyn Melton; John DiCaprio

TAA Representative for Platform 1 & 2: IT1 (pg. 1/3)

V Certification Interview Key Code Phra			*About the Interviewee*				*The Program*		
Derek Dennis	**1/3/2021**		**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**
			What is your name, position or title, and the program office you work in?	How long have you worked in AC systems?	What modifications and platforms have you worked on? What is the most recent? When was it?	What is your role in the modification?	What is the modification we are talking about today? (Size, Time functionality, ACAT level, Dollar Amount, etc)	Was the original design of this aircraft for the military, or is it a Commercial Derivative Aircraft?	How long has the Air Force been utilizing the aircraft?
Date	**Code Name**	**Finding ->**	Position Type	Experience	Experience	Position	Type of mod	AC type	Time of use
20211215	IT1		TAA - Technical Expert CDA, EN	12 yrs ac systems / 3 yrs TAA	As DTA: Multiple MCDA aircraft including FMS // As EN: 1 MCDA, 2 mil UAS	delegated technical aiworthiness authority/ Advise PMO of airworthiness strategy. Guide to following AF policy and criteria basis and compliance reports	Mil GPS - defer further detail to the PMOs	2 of 3 aircraft were MCDA. Those 2 I worked with. These 2 selected with the basis that they were FAA certified	Defer to PMO

TAA Representative for Platform 1 & 2: IT1 (pg. 2/3)

/ Certification Interview Key Code Phra			*Airworthiness Certification*								
Derek Dennis	1/3/2021		Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16
			What level of Airworthiness certification did you seek to accomplish through the FAA? How much did you seek to accomplish through the TAA?	Why did you strive for that certification level?	What were the benefits or drivers of this path?	What were the costs of this path?	Did you achieve the Airworthiness certification from the FAA and TAA that you wanted? Were the benefits sought achieved?	What were the major setbacks encountered or biggest moments of tension in the certification path?	Did you make multiple adjustments to the initial AW plan or Criteria Basis through the process? Did you meet all standards or able to show compliance in every area?	What risks do you currently carry?	Are you flying today on a Military Type Certificate (MTC), Military Flight Release (MFR), or Supplemental Type Certificate (STC)?
Date	**Code Name**	**Finding ->**	Certification Path	Factors for Cert Path	Benefits	Costs	Success rate	Setbacks / Difficulties	# of adjustments	Risk types	Flying Cert
20211215	IT1		Both Progs should have pursued Full/limited FAA cert to the maximum ability of all milGPS aspects. AB 360, 8110-101. FAA wont cover all military pieces and so compliances for antijam etc would come through mil statement of functionality. // Prog 2: Limited FAA certification w/ statement of functionality. Complies with AF policy. Prog 1: military certification milhdbk 516. TAA told to pursue FAA and so interim risk based assessment while future plan for full FAA certification.	AF policy to use FAA max extent possible. The base ac certified by FAA, so maintain the standards approvals and safety assessments for modifications since there are interdependencies. Mixing the certification paths cause gaps	Ensuring all apsects are under FAA certification. Safe carriage and Provisions only doesn't have FAA certify any system integration aspects. We don't have access to all data so more the FAA does is better. Integration will have tentacles touching many pieces, limited confines most of that under FAA and TAA looks at very specific feature of mil GPS system. Dont need green aircraft data. More TAA involvement opens to more uncertainty.	FAA route traditionally labeled as more expensive. Lose risk relief valve from military if not meeting compliance. But in reality work needing to get done is similar so no real difference. "You know Mil Cert doesn't mean no cert right?"	____ still at serious risk, need full FAA cert. ____ cert basis approved, still no flight test.	lithium battery. ____ faced more challenges assessing military AW for system since intended for FAA. Lack of data to show compliances. Having to do safety critical function assesment and threat anlysis, TAA requirments different than FAA reqts.	P2: multiple revisions. But necessary to be successful. Early AW plan that gets multiple iterations. P1: from TAA perspective has no certification basis. Would have met some compliances in mil cert but not all because of data availability.	P2: No AW risks. Any risks should be rolled into the FAA structured reqts. Once flight test is reached should only be proving that everything is correct. P1: Safety critical function risks associated w/ lithium battery. Risks are assessed during a compliance/ AW assessment. TAA process doesn't need risks to be accepted until you go to fly.	An MTC or MFR in the end. CDA will obtain STCs that will roll into AF approval for MTC. Use of aircraft has to be consistent with the STC if new configuration or capability occurs.

