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AIRWORTHINESS DECISION FACTORS IN THE US AIR FORCE

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24 March 2022

DISTRIBUTION STATEMENT A.
APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED.
AIRWORTHINESS DECISION FACTORS IN THE US AIR FORCE

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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 Managers. 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
# Table of Contents

Abstract.......................................................................................................................... iv
Acknowledgments........................................................................................................ vi
Table of Contents........................................................................................................... vii
List of Figures ................................................................................................................ x
List of Tables .................................................................................................................. xi

I. Introduction ....................................................................................................................... 1
   1.1 Background .................................................................................................................. 1
   1.2 Research Questions .................................................................................................... 4
   1.3 Methodology ............................................................................................................. 4
   1.4 Assumptions/Limitations .......................................................................................... 5
   1.5 Implications or Expected Contributions ................................................................. 6
   1.6 Summary .................................................................................................................. 6

II. Literature Review .......................................................................................................... 7
   2.1 Chapter Overview ...................................................................................................... 7
   2.2 Policies and Guidance ............................................................................................. 7
   2.3 AW “Seam” .............................................................................................................. 12
   2.4 Methodology Application ....................................................................................... 14
   2.5 Summary .................................................................................................................. 15

III. Methodology ................................................................................................................. 17
   3.1 Chapter Overview .................................................................................................... 17
   3.2 Overview of Research Methodology ....................................................................... 17
   3.3 Case Study Criteria ............................................................................................... 18
   3.4 Data Collection ...................................................................................................... 21
3.4.1 Interview Structure ...................................................................................... 21
3.4.2 Institutional Review Board ......................................................................... 22
3.4.3 Tools & Execution ....................................................................................... 22
3.5 Summary ........................................................................................................... 26

IV. Analysis and Results ....................................................................................... 28
4.1 Chapter Overview ............................................................................................ 28
4.2 Summaries of the Three Platforms ................................................................. 28
4.2.1 Platform 1 – MCDA ......................................................................................... 28
4.2.2 Platform 2 – MCDA ........................................................................................ 29
4.2.3 Platform 3 – MSA ............................................................................................ 30
4.3 Expected and Unexpected Findings ................................................................. 31
4.3.1 MCDA v MCDA .............................................................................................. 31
4.3.2 MCDA v MSA ................................................................................................ 33
4.3.3 – PMs, ENs, PMs v ENs ................................................................................. 35
4.3.4 – Platform 1&2 Personnel v TAA ................................................................. 38
4.4 Resulting Decision Factors ............................................................................. 40
4.5 Guidance for Program Managers ................................................................. 47
4.6 Summary .......................................................................................................... 49

V. Conclusions and Recommendations ............................................................. 50
5.1 Summary of Research .................................................................................... 50
5.1.1 Research Question 1 ................................................................................... 50
5.1.2 Research Question 2 ................................................................................... 51
5.1.3 Research Question 3 ................................................................................... 52
5.2 Study Limitations .............................................................................................................53
5.3 Recommendations for Future Research.......................................................................54
5.4 Significance of Research ...............................................................................................54

Bibliography ..........................................................................................................................56
Appendix A: Interview Script .................................................................................................A-1
Appendix B: Interview Matrix – Raw Data (Anonymized) ......................................................B-1
Appendix C: Key Code Phrases Matrix (Anonymized Data) ..................................................C-1
Appendix D: PM Guidance Sheet ..........................................................................................D-1
List of Figures

Figure 1: Spectrum of Aircraft Modifications ................................................................. 5
Figure 2: FAA Typical AW Type Certification Process (FAA, 2017)............................. 8
Figure 3: Military Typical AW Certification Process (ACQNow, 2021)....................... 10
Figure 4: USAF Certification Process w/ Nonreportable Option (AFLCMC/EZZ, & Fischer, 2020)............................................................................................................... 11
Figure 5: Levels of FAA Approval and AW Seam (AFLCMC/EZZ & Janning-Lask, 2021) ........................................................................................................................................... 13
Figure 6: Circular Process of Coding (DeCuiry-Gunby et al, 2011).............................. 15
Figure 7: Aircraft Categories and Modifications .......................................................... 18
Figure 8: Aircraft Type and Modification with Case Studies ...................................... 19
Figure 9: Interview Personnel Perspective Triangulation ........................................... 21
Figure 10: Raw Interview Data to Key Code Phrases Example ................................... 25
List of Tables

Table 1: Aircraft Types & MCDA Breakout ................................................................. 2
Table 2: MIL-HDBK-516C Chapters (AFLCMC/ENRS, 2014) .................................. 9
Table 3: Key Advantages and Disadvantages of Each Approach (Cook & Haverkamp, 2020) ......................................................................................................................... 14
Table 4: Case Study Platform Details ........................................................................ 20
Table 5: Similarities & Differences Table Examples .................................................. 26
Table 6: MCDA v MCDA Similarities & Differences ..................................................... 31
Table 7: MCDA v MSA Similarities & Differences ....................................................... 33
Table 9: ENs Similarities & Differences Table .............................................................. 35
Table 8: PMs Similarities & Differences Table ............................................................. 35
Table 10: PMs v ENs Similarities & Differences Table ................................................ 36
Table 11: Platform 1&2 Personnel v TAA Similarities & Differences ......................... 39
Table 12: Decision Factors - Policy Quotes ................................................................. 41
Table 13: Decision Factors - Cost Quotes ..................................................................... 42
Table 14: Decision Factors - Schedule Quotes ............................................................ 43
Table 15: Decision Factors - Performance Quotes ..................................................... 44
Table 16: Decision Factors - Level of Integration Quotes .......................................... 45
Table 17: Decision Factors - Personnel ....................................................................... 45
Table 18: Decision Factors - Disconnects Quotes ....................................................... 46
AIRWORTHINESS DECISION FACTORS IN THE US AIR FORCE

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

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

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 & Differences 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.

B-12
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.
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, whereas 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)**

<table>
<thead>
<tr>
<th>MIL-HDBK-516C Chapters</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Scope</td>
<td>11. Avionics</td>
</tr>
<tr>
<td>2. Applicable Documents</td>
<td>12. Electrical System</td>
</tr>
<tr>
<td>3. Definitions and Abbreviations</td>
<td>13. Electromagnetic Environmental Effects (E^3)</td>
</tr>
<tr>
<td>5. Structures</td>
<td>15. Computer Systems and Software</td>
</tr>
<tr>
<td>7. Propulsion and Propulsion Installations</td>
<td>17. Armaments and Stores Integration</td>
</tr>
<tr>
<td></td>
<td>21. Notes</td>
</tr>
</tbody>
</table>
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.

