Evaluation of RSAF Airworthiness and Applicability

THESIS

Majed M. Altowairqi, Captain, RSAF

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DEPARTMENT OF THE AIR FORCE
AIR UNIVERSITY

AIR FORCE INSTITUTE OF TECHNOLOGY

Wright-Patterson Air Force Base, Ohio

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Majed M. Altowairqi, B.Av.E.

Captain, RSAF

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Majed M. Altowairqi, B.Av.E.
Captain, RSAF

Committee Membership:

Dr. William Cunningham
Chair

Dr. Alfred E. Thal, Jr.
Member

Dr.Amy Cox
Member

AFIT-ENS-MS-18-S-079

Abstract

This research focuses on evaluation of Royal Saudi Air Force (RSAF) airworthiness processes and their applicability. The current RSAF airworthiness process is in accordance with internationally recognized best practice in the area of military aviation, this is achieved by benchmarking against European Aviation Safety Agency (EASA) and International Organization for Standardization (ISO) standards. Airworthiness policy for the RSAF is developed on the basis that it will be as civil as possible and as military as necessary. For the purpose of this research, the current RSAF airworthiness process will be benchmarked against the United States Air Force (USAF) airworthiness process. That can be done by understanding the current airworthiness process for RSAF and USAF, types of airworthiness certificates and determining the commonality and differences between both processes including the initial airworthiness, continued airworthiness and continuing airworthiness and compare the organizational structure, planning, execution, and the final products of airworthiness process. The main difference between RSAF and USAF in organizational structure is the existence of the Technical Airworthiness Authority (TAA) and Delegated Technical Airworthiness Authority (DTA) in the USAF, whereas in the current RSAF organizational structure the TAA and DTA do not exist. As consequence, some of the products of these organizations are missing in the RSAF. This research suggests that those techniques can help to improve the airworthiness process in the Royal Saudi Air Force.

To my God, with Whom all things are possible.

To my parents

To my wife

To my kids

To my country

for their unwavering support.

"He who does not thank people, does not thank Allah"

– Prophet Muhammad

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Majed M. Altowairqi

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EVALUATION OF RSAF AIRWORTHINESS AND APPLICABILITY

I. Introduction

1.1 Chapter Overview

On December 17, 1903 the Wright brothers invention was announced to be successful; they could create a powered and controllable machine to sustain a flight. Achieving a twelve-second flight was the first step that led to a great development effort to build better flying machines. The early 20th century witnessed the aviation developments including planes and technologies that entered the aviation world. The airplanes played a main role during World War I and proved to be the main military tool to control the sky and cover ground troops during wartime.

The arrival of early airmail service showed a great potential for commercial applications. This new and unique equipment changed the world in all aspects of peace and wartime. The new machine could transport people and goods in the sky instead of the old generation which was only operated on ground and sea. Before the Wright brothers invention, there were a number of attempts to fly but they were unsuccess-ful and caused some injuries to the pilots. Infact, Wilbur Wright died from injuries suffered on a crash.

When the Wright brothers were trying to make their own airplane and fly it they put their life at risk. As the concept of the flying was developing. The requirement was different according to the operator's perspective and the mission. The aviation industry started producing commercial and military aircraft and as a consequence air travel increased. Early operators used to stand on the field and wave flags to

communicate with pilots. The diverse uses of the airplane were explored to bring rules and regulation to ensure the flight safety and minimize the risk of life losses and property damage.

By 1926, the Air Commerce Act was passed. This landmark legislation charged the Secretary of Commerce with fostering air commerce, issuing and enforcing air traffic rules, licensing pilots, certifying aircraft, establishing airways, and operating and maintaining aids to air navigation. A new Aeronautics Branch started in the Department of Commerce was the primary responsible for the overall aviation. At that time, the airworthiness terminology and concept was introduced to the aviation world. Airworthiness is related to the safety of the airplane, maintenance and modification activities which determine if the aircraft is airworthy. The Federal Aviation Agency (FAA) is responsible for civil aviation safety in the United States according to the needs and requirement to ensure flight safety. On the other hand, the military aviation with different goals and flight profile cannot be limited the FAA rules and regulation. The military airworthiness cannot be standardized for all countries, every country adopts their own military airworthiness processes and procedures according to the need and mission. The United States Air Force (USAF) is a lead air force in this field where they have a set of manuals, policies, directives, and instructions to ensure that all the aircraft under their authority are airworthy. Also the USAF will apply their processes and procedures to the foreign military sale (FMS) aircraft before delivery to the customer.