TAA Representative for Platform 1 & 2: IT1 (pg. 3/3)

V Certification Interview Key Code Phra			*Reflections*			
Derek Dennis	**1/3/2021**		**Q17**	**Q18**	**Q19**	**Q20**
			What documents and communications did you find most helpful in establishing the AW certification?	Was the path your program took the right path and why?	What is something you wish you had or knew up front when going for the AW certification? Any future recommendations?	Who or what other programs would be of good value for me to pursue in an interview for more data collection?
Date	**Code Name**	**Finding ->**	Known knowledge	Correct decision	Lack of Knowledge	Contacts for Me
20211215	IT1		AW plan before Contract Award. Knowing the military side of requiremtents for AW cert basis and approval from TAA early on. Know the AW seam - understanding all aspects from FAA and TAA and any interdependencies that could lead to gaps between the two different compliance assessments.	P2: Right path. Critical Safety Function touching avionics stays within FAA cert. P1: Not right path. Would have been more beneficial for FAA cert from the start. Program reqts are still being met.	AW plan established before the RFP to contractor. So they properly propose. All stakeholders involved and in agreement before press, with a TAA established Seam. Understand your reqt and modification. Certain things line up better for which level of FAA certification. Air refueling - safe carriage, Mil GPS - limited, ARC 210 - provisions only or safe carriage. Safe carriage dont affect avionics.	For future research diversify what type of modifications maybe more miliaristic mods and or platforms. Also tracing a new platform and what decisions are best to go FAA or Military on a new platform based on requirements.

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24 March 2022

Appendix D: PM Guidance Sheet

What to Think About for MCDA Airworthiness Certification,
A PM's Guide to Better Airworthiness Decisions

Know Your Platform:

- Military Commercial Derivative Aircraft (MCDA) or Military Specific Aircraft (MSA)
  - Mod/Platform Mission Type: Communication or Passenger seek FAA approval, Weapon-Based Mil Reqt seek Military Airworthiness (read Order 8110.101A)
- Prime Ktr as Original Equipment Manufacturer (OEM): clear communication with FAA
- Reach out to other platforms that have similar requirements

Understand Airworthiness Processes:

- Read AFPD 62-6: USAF Airworthiness – "the Air Force shall obtain and maintain Federal Aviation Administration type certification to the maximum extent practical."
- Read and Keep Copy of FAA Order 8110.101A – know your stakeholders and certification levels
- Read AWB-360 for MCDA AW "Seam" // AWB-100 for AW terms & definitions
- Familiarize with any applicable AWBs - https://daytonaero.com/usaf-mil-hdbk-516-airworthiness-certification-library-2/
- Take AIR-116: Introduction to AF Airworthiness Certification (ACQNow)
- See Back for Levels of FAA approval and the AW seam (Fig 1, AWB 360)
  - Talk to FAA and TAA as early and as often as possible (once you here of a potential reqt)

Decision Factors: (in order of importance)

1. Level of Integration – Where does the new system touch and how does it affect the existing system
2. Disconnects – Know the platform and AW processes and communicate with stakeholders well before Contract Award or Acquisition Strategy occurs.
3. Performance – The capability of the system, the mission of the aircraft
4. Policy – What is the furthest FAA can certify on the system
5. Personnel – Is your office structured for a certain certification level (most MCDAs would not be able to handle the workload of a military certification)
6. Cost – Similar work would have to be executed for military cert or Full FAA. Refrain from work that would overlap causing double payment.
7. Schedule – No path is significantly faster than the other. Shortcuts such as risk approvals lead to more disconnects ending in negligible time savings.