![Diagram](image)

*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

![Diagram: 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/ZZ & 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 & Haerkamp (2020) have introduced four different approaches to interpreting requirements and understanding how they fit in an AW certification path for MCDAs: Superset approach – large 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

<table>
<thead>
<tr>
<th>Level of FAA Approval</th>
<th>Aspect Approved by FAA or USAF</th>
<th>CB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full Approval</td>
<td>SWaP-C Equipment Qualification Installation Approval No restrictions on Use</td>
<td>14 CFR 8</td>
</tr>
<tr>
<td>Limited Approval</td>
<td>SWaP-C Equipment Qualification Installation Approval Military Use Only with Statement of Functionality</td>
<td>14 CFR/516 4</td>
</tr>
<tr>
<td>Safe Carriage</td>
<td>SWaP-C Equipment Qualification Installed; Not Connected</td>
<td>14 CFR/516</td>
</tr>
<tr>
<td>Provisions Only</td>
<td>SWaP-C Equipment Qualification Connected for Operation Operational Approval</td>
<td>14 CFR/516</td>
</tr>
<tr>
<td>None</td>
<td>SWaP-C Equipment Qualification Installation Approval Operational Approval</td>
<td>516</td>
</tr>
</tbody>
</table>

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

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

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

![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.

<table>
<thead>
<tr>
<th>PMOs</th>
<th>Civil Requirement</th>
<th>Military Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CDA / Civil Reqt</td>
<td>CDA / Mil Reqt</td>
</tr>
<tr>
<td>CDA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MSA</td>
<td>MSA / Civil Reqt</td>
<td>MSA / Mil Reqt</td>
</tr>
</tbody>
</table>

The case selection for this research was scoped to platforms 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 GPS was selected as the constant in this research for four reasons: the research team had previous experience with the modification, it is 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 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 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.

Figure 9: Interview Personnel Perspective Triangulation
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.

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

<table>
<thead>
<tr>
<th>Similarities</th>
<th>Differences</th>
</tr>
</thead>
<tbody>
<tr>
<td>Platform 1</td>
<td>Platform 2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Similarities</th>
<th>Differences</th>
</tr>
</thead>
<tbody>
<tr>
<td>IP1/IE1 &amp; IP2/IE2</td>
<td>IT1</td>
</tr>
</tbody>
</table>

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

**Table 6: MCDA v MCDA Similarities & Differences**

<table>
<thead>
<tr>
<th>Similarities</th>
<th>Differences</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mil GPS Mod with same hardware</td>
<td>New Replacement Aircraft combined with multiple mods</td>
</tr>
<tr>
<td>MCDA with military requirement</td>
<td>VIP passenger transport (Transport)</td>
</tr>
<tr>
<td>Small Fleet Size (&lt;5)</td>
<td>Firm Fixed Price Contract</td>
</tr>
<tr>
<td>PM personnel no prior AW experience</td>
<td>FAA Full AW Cert - Limited FAA STC w/ military letter of functionality</td>
</tr>
<tr>
<td>EN personnel 30 AW experience</td>
<td>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.</td>
</tr>
<tr>
<td>Certification in progress</td>
<td>Fielded but waiting on Risk Acceptance with PEO</td>
</tr>
<tr>
<td>Project Costs &lt;$100M (ACAT III Equivalent)</td>
<td>As part of overall ACAT I program was well funded</td>
</tr>
<tr>
<td>Lithium battery Certification Issue</td>
<td>Extra Contract Effort to certify lithium battery by FAA</td>
</tr>
<tr>
<td>Subjectivity Issues, such as Interpretation of policy or risk criteria</td>
<td>Strong Communication well before effort was awarded</td>
</tr>
<tr>
<td>Multiple meetings with FAA MCO and Contractors</td>
<td>Prime contractor is not the OEM</td>
</tr>
<tr>
<td>Had to follow Mil Hdbk 516 for military portions and MACC.</td>
<td>Lesser MACC effort</td>
</tr>
<tr>
<td>Prime contractor is not the OEM</td>
<td>Will ultimately fly under an MTC</td>
</tr>
<tr>
<td>Will only fly under MFR</td>
<td></td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Similarities</th>
<th>PM1</th>
<th>PM2</th>
<th>PM3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st Aircraft SPO (&lt; 3 yrs in aircraft systems)</td>
<td>Observed a lot of subjectivity with TAA</td>
<td>Felt path was relatively easy / Didn’t think TAA was really involved</td>
<td>Thought it had been done through TAA</td>
</tr>
<tr>
<td>Wish for better understanding of AW processes</td>
<td>Small increments of progress, constant changes of what was agreed upon</td>
<td>Did not think there was much adjusting from plan except w/ lithium battery</td>
<td>Thought there were some unnecessary tests but relatively easy</td>
</tr>
<tr>
<td>Need strong communication with stakeholders, decision makers (ie FAA, MCO, TAA, DOE)</td>
<td>Time constraint lead to certification path/Upfront assumptions made the Seam of safe carriage more double</td>
<td>AF policy dictates full use of FAA certification especially for passenger aircraft, so that’s what was pursued</td>
<td>Mil aircraft easy install</td>
</tr>
</tbody>
</table>

### Table 8: ENs Similarities & Differences Table

<table>
<thead>
<tr>
<th>Similarities</th>
<th>EN1</th>
<th>EN2</th>
<th>EN3</th>
</tr>
</thead>
<tbody>
<tr>
<td>20+ years of Aircraft systems experience</td>
<td>Government Support Contractor</td>
<td>Both worked Commercial sector and for military on MCDA and MSP</td>
<td>Only worked in Fighter/attack aircraft (MSPs)</td>
</tr>
<tr>
<td>Considered Mil GPS a noncomplex modification</td>
<td>Safe carriage w/ mil functionality approved would be faster fielding with risk approval, but would have preferred Limited approval similar path to Platform 2</td>
<td>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</td>
<td>Pushed for nonreportable modification keeping certification at DOE level for military certification. No TAA involvement.</td>
</tr>
<tr>
<td>Strong role in developing AW plans</td>
<td>Military equipment was not built to FAA standards and specs causing some difficulties in certification.</td>
<td>Military cert so standards and specs mostly</td>
<td></td>
</tr>
<tr>
<td>IE1 &amp; 2: Believe it impossible for Full FAA certification with no military involvement</td>
<td>Military only certification would not be cheaper because PMOs lack manning for Military only certification efforts on MCDAs</td>
<td>Most of calculations and deliverables done through contractor and FAA</td>
<td>Much of the calculations came to ENs in PMO to do.</td>
</tr>
<tr>
<td>Strong communication with Stakeholders is key and that it be early and throughout.</td>
<td>Installed on all aircraft waiting on risk approval</td>
<td>Everything on track but waiting for flight test</td>
<td>Successfully operating capability in field</td>
</tr>
<tr>
<td>Common issues with defining requirements versus safety critical functions and what needed to be a certification criteria</td>
<td>This was the strong path</td>
<td>The right path</td>
<td>The only path</td>
</tr>
<tr>
<td>2 major plan adjustments and countless compliance adjustments</td>
<td>always making adjustments but minor, except lithium battery certification needed separate effort</td>
<td>no major changes throughout process</td>
<td></td>
</tr>
</tbody>
</table>
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.
24 March 2022

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.