The Kingdom of Saudi Arabia (KSA) is a strategic military partner to the United States and its one of the most important countries in the world where it plays the main role for maintaining the Middle East and region stability. The Royal Saudi Air Force (RSAF) is the air power within the Ministry of Defense (MOD). The RSAF operates different types of manned and unmanned aircraft.

The airworthiness of civil aircraft registered within KSA is regulated by General Authority for Civil Aviation (GACA). State aircraft, including those of the RSAF are exempt from these regulations, as military flying is permitted and authorized under Royal decree by the MOD, with each armed service charged with developing its own airworthiness policies and governance frameworks, as applicable. There are no clear links with GACA and its airworthiness directives and regulations. However, responsible governance principles demand that the national regulation of State aircraft should be as good as that provided by national and international bodies for civil aircraft. Therefore, and in accordance with internationally recognized best practice in the area of military aviation, this is achieved by benchmarking against the European Aviation Safety Agency (EASA) and International Organization for Standardization (ISO) standards. The RSAF airworthiness policy is based on the concept that it will be as civil as possible, military as necessary.

1.2 Motivation

The motivation for this research is Saudi Arabia's Vision for the future (vision 2030) which is aiming to transform Saudi Arabia to an industrial country in all fields. The aviation industry is one of the most important fields for this vision. A first step for such transformation in military aviation is to know how the other leading countries are working to achieve the airworthiness for their aircraft. The RSAF Head Quarter(HQ) is developing initiatives intended to optimize operational availability of aircraft, reduce the cost of redesign and modification, and standardize the risk assessment and mitigation processes for all RSAF aircraft.

1.3 Problem Statement

The current RSAF airworthiness processes account for Maintenance and Operations to achieve the continuing airworthiness, and continued airworthiness deals with modification of existing air system. Within the RSAF, the Directorate of Aeronautical Engineering (DoAE) has responsibility for the Engineering Authority Change Process (EACP) and Engineering Change Modification Process (ECMP), which focus on how to embody modifications when the Design Organization (DO) Modification procedure will not meet the required timeframe, or where the Weapon System Support Manager (WSSM) believes that it is more cost-effective to introduce and support an Engineering authority (EA) Change. These processes are part of the airworthiness activities included and extend to address continued airworthiness and continuing airworthiness.

At present, initial airworthiness is delegated to the contracted government; they hold the responsibility to ensure all airworthiness activities are included in the planning phase. Further, they are responsible for ensuring that the air system is airworthy according to the design and they support the receipt of a Military Type Certificate (MTC). The RSAF's objective is to have the regulatory structures, procedures, processes and activities in place to enable an independent authority in order to achieve MTCs and other Flight releases.

1.4 Importance

All change activities have the potential to impact airworthiness of an air system. For this reason all system design, military operational usage, flight envelope changes, and life extensions to an air system require an airworthiness assessment. The purpose of such an assessment is to determine if the modification has an impact on airworthiness.

1.5 Research Focus

The research will focus on current RSAF airworthiness processes and how they align with the USAF airworthiness processes. This research will include, but is not limited to, the consideration of the following:

1. Current RSAF program activities for adopting Military Airworthiness Authority (MAA) and Technical Airworthiness Authority (TAA).

2. The roles, responsibility and processes to be adopted to implement and manage any military aviation manufacturing activities within KSA.

3. USAF airworthiness processes, policies and documentations.

1.6 Research Objectives and Research Questions

The objective of this research is to compare the current RSAF airworthiness process versus a benchmarks specifically the USAF airworthiness process for ensuring the safety of the RSAF fleet, and the recommendation of a framework for better implementation of the initial airworthiness. The results will provide recommendations for appropriate auditing tools, process improvement, and opportunities for additional research.

The following are the research questions that need to be answered by the end of this research

Q1: What airworthiness processes does the RSAF currently use?

Q2: What airworthiness processes does the USAF currently use?

Q3: What are the similarities and differences between RSAF and USAF in the airworthiness aspects including initial airworthiness, continued airworthiness, continuing airworthiness, processes, organizational structures, and products of the airworthiness processes?