Airworthiness is ultimately about knowing you are safe to fly and so the technical and system related aspects come before programmatic constraints like Cost and Schedule.

Assumption Fallacy:

- Military certification is cheaper and faster due to the ability to accept risk
  - *Do not go into a project with this assumption; it can lead to a lot of disconnects across your decision factors and make you lose sight of the best path*

"AW seam" - The junction between the FAA and USAF compliance assessments.

Full Definition - Some aspects of the design and/or operations may be ineligible for FAA type certification due to a violation or lack of FAA AW regulations.2 The USAF assesses, to the applicable criteria in MIL-HDBK-516, the aspects (i.e., CUE) not planned to be included in the FAA's finding of compliance.

Level of FAA Approval	Aspect Approved by FAA or USAF				CB
Full Approval	SWaP-C	Equipment Qualification	Installation Approval	No restrictions on Use	14 CFR [6]
Limited Approval	SWaP-C	Equipment Qualification	Installation Approval	Military Use Only with Statement of Functionality	14 CFR/516 [4]
Safe Carriage	SWaP-C	Equipment Qualification [5]	Installed; Not Connected	Operational Approval	14 CFR/516
		Equipment Qualification	Connected forOperation		
Provisions Only	SWaP-C	Equipment Qualification	Installation Approval	Operational Approval	14 CFR/516
None	SWaP-C	Equipment Qualification	Installation Approval	Operational Approval	516

Notes:
1. Red line represents the AW seam.
2. Blue shading represents aspects the FAA will approve. Green shading represents aspects the USAF will approve.
3. SWaP-C is Space, Weight, Power, and Cooling.
4. MIL-HDBK-516 certification basis limited to AW-related aspects of the Statement of Functionality.
5. For FAA Equipment Qualification, equipment is in a non-functional state. Additional testing may be required by the USAF.
6. Certification basis also includes MIL-HDBK-516, criterion 4.1.3.

Figure 1. Levels of FAA Approval and AW Seam.

Reference: AWB-360: Commercial Derivative Aircraft Airworthiness

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Air Force Institute of Technology
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2950 Hobson Way
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AFLCMC/EZZ – USAF Airworthiness Office
Brian C. Roth, Technical Director
2145 Monohan Way, BLDG 28
Wright-Patterson AFB OH
Brian.roth.2@us.af.mil & (937) 656-9564

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14. ABSTRACT
There are multiple airworthiness (AW) certification paths for aircraft platforms and their modifications. Specifically, military commercial derivative aircraft (MCDA) have a unique opportunity to pursue either FAA certification, military certification or a combination of both known as the AW "seam". Policy tells MCDA to pursue FAA certification to the max extent possible, but lacks clarity of where that extent ends. Therefore, this research conducted a comparative case study analysis through interviews, of two MCDA and one military specific aircraft (MSA) with the same military requirement. The data set is small, but representative of many common platform requirements. This insight provided continuity and lessons learned from their decision factors to be documented as guidance for future programs to take into consideration when pursuing certification. Program managers lack of AW experience also motivated the guidance to provide the necessary prerequisite knowledge before making AW decisions. Two major decision factors in choosing a safe carriage FAA certification versus a limited FAA certification (more military involvement versus less along the AW "seam") are cost and schedule, but the findings show the paths are relatively equal and therefore programs should not let a time or cost constraint dictate their decision. The primary decision factor should be the technical integration of the modification with the existing platform when choosing the AW certification path.

15. SUBJECT TERMS
Military commercial derivative aircraft, Airworthiness, Airworthiness certification, Airworthiness "seam", Decision factors, Semi-structured interviews

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