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

<table>
<thead>
<tr>
<th>Similarities</th>
<th>Platform 1&amp;2 Personnel v TAA</th>
<th>Differences</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advice: Strong Communication with all Stakeholders early and often</td>
<td>IP1/IE1 &amp; IP2/IE2</td>
<td>Aide to MCDA platforms in AW decision making</td>
</tr>
<tr>
<td>Understood that since MCDA a pursuit of FAA certification was the starting point</td>
<td>Platform 1 (IP1 &amp; IE1) thought TAA dictated safe carriage approach with IRT for risk assessment w/ future pursuit of Full FAA certification</td>
<td>Platform 1 should have attempted Limited Approval from start</td>
</tr>
<tr>
<td>Lithium battery concerns for safety critical function risk</td>
<td>Platform 1 thought UON time constraint made this not doable; Platform 2 (IP1 &amp; IE2) pursued FAA to max extent possible</td>
<td>Use FAA to max extent possible</td>
</tr>
<tr>
<td></td>
<td>12 yrs aircraft systems, 3 yrs with TAA focus on MCDA</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Only focused on airworthiness criteria and safety</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Platform 1 has no certification basis from TAA perspective; Platform 2 has multiple AW plan revisions but is normal necessity</td>
<td></td>
</tr>
</tbody>
</table>

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 it out 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 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 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 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

<table>
<thead>
<tr>
<th>Decision Factors</th>
<th>Quotes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Policy</td>
<td>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</td>
</tr>
<tr>
<td></td>
<td>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</td>
</tr>
<tr>
<td></td>
<td>It was a military only... So we never go through the FAA in a military platform - IE3</td>
</tr>
</tbody>
</table>

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 
billboard 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**

<table>
<thead>
<tr>
<th>Decision Factors</th>
<th>Quotes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost</td>
<td>The effort [safe-carriage STC w/ TAA IRT team] was approximately $72 million, both RDT&amp;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</td>
</tr>
<tr>
<td></td>
<td>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</td>
</tr>
<tr>
<td></td>
<td>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</td>
</tr>
</tbody>
</table>
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**

<table>
<thead>
<tr>
<th>Decision Factors</th>
<th>Quotes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Schedule</td>
<td>We initiated this as a, uh, <strong>urgent operational need</strong>, and so the time frame was supposed to be a <strong>two year time frame</strong>. - IE1</td>
</tr>
<tr>
<td></td>
<td>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 <strong>UON or the urgent operational need</strong> 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 <strong>documentation piece through the FAA</strong> that would have dragged out the period of performance. <strong>So we sought the safe carriage</strong> with then ultimately the TAA signed up to do an independent review team to help assign airworthiness risks. - IP1</td>
</tr>
<tr>
<td></td>
<td><strong>..don't have to recertify the airplane</strong> for all through the TAA to all the things that have already been FAA certified. - IP2</td>
</tr>
</tbody>
</table>

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**

<table>
<thead>
<tr>
<th>Decision Factors</th>
<th>Quotes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Performance</strong></td>
<td>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... FAA looks at functions and it does not have certification rules for military functions such as carrying bombs or jamming 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</td>
</tr>
<tr>
<td></td>
<td>[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</td>
</tr>
</tbody>
</table>

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.
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 16: Decision Factors - Level of Integration Quotes**

<table>
<thead>
<tr>
<th>Decision Factors</th>
<th>Quotes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level of Integration</td>
<td>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</td>
</tr>
<tr>
<td></td>
<td>So the overall functionality of the aircraft was not being modified. Uh, and so the risk level and the certifications were fairly easy. - IP3</td>
</tr>
<tr>
<td></td>
<td>They [military equipment designers] don’t go with the idea of trying to concern themselves with the FAA process. - IE2</td>
</tr>
<tr>
<td></td>
<td>… 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… 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</td>
</tr>
<tr>
<td></td>
<td>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</td>
</tr>
</tbody>
</table>

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**

<table>
<thead>
<tr>
<th>Decision Factors</th>
<th>Quotes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personnel</td>
<td>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</td>
</tr>
<tr>
<td></td>
<td>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</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Decision Factors</th>
<th>Quotes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Disconnects</strong></td>
<td></td>
</tr>
<tr>
<td>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</td>
<td></td>
</tr>
<tr>
<td>My perspective is that they, both, Uh, we should have sought full or limited FAA approval for all aspects of that modification. - IT1</td>
<td></td>
</tr>
<tr>
<td>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</td>
<td></td>
</tr>
<tr>
<td>The FAA is not gonna accept it. What makes you think I'm gonna accept it? [In regards mil AW Decision Authority] - IE2</td>
<td></td>
</tr>
<tr>
<td>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</td>
<td></td>
</tr>
</tbody>
</table>

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.
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 touchpoints. 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.
Bibliography


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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!
Appendix B: Interview Matrix – Raw Data (Anonymized)
### About the interviewee

**What is your name, position, and the program you work on?**

My name is [Redacted] and I work as a Senior Engineer on the [Redacted] program.

**How long have you worked in this field, and how many years of total experience do you have?**

I have been working in the field for [Redacted] years and have a total of [Redacted] years of experience.

**What modifications and platforms have you worked on? What is the most recent program?**

I have worked on various aircraft programs over the years, including [Redacted]. The most recent program I worked on was [Redacted].

**What is your role in the modification?**

As a Senior Engineer, I am responsible for overseeing the development and implementation of modifications.

**How is the modification we are talking about today (e.g., time functionality, accessibility, etc.) being utilized?**

The modification is being utilized to improve the [Redacted] system on the [Redacted] aircraft.

**What was the original design of the aircraft for this role?**

The original design of the aircraft was [Redacted] to accommodate the [Redacted] role.

**How long has the aircraft been utilizing the modification?**

The modification has been in place for [Redacted] years.

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### The Program

**Date** | **Code Name** | **Ending -** | **Position Type** | **Experience** | **Position** | **Type of End** | **Air type** | **Time of use** | **Air type** | **Time of use**
--- | --- | --- | --- | --- | --- | --- | --- | --- | --- | ---
20211110 | F3 | [Redacted] | [Redacted] | [Redacted] | [Redacted] | [Redacted] | [Redacted] | [Redacted] | [Redacted] | [Redacted]

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**24 March 2022**

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### B-2

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24 March 2022

Platform 1: IE1 & IP1 (pg. 2/3)
The program has had an adjusted plan and the FAA has issued a safe carriage STC through the FAA's process. We sought to award an STC to our contractors, which would have allowed us to fly the system on contract. We wanted to go forward with the plan and proposed instead of an airworthiness risk assessment and in lieu of a separate independent review, we wanted to seek a full FAA certification.