1.7 Methodology Overview

The proposed research will be conducted using comparative case study. The data needed will be available from the RSAF and USAF, in accessible regulations, policies, material management reports, briefings, and papers. In addition, the materials supporting the theoretical framework of the proposed study are available in open source literature. Analysis techniques for the proposed research will include a literature review and the application of airworthiness process in RSAF and USAF to compare and contrast the airworthiness aspects including initial airworthiness, continued airworthiness, continuing airworthiness, processes, organizational structures, and products of the airworthiness. All the required data will be available from USAF, AFIT, AFLCMC/ENZ, and RSAF/DoAE. The researcher utilized an assessment to compare between USAF and RSAF airworthiness precesses including initial, continued, and continuing airworthiness to capture the main differences and commonality between both processes. This technique focus on organizational structure, planning, execution, and the final products of the airworthiness process.

1.8 Assumptions and Limitations

This research will deal with available resources and will not try to go deep into any financial matter or administration processes. It will focus on the enterprise level of the airworthiness process.

1.9 Chapter Summary

In this chapter, an overview of the flying history and airworthiness process improvement are discussed. Next, the motivation behind this research and the problem statement are explained. After that,the importance to develop an airworthiness pro-

cess in RSAF is stated. Later, the research Focus is mentioned as what processes needed to be adopted to implement and manage any military aviation manufacturing activities within Saudi Arabia. Chapter 2,presents the material investigated to understand the current airworthiness processes for RSAF and USAF during researching the problem statement of this thesis. In Chapter 3, the methodology and solution technique of the problem is explained. In Chapter 4, the solution technique is examined and evaluated. In Chapter 5, the conclusion,summary of the research, and recommendation for future research are mentioned.

II. Literature Review

2.1 Chapter Overview

This chapter presents the material investigated to understand the current airworthiness process during researching the problem statement of this thesis. Although only the literature related to this problem is mentioned here, it explains how the process work in the USAF and RSAF and will be helpful for understanding the conclusion of this research.

2.2 What is airworthiness process management?

The definition of airworthiness process management is a key starting point to do the study about any related activities to airworthiness. But before defining airworthiness process management it is important to understand what is airworthiness? USAF Instruction AFI 62-601 *"USAF AIRWORTHINESS"* published in 2010 defined airworthiness as "the verified and documented capability of an air system configuration to safely attain, sustain, and terminate flight in accordance with the approved aircraft usage and operating limits"[4]. The management of these processes is the airworthiness process management.

Airworthiness Process Management is defined as "The Technical Airworthiness Authority (TAA) will develops, documents, and deploys standard processes and issues supplementary guidance as needed to assess and maintain the airworthiness of Air Force aircraft"[4]. multiple organizations are responsible for implementing the USAF's airworthiness processes. we need to characterize both the processes accomplished as well as the organization structure that realizes those processes.

Figure 1 illustrates the airworthiness life cycle including the airworthiness aspect initial, continued, and continuing airworthiness,where the development and produc-

tion phase is the core of the initial airworthiness, and the operations and sustainment phase is part of the continued, and continuing airworthiness.