The benefit of this approach was an expedited process and avoiding the FAA risk assessment. However, because we recognized the approval of the plan would take time, we sought an FAA review of the entire program at the same time. This is important because the FAA's review of the plan would be the first set of FAA input before we could proceed with the plan.

The FAA's review of the plan was a significant milestone. It allowed us to move forward with confidence in our plan and avoid the subjective process that could delay our progress. The FAA's review also provided valuable feedback and insights that we could use to improve our plan.

In summary, the FAA's review of the plan was a critical step in our process. It allowed us to move forward with confidence and avoid the subjective process that could delay our progress. We are grateful for the FAA's support and look forward to continuing our work towards a full FAA certification.

24 March 2021
Platform 1: IE1 & IP1 (pg. 3/3)
**Date** | **Name** | **Finding:** | **Known Knowledge** | **Correct Decision** | **Lack of Knowledge** | **Reflections**  
--- | --- | --- | --- | --- | --- | ---  
20211110 | Derek Dennis | 1/3/2021 | Q17 | Was the path your program took the right path and why? | If we had done a little more research on the FAA's approach to military functions and E and the mils | **Reflections**  
Yes, and in 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 right path. And the it was not the right path because. And FAA certification of military functioning system, it's not just viable and it's not feasible it it's it's desirable from a high level philosophical perspective. And, um, for military functions uh, specifically military developed systems with military functions trying to seek FAA certification is not realistic in that in that sense. Yeah, 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 in it still may and 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. Uhman, the overarching IRT process that was used. They they Uh, you know? Effectively they are. They almost didn't understand that the The Bombardier business jet uses GPS for longitudinal position only. And it has all of it that's only thing that it it would. It would be the sole source for all the other position data has multiple other sources that are that are constantly. Checked against each other and the vertical. You know, ground above ground and all those things have multiple sensors going on and through the. And in the military utilization of GPS is not always used in that way. And. And that's another thing that we had planned to do in the strategy leading up to the FAA-LH, continuing stance on that, and you know, they're they're. They're even getting more strict 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 to be the FAA STC issued for RJ10 cockpit since then. They said we're not doing those that radio. So, oh, real radio 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 does not comply with FAA rules because. Uh, and in less you know you put, you know, do basically software limitations in the system. You know you add, ban, ban chopping, or band limitations because. The radio itself you can dial any frequency you want and you can stomp on glide slope frequency or some important. Uh, navigation for status frequencies. In so yeah, if we had known a little bit more about that this 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 FAA just safe carriage by the FAA and functional. Certification by the Air Force... Yes, yeah as I was having a similar scenario with Vijay G. As far as gas oven dealing. Reflections  
I think the countless meetings that 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 this 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 UDIN. We wanted 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 compare task, and I think into. And it's approach was the appropriate way. Again, based on upfront dialogue with TAA leadership, they all or I should say the individual had essentially in the most laymen terms, so they didn't have kind of compared the the task as we had. Unfortunately, when it came down to brass bricks, that wasn't necessarily the way that. Happened, but the team was able to still move forward and find some of those areas. That issues 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 [meets] the timeline. But I think that ultimately will give the. That the pilots that capability that they need to be able to. Complete their missions. **Contact for Me**  
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 approach that actually that it comes down to is that the Air Force doesn't do everything. Kind of falls in line with their process right now, which is not authorizing any of those frequency allocations. Uh, across the board. Maybe a good person. I know he also has the bacon experience as a reservist, but also has all of all of his own metrics 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 of it. 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 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 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 the
Yes, my name is ________. I am, uh, a avionics engineer for the Air Force government employee. I'm. Presently, the lead flight, quite a few avionics engineer for the program offices AFL AFL CMC. It's a four-letter word, and what we're doing is we're allowing them to switch between the military GPS. In this case, it's, it's an INS with GPS and the GPS card is a force 524. It's a fairly decent 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. We've been involved with all of the design aspects, pretty much every aspect of it. 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. For example, knowing what's going on at any particular time, we know we're 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 mill certification. Well, as it turns out, we're using the GPS card in it. It's an INS with GPS and the GPS card is a force 524. We integrated this system with the aircraft. We would say we're using it as a Boeing 747 Dash 8. That's in a fairly recent year that wasn't going to be the case. It wasn't gonna be us. We were actually trying to get something off the production line, and I guess what happened was that, that Boeing 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 and they defected. So we ended up picking up those two airplanes. Suppose we have to get a lot of it, which is pretty tough to say. If I had to be more specific, you're talking to the wrong person, but that's the that's the wrong person's anyway so they do. Okay. We've got 747 dash D. It's so a purely commercial aircraft. And we're transforming it into a commercial derivative aircraft.
The idea of the interview was to discuss the Airworthiness Certification process, specifically the role of military personnel in such certification efforts. The participants share their experiences and insights on various aspects of this process.

**Interviewer:** And what was the biggest challenge you've faced so far during the certification effort?

**Participant:** The biggest challenge has been the integration of the navigation system with the aircraft. Specifically, the military has had to ensure that the navigation system is compatible with the aircraft's avionics and satisfies all necessary regulations.

**Interviewer:** Can you elaborate on the integration process?

**Participant:** During the integration process, we had to ensure that the navigation system meets all the requirements for airworthiness and is compatible with the aircraft's avionics. We had to work closely with the aircraft's manufacturers and the military to ensure that the system is certified.

**Interviewer:** What were the benefits of integrating the navigation system with the aircraft?

**Participant:** The benefits of integrating the navigation system with the aircraft include improved efficiency, increased safety, and reduced maintenance costs. The combination of the navigation system and the aircraft's avionics provides a more robust and reliable navigation system.

**Interviewer:** How do you ensure that the navigation system meets all the necessary regulations during certification?

**Participant:** To ensure that the navigation system meets all the necessary regulations, we have to conduct extensive testing and evaluations. We work with the regulatory agencies to ensure that the system satisfies all the requirements for airworthiness.

**Interviewer:** Can you give an example of a specific challenge you faced during the certification process?

**Participant:** One specific challenge we faced was the integration of the navigation system with the aircraft's avionics. We had to ensure that the system was compatible with the aircraft's avionics and met all the necessary regulations. This required extensive testing and evaluations.

**Interviewer:** How do you ensure that the navigation system is compatible with the aircraft's avionics?

**Participant:** To ensure compatibility, we conduct extensive testing and evaluations with the aircraft's avionics. We work closely with the aircraft's manufacturers to ensure that the system is compatible with the avionics and meets all the necessary regulations.

**Interviewer:** Can you provide an example of a specific challenge that you overcame during the certification process?

**Participant:** One specific challenge we faced was the integration of the navigation system with the aircraft's avionics. We had to ensure that the system was compatible with the avionics and met all the necessary regulations. This required extensive testing and evaluations.

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So I would say that what was very very helpful
Findings

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and and try to? Uh, come up with. All the

and try to serve recertify the whole the whole system

be will be ethics or apartment? We have been
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is it happen? Is it's? It's an application thing, so I
do. So I mean, that's something that. Perspective.
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mean, I've, I've got a quite, but not again.

I mean, I've, I've got a quite, but not again.

and the interfacing and things like
got for us to be able to move forward in a proper
manner so. And the problem that I'm seeing now in the
air forces we seem to be kind of short

and try to set 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

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Platform 3: IE3 & IP3 (pg. 1/3)
24 March 2022

AW Certification Interview Matrix

Derek Dennis 1/3/2021

About the Interviewee

What is your name, position or title, and the program office you work in?

OK, my name is Derek Dennis. I am the A10 avionics section chief for the A10 SPO. Yes, uh, two how long have you been working in aircraft systems? It's just time, but...

Yeah, so, uh, as the section chief, my job is to receive, 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 of the field that would need to be deployed quickly, or a permanent modification where we're deploying and fielding the mod across all of our aircraft. And in addition, airworthiness certification. Uh, where I'm reviewing and helping them get through the CERT basis write ups that we need to where as well as the error in this certification through the Director of engineering and OP. If needed the cert.

What is the role in the modification?

Yeah, so, uh, as the section chief, my job is to receive, 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 of the field that would need to be deployed quickly, or a permanent modification where we're deploying and fielding the mod across all of our aircraft. And in addition, airworthiness certification. Uh, where I'm reviewing and helping them get through the CERT basis write ups that we need to where as well as the error in this certification through the Director of engineering and OP. If needed the cert.

What are the modifications and platforms you have worked on?

Yeah, so, uh, as the section chief, my job is to receive, 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 of the field that would need to be deployed quickly, or a permanent modification where we're deploying and fielding the mod across all of our aircraft. And in addition, airworthiness certification. Uh, where I'm reviewing and helping them get through the CERT basis write ups that we need to where as well as the error in this certification through the Director of engineering and OP. If needed the cert.

What is the modification we are talking about today? (Size, Time functionality, ACAT level, Dollar Amount, etc)

OK, so you know, we've been working since 2000 for about 23 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 way at the A10 we only include aircraft systems as a system as we a whole experience when you're actually working within a LRU. Or avionics. Business or about that let me shut this up. OK. And so, so that's so it's just the 21 years.

The Program

What was the original design of this aircraft for the military, or is it a Commercial Derivative Aircraft?

OK, so you know, we've been working since 2000 for about 23 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 way at the A10 we only include aircraft systems as a system as we a whole experience when you're actually working within a LRU. Or avionics. Business or about that let me shut this up. OK. And so, so that's so it's just the 21 years.

How long has the Air Force been utilizing the aircraft?

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20211211 E3

OK, my name is Derek Dennis. 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...

OK, yeah, I've been working since 2000 for about 23 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 way at the A10 we only include aircraft systems as a system as we a whole experience when you're actually working within a LRU. Or avionics. Business or about that let me shut this up. OK. And so, so that's so it's just the 21 years.

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I was there for approximately 2 years. So that was my only experience in aircraft systems. Prior to that I had worked. Yeah on GID, which is a. NAC intercontinental ballistic missile program in their program offices and prior to that I worked for a test range.

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So I was the program manager over a modification. Uh, to digital beam steering and upgrade the GPS NAV navigation unit on the attack.

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So that was kind of my role. "Home real quick. What is JRP? What does that acronym stand for(“)? It's a JRP's anti jamming GPS system. It's an aerosol based system. Uhm, it's a jamming mitigation technique.

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Of course then we would have to work with the new GPS receiver. And DARO 'cause it Iggy interfaces with the DARO ibda interfaces with the CRPA antenna. So it's the taking our current Iggy. Installing this, this new GPS receiver in it and then putting a CRPA antenna in in. You, uh, interface with the DAV in order to make the whole system now function and provide as this jamming resistant GPS capability. ("OK, so you already had an EGI installed. You're just swtiching up the GPS card that was in it.")

Correct and the op software within it to work with the new GPS receiver. And DARO 'cause it Iggy interfaces with the DARO ibda interfaces with the CRPA antenna. So it's the taking our current Iggy. Installing this, this new GPS receiver in it and then putting a CRPA antenna in in. You, uh, interface with the DAV in order to make the whole system now function and provide as 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.")

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The nature of the Airworthiness certification path was to seek and maintain a level of Airworthiness Certification that was sufficient to meet the requirements of the contract and to ensure that the aircraft was operable under the conditions specified in the contract. To achieve this, the team had to follow a number of procedural steps, including:

1. Understanding the requirements of the contract and identifying the level of Airworthiness Certification needed.
2. Developing a plan to achieve the required level of Airworthiness Certification.
3. Implementing the plan, including the completion of necessary tests and evaluations.
4. Reviewing the results of the tests and evaluations to ensure compliance with the requirements.
5. Submitting the results to the appropriate authorities for approval.

The team faced a number of challenges in achieving Airworthiness Certification, including:

- Time constraints and the need to meet deadlines.
- Resource limitations and the need to work within budget constraints.
- Complex regulations and the need to ensure compliance with all relevant standards.

Despite these challenges, the team worked diligently to achieve Airworthiness Certification and ensure the safety and operability of the aircraft. This required a high level of coordination and collaboration among all members of the team, including engineers, technicians, and administrators. The team's success in achieving Airworthiness Certification was a testament to their dedication and hard work.
24 March 2022

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<tr>
<th>AW Certification Interview Matrix</th>
<th>Q17</th>
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<th>Q19</th>
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<td>Derek Dennis</td>
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<td>Reflections</td>
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<td>So for us, the UMI MIL handbook, 15 C MIL Handbook A461, 4S 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 156 and in looking at the Air Force 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 that’s the best that we have. And so we utilized those plus personal experience and guidance from our Chief engineer.</td>
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<td>Well, it’s 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.</td>
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<td>Uh, better clear definition of what is reportable and 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 a path or maybe obtaining additional. Uh qualification Aurora documentation to prove that your system is not going to be detrimental in any way. Ascertained airworthiness certification checklists.</td>
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<td>A man that was more of a question for the engineers. The engineers were really the ones that I had to deal with. They had a lot of matrix that for airworthiness that they had to do, and I remember this massive matrix and it covered everything and then we had to tailor that matrix. Uh, once that matrix was 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, the, the matrix that I had to deal with. (So did the TA have to say anything with the matrix?) I think they went to 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</td>
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<td>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 this. 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.</td>
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| 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. They’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 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 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 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 inventing a lot of the documentation and stuff. Uh, 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 a while 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 other program offices 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 face in my head, but I can’t see 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’s worked for F16 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 supervisors names and all of that kind of stuff. When you went, you actually find that contact card in Outlook, so that’s what I’m doing really quickly. For insulation, oh Michael Hackett That is the chief
### About the Interviewee

**What is your name, position or title, and the program office you work in?**

I'm Derek Dennis, 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.

**How long have you worked in AC systems?**

I've worked in aircraft systems for about 12 years.

**What modifications and platforms have you worked on? What is the most recent? When was it?**

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 did risk management for the Airworthiness Office before coming to there were in this office.

As lead engineer in Big Safari for several different aircraft programs to include commercial derivative aircraft. Was various, you know, organic Air Force developed aircraft. 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 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.

**What is your role in the modification?**

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 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 test aircraft that we managed...So some of the modifications so recently. Well, in 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 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 test aircraft that we managed...So some of the modifications so recently. Well, in 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.

**What is the modification we are talking about today? (Size, Time functionality, ACAT level, Dollar Amount, etc)**

I'd say the programs probably I would defer to them for this specific, you know. Details to comment on that.

**Was the original design of this aircraft for the military, or is it a Commercial Derivative Aircraft?**

I guess I would have to defer to the. I would defer to the programs on that I. I don't recall the exact date that they were placed in service obviously _____. It is still in development.

### The Program

**What is your role in the modification?**

So my role is to advise the programs. Uh, run 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 um 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.

**Was the original design of this aircraft for the military, or is it a Commercial Derivative Aircraft?**

Yeah, 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 essentially the the basis for the aircraft was certified by the FAA.

**How long has the Air Force been utilizing the aircraft?**

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 essentially the the basis for the aircraft was certified by the FAA.
"your perspective on the _____ and then done for them, so I guess for this one are initially. Uh, I think yeah it would have all aspects of that modification. It's appropriate and I think you know some of the FAA worthiness standards and. Two and I think it's important to have safety that you now the FAA you know, standards and. And that's an STC that where we would, if we didn't get a limited approval, we would have a risk of requirements and for the- and the rules that you know the requirements. You have to say that the FAA will certify. No, it's the standard. In the system from the through the lens of our military. The requirements, you know a system has a safety. Situation is that the costs are that you know, if it were being face or to fight or different than the same. It's just the lack of data and the fact that you know the data and the fact that you know the data. The situation is that the costs are that you know, that in it, you know either refinements or you know changes or new things that you that you learn right. So, I think it's essential to ensure that the plan is refined. We're fine. Different stuff. Situation is that the costs are that you know, if it were being face or to fight or different than the same. It's just the lack of data and the fact that you know the data and the fact that you know the data. The situation is that the costs are that you know, that in it, you know either refinements or you know changes or new things that you that you learn right. So, I think it's essential to ensure that the plan is refined. We're fine. Different stuff. Situation is that the costs are that you know, if it were being face or to fight or different than the same. It's just the lack of data and the fact that you know the data and the fact that you know the data. The situation is that the costs are that you know, that in it, you know either refinements or you know changes or new things that you that you learn right. So, I think it's essential to ensure that the plan is refined. We're fine. Different stuff.
AW Certification Interview Matrix

Derek Dennis 1/3/2021

Reflections

Q17 What documents and communications did you find most helpful in establishing the AW certification?

Q18 Was the path your program took the right path and why?

Q19 What is something you wish you had or knew up front when going for the AW certification? Any future recommendations?

Q20 Who or what other programs would be of good value for me to pursue in an interview for more data collection?

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<thead>
<tr>
<th>Date</th>
<th>Code Name</th>
<th>Finding -&gt;</th>
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<th>Correct decision</th>
<th>Lack of Knowledge</th>
<th>Contacts for Me</th>
</tr>
</thead>
<tbody>
<tr>
<td>20211215</td>
<td>IT1</td>
<td></td>
<td></td>
<td>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 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.</td>
<td>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 didn't, I yeah, 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. Uh, in the program and I think having a TA established airworthiness seem. Uh, you know before you know you say go to RFP, right? I think that 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 enough and important. Because you know, it was. 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 that are that, 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 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</td>
<td></td>
</tr>
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</table>

B-24
### 24 March 2022

**Appendix C: Key Code Phrases Matrix (Anonymized Data)**

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

<table>
<thead>
<tr>
<th>Date</th>
<th>Code Name</th>
<th>Finding</th>
<th>Position Type</th>
<th>Experience</th>
<th>Position</th>
<th>Type of mod</th>
<th>AC type</th>
<th>Time of use</th>
</tr>
</thead>
<tbody>
<tr>
<td>20211110</td>
<td>IE1</td>
<td></td>
<td>EN - Airworthiness Engineer</td>
<td>34yrs EN AW experience</td>
<td>AW lead in develop AW plan and Compliance documentation</td>
<td>non-complex modification; Touches cockpit avionics; affects Outer Mode Line (OML); 2 antennae 2 mil GPS boxes, 2 DAE; $70Mil ~ ACATIII; UON</td>
<td>CDA w/ mil reqt</td>
<td>13 yrs flying w/ military</td>
</tr>
<tr>
<td>20211110</td>
<td>IP1</td>
<td></td>
<td>PM - IPT Lead</td>
<td>3yrs PM AW experience</td>
<td>PM above day to day PM, aircraft IPT lead</td>
<td>small fleet (x3); Mil GPS /IFF Mode 5; Time constrained 2yr UON; $72M ~ ACATIII; Full FAA Cert Double $5 for cert portion; safe carriage STC w/ military risk to operate pending approval</td>
<td>CDA w/ mil reqt</td>
<td>13 yrs flying w/ military</td>
</tr>
</tbody>
</table>
### Airworthiness Certification

<table>
<thead>
<tr>
<th>Date</th>
<th>Code Name</th>
<th>Finding</th>
<th>Certification Path</th>
<th>Factors for Cert Path</th>
<th>Benefits</th>
<th>Costs</th>
<th>Success rate</th>
<th>Setbacks / Difficulties</th>
<th>Risk types</th>
<th>Flying Cert</th>
</tr>
</thead>
<tbody>
<tr>
<td>20211110 IE1</td>
<td>Initial: Safe Carriage STC w/ mil functionality approved through TAA</td>
<td>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 TAA IRT assign AW risks.</td>
<td>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 TAA IRT assign AW risks.</td>
<td>NO, not achieved. Have seen all downsides and no benefit yet. FAA Full cert is not achieved. 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.</td>
<td>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.</td>
<td>Multiple adjustments. 2 plan adjustments, Countless Compliance adjustments for TAA MACC. PMO said Medium risk and TAA said High mitigate to serious.</td>
<td>4 serious level risks, number of lower risks of due to noncompliances.</td>
<td>M8GPS flies under Safe Carriage STC. Once risk acceptance by PEO will have MFR. MTC obtained once a Full STC is accomplished.</td>
<td></td>
<td></td>
</tr>
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</table>

| 20211110 IP1 | Initial: Safe Carriage STC (FAA) w/ mil functionality approved through TAA plan | Safe Carriage STC | 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. | $700M+ Safe carriage STC w/ TAA IRT risk assessment. +$20 mil for Full FAA effort (Gsc Estimate) ($54 mil contractor proposed). Full TAA was estimated at $400M. 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. FAA 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 FAA to bring down risk level. ($50mil). 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. |
### Reflections

**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?**

<table>
<thead>
<tr>
<th>Date</th>
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<th>Correct decision</th>
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<th>Contacts for Me</th>
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</thead>
<tbody>
<tr>
<td>20211110</td>
<td>IE1</td>
<td>The AW plan. Project Specific Certification Plan (PSCP). Mil Hdbk 516. MACC matrix.</td>
<td>Not the right path, we still can't fly. FAA certifying the military reqts is not feasible. Sounds good from philopical perspective but not realistic perspective. MACC is only viable method and you would still have noncompliance. A better understanding of the AC is needed.</td>
<td>Needed more research into the FAA's 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.</td>
<td>IFF</td>
<td></td>
</tr>
<tr>
<td>20211110</td>
<td>IP1</td>
<td>Countless meetings with MCO and TAA to get everyone on the same page.</td>
<td>Yes because of trying to meet the UON. Upfront impressions made Seam method more doable.</td>
<td>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.</td>
<td>HNAG. AWACS (HBS)</td>
<td></td>
</tr>
</tbody>
</table>
24 March 2022

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

<table>
<thead>
<tr>
<th>Certification Interview Key Code Phrases</th>
<th>About the Interviewee</th>
<th>The Program</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date</td>
<td>Code Name</td>
<td>Finding</td>
</tr>
<tr>
<td>-----</td>
<td>-----------</td>
<td>---------</td>
</tr>
<tr>
<td>20211118 IE2</td>
<td>EN - Avionics Engineer</td>
<td>30 yrs avionics experience</td>
</tr>
<tr>
<td>20211130 IP2</td>
<td>PM - Avionics IPT Lead</td>
<td>20 mos about 2yrs</td>
</tr>
</tbody>
</table>
### Platform 2: IE2 & IP2 (pg. 2/3)

#### Certiﬁcation Interview Key Code Phrases

<table>
<thead>
<tr>
<th>Date</th>
<th>Name</th>
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<th>Finding</th>
<th>Certificate Path</th>
<th>Factors for Cert Path</th>
<th>Benefits</th>
<th>Costs</th>
<th>Success Rate</th>
<th>Anticipations / Diﬃculties</th>
<th>Of Adjustments</th>
<th>Risk Types</th>
<th>Filing Cert</th>
</tr>
</thead>
<tbody>
<tr>
<td>20211110</td>
<td>IE2</td>
<td>201111</td>
<td>-</td>
<td>Draft cert plans held up.</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>IP2</td>
<td>20211110</td>
<td>-</td>
<td>Max FAA cert possible. Full cert with statement of functionality on military side.</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>20211120</td>
<td>IE2</td>
<td>20211110</td>
<td>-</td>
<td>Max FAA cert possible. Full cert with statement of functionality on military side.</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
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</tr>
</tbody>
</table>

**Certification**

- Airworthiness Certification

**Factors for Cert Path**

- Military mission but is still a civil aircraft.
- Learned from other program horror stories.
- Policy dictates it. Especially for commercial passenger air vehicle.
- No mention of TAA involvement.
- Additional testing for those to see if certification is possible

**Benefits**

- No WBS for effort/sack insight.
- Lithium batteries driving additional work for certificaation.
- Contract struggles for additional work.

**Costs**

- Work in Progress. Ctr needs to submit cert paperwork still for FAA.
- Lithium battery issues. 18-20 flight deck STCs.

**Success Rate**

- 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.

**Anticipations / Diﬃculties**

- 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

**Of Adjustments**

- Always adjustments. Not much insight, without pushing for it. Hard direct comms with FAA, MIL, and CTR. Lithium battery - had separate effort for certification. Looked into alternate battery HW.

**Risk Types**

- If FAA cert is not accomplished then unable to get mil cert. Everyone on board with FAA cert and no real other plan.

**Filing Cert**

- Eventually Full MTC, STC for mod rolls up into MTC. Military has ownership.
Platform 2: IE2 & IP2 (pg. 3/3)
| Date       | Code Name | Finding            | Known knowledge                                                                 | Correct decision                                                                 | Lack of Knowledge                                                                 | Contacts for Me                                                                 | Reflections |
|------------|-----------|--------------------|---------------------------------------------------------------------------------|----------------------------------------------------------------------------------|----------------------------------------------------------------------------------|--------------------------------------------------------------------------------|
| 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 to 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 analysis 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. | Derek Dennis, 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. | 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. | 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. |
### About the Interviewee

<table>
<thead>
<tr>
<th>Name</th>
<th>Position Type</th>
<th>Experience</th>
<th>Position Type 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</th>
</tr>
</thead>
<tbody>
<tr>
<td>Derek Dennis</td>
<td>EN - Avionics Section Chief</td>
<td>21 yrs ac systems</td>
<td>5 platforms: MI Attack/Fighter</td>
</tr>
</tbody>
</table>

### The Program

<table>
<thead>
<tr>
<th>Date</th>
<th>Code Name</th>
<th>Finding -&gt;</th>
<th>Position Type</th>
<th>Time of Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>20211213</td>
<td>IE3</td>
<td>5 platforms: MI attack/fighter</td>
<td>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</td>
<td>1976</td>
</tr>
</tbody>
</table>

- **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?**

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</thead>
<tbody>
<tr>
<td>20211214</td>
<td>IP3</td>
<td>Design criteria to present up to DOE and OP</td>
<td>Program manager over digital beam steering and upgraded the Nav to combat attack. From 10: Make sure we meet timeline.</td>
<td>early 70s, ~50 yrs old</td>
</tr>
</tbody>
</table>

- **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?**
### Certification Interview Key Code Phrases

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<th>Setbacks / Difficulties</th>
<th>No of adjustments</th>
<th>Risk types</th>
<th>Flying Cert</th>
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</thead>
<tbody>
<tr>
<td>20211213</td>
<td>IE3</td>
<td></td>
<td>No FAA for mil aircraft. EN process military certification thru DOE and TAA if reportable. Follow 62601 and Mil Hdbk 516C.</td>
<td>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.</td>
<td>Yes. Successful GPS in jammed environments in the field.</td>
<td>MACC process ensures safe to fly. Multiple checks ensure no critical safety of flight issues. In accordance w/ SE processes.</td>
<td>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 &quot;last aircraft in the inventory&quot; targeted for M-code: &quot;Always get the scrap&quot;</td>
<td>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 analysis would be used</td>
<td>0</td>
<td>No risks</td>
<td>MFR as amendment 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.</td>
</tr>
<tr>
<td>20211124</td>
<td>IP3</td>
<td></td>
<td>Risk level low and certification fairly easy. Not certifying whole aircraft. Most done through TAA. No basis for FAA, although FAA like requirements. Sign off from AF M1 GPS office. Large matrix for certifying.</td>
<td>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.</td>
<td>Time, multiple layers of briefings up to chain to get go ahead. Locked a prime contractor, more coordination fell on PM in PMO of multiple sub contractors integrating on same system. A-10 lab testing lacked so more push for flight testing. Small program in fighter attack world, lacked support.</td>
<td>At least finished flight testing, on track for fielding.</td>
<td>No adjustments. Small scope fairly easy. Some unnecessary tests.</td>
<td>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.</td>
<td>0</td>
<td>No risks</td>
<td>Can't really know the certificate names/meanings.</td>
</tr>
</tbody>
</table>
## Reflections

<table>
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<tr>
<th>Date</th>
<th>Code Name</th>
<th>Finding -&gt;</th>
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<th>Contacts for Me</th>
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<tr>
<td>20211213</td>
<td>E3</td>
<td>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.</td>
<td>Not right. The only path. Required by AF as the best process.</td>
<td>&quot;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.&quot; Misunderstandings lead to extra work that may be unnecessary. 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.</td>
<td>Q11: &quot;What you don't know is what's gonna kill you.&quot; &quot;And make sure you know what the heck you're talking about when you're doing these modifications.&quot; Q20: PMs know the technology but dont try and be an engineer. Trust the EN team and understand the process takes time.</td>
<td></td>
</tr>
<tr>
<td>20211124</td>
<td>IP3</td>
<td>Engineering question. (PM lack of knowledge). Had a matrix to track AW that had to be approved up EN chain of command.</td>
<td>Yes. Low risk effort and properly manned to do the work. Certification is hard work.</td>
<td>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.</td>
<td>A-10 additional contacts: Le Shi Sueng (Albert); Christian; Michael Hackett (CE); ___ (EN); Pamela Lee (Division Chief, PM); Jaclyn Melton; John DiCaprio</td>
<td></td>
</tr>
</tbody>
</table>
TAA Representative for Platform 1 & 2: IT1 (pg. 1/3)

<table>
<thead>
<tr>
<th>Certification Interview Key Code Phrase</th>
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<tbody>
<tr>
<td>Derek Dennis</td>
<td>1/3/2021</td>
<td></td>
</tr>
</tbody>
</table>

**Q1:** What is your name, position or title, and the program office you work in?

**Q2:** How long have you worked in AC systems?

**Q3:** What modifications and platforms have you worked on? What is the most recent? When was it?

**Q4:** What is your role in the modification?

**Q5:** What is the modification we are talking about today? (Size, Time functionality, ACAT level, Dollar Amount, etc)

**Q6:** Was the original design of this aircraft for the military, or is it a Commercial Derivative Aircraft?

**Q7:** How long has the Air Force been utilizing the aircraft?

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<th>Time of use</th>
</tr>
</thead>
<tbody>
<tr>
<td>20211215</td>
<td>IT1</td>
<td>TAA - Technical Expert CDA, EN</td>
<td>12 yrs ac systems / 3 yrs TAA</td>
<td>As DTA: Multiple MCDA aircraft including FMS. // As EN: 1 MCDA, 2 mil UAS</td>
<td>delegated technical airworthiness authority/ Advise PMO of airworthiness strategy. Guide to following AF policy and criteria basis and compliance reports</td>
<td>Mil GPS - defer further detail to the PMOs</td>
<td>2 of 3 aircraft were MCDA. Those 2 I worked with. These 2 selected with the basis that they were FAA certified</td>
<td>Defer to PMO</td>
<td></td>
</tr>
</tbody>
</table>
TAA Representative for Platform 1 & 2: IT1 (pg. 2/3)

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<tr>
<td>20211215</td>
<td>IT1</td>
<td></td>
<td>Both Progs should have pursued full/limited FAA cert to the maximum ability of all milGPS aspects. AB 360, B110-101. FAA won’t 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.</td>
<td>Full policy to use FAA max extent possible. The base as certified by FAA, so maintain the standards approvals and safety assessments for modifications since there are interdependencies. Mixing the certification paths cause gaps</td>
<td>Ensuring all aspects 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. Don’t need green aircraft data. More TAA involvement opens to more uncertainty.</td>
<td>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?”</td>
<td>__ still at serious risk, need full FAA cert. ___ cert basis approved, still no flight test.</td>
<td>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 assessment and threat analysis, TAA requirements different than FAA reqts.</td>
<td>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.</td>
<td>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.</td>
<td>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.</td>
</tr>
</tbody>
</table>
### Reflections

**What documents and communications did you find most helpful in establishing the AW certification?**

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?

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<table>
<thead>
<tr>
<th>Date</th>
<th>Code Name</th>
<th>Finding -&gt;</th>
<th>Known knowledge</th>
<th>Correct decision</th>
<th>Lack of Knowledge</th>
<th>Contacts for Me</th>
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<tbody>
<tr>
<td>20211215</td>
<td>IT1</td>
<td></td>
<td>AW plan before Contract Award. Knowing the military side of requirements 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.</td>
<td>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.</td>
<td>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.</td>
<td>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.</td>
</tr>
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</table>
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
  o 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. 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.

<table>
<thead>
<tr>
<th>Level of FAA Approval</th>
<th>Aspect Approved by FAA or USAF</th>
<th>CB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full Approval</td>
<td>SWaP-C Equipment Qualification Installation Approval No restrictions on Use</td>
<td>14 CFR 8</td>
</tr>
<tr>
<td>Limited Approval</td>
<td>SWaP-C Equipment Qualification Installation Approval Military Use Only with Statement of Functionality</td>
<td>14 CFR/516 4</td>
</tr>
<tr>
<td>Safe Carriage</td>
<td>SWaP-C Equipment Qualification Installed; Not Connected Equipment Qualification Connected for Operation Operational Approval</td>
<td>14 CFR/516</td>
</tr>
<tr>
<td>Provisions Only</td>
<td>SWaP-C Equipment Qualification Installation Approval Operational Approval</td>
<td>14 CFR/516</td>
</tr>
<tr>
<td>None</td>
<td>SWaP-C Equipment Qualification Installation Approval Operational Approval</td>
<td>516</td>
</tr>
</tbody>
</table>

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
**Title and Subtitle:**
Airworthiness Decision Factors in the US Air Force

**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.

**Subject Terms:**
Military commercial derivative aircraft, Airworthiness, Airworthiness certification, Airworthiness “seam”, Decision factors, Semi-structured interviews