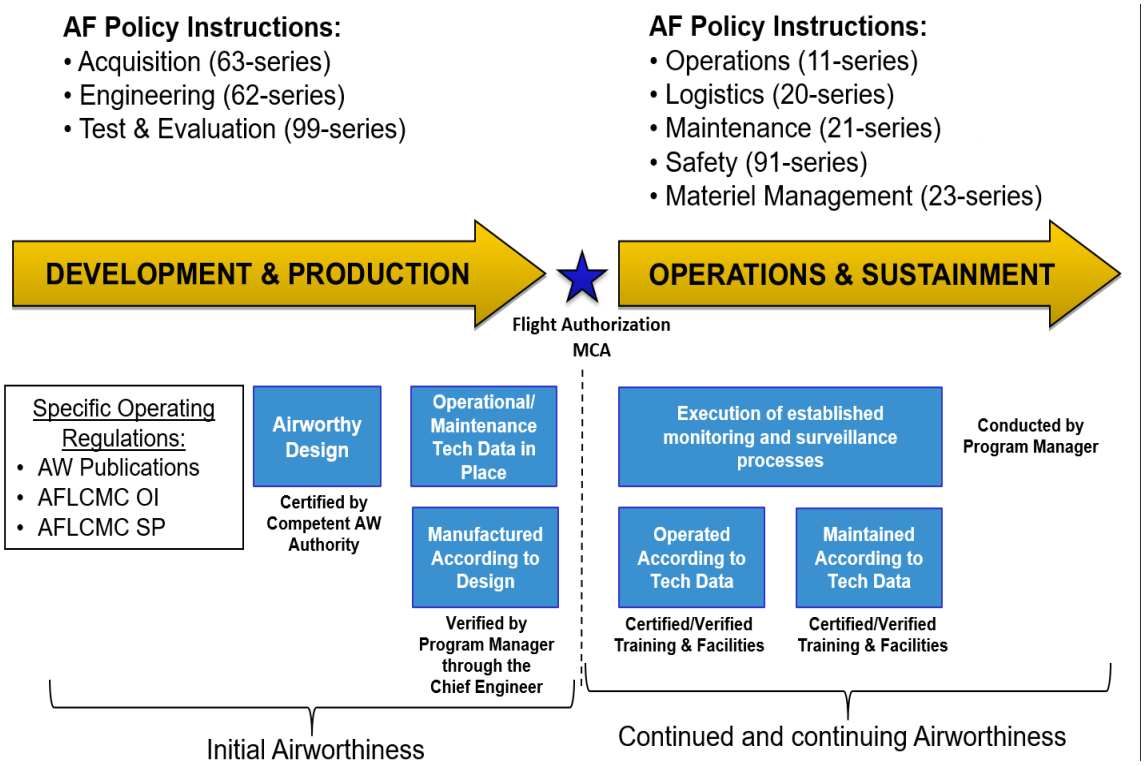

Figure 1. Airworthiness life cycle (Keil, 2017)

2.3 Who Is Involved In The Airworthiness Process?

The military airworthiness organization is complicated. There are different parties and functions involved to ensure the best engineering practices of the airworthiness activities during the life cycle of an air system for all projects, including new or modification of an air system. Due to the complexity of the military organizations there are different stakeholders and functions involved in the process to achieve the airworthiness objectives. The military airworthiness functions include operational airworthiness which govern the use and control of aircraft by aircrew, and maintenance procedures for the air system is responsibility of the major command for ensuring continued, and continuing airworthiness. Also, the technical airworthiness is part of the

military airworthiness processes which determines the requirements for the aircraft when being designed, produced or maintained to meet the requirement of the initial airworthiness. The stakeholders of the USAF technical airworthiness process according to Air Force Life Cycle Management Center (AFLCMC) Operating Instruction 62-601 *"USAF Airworthiness process for Delegated Authority (DTA)"* [5] published in 2013 are:

- The Technical Airworthiness Authority (TAA) is the independent and authorized USAF office who defines airworthiness requirements, standards, approves the certification basis for an air vehicle, issues findings of compliance, and issues Military Type Certificates as well as other flight releases.

- Component Acquisition Executive (CAE) and Program Executive Officer (PEO) are the USAF risk acceptance authorities for high and serious risk respectively. For aircraft not governed under the AF CAE/PEO, an equivalent authority would be required to accept airworthiness risks. The PEO is responsible to ensure successful completion of airworthiness reviews/releases prior to First Flight (FF), ensures final flight authorization achieved prior to Operational Test and Evaluation and fielding, and monitor risk mitigation implementation as mentioned in USAF safety instructions when appropriate.

- System Program Manager (SPM) are the supervising authorities for programs; they meet user's operational needs by accomplishing program objectives for development, production, and sustainment . Program Managers (PM) for subsystems support overall system objectives as required by the System Program Manager (SPM) and are responsible for cost, schedule, performance, and material readiness of the system.

- Chief Engineer/Delegated Technical Authorities (CE/DTA) the DTA at the

Chief Engineer level is responsible for determining modifications whether airworthiness related or not. They approve final Modification Airworthiness Certification Criteria (MACC) for aircraft undergoing non-reportable modifications on applications for MTC; coordinate on product acceptance documents and Military Certificates of Airworthiness (MCA) and approve deviations from MTC compliance.

- Director of Engineering/Delegated Technical Authorities (DOE/DTA). In addition to CE/DTA authority, DTA at the DOE level has the authority to classify modifications that impact the airworthiness as reportable or non-reportable. The annual summary report of reportable/non-reportable modifications is the responsibility of DOE/DTA to deliver it to the TAA. Further, they are a participant in the regular reviews of their DTA related activities with the TAA. Figure 2 shows the TAA and DTA top level organizational structure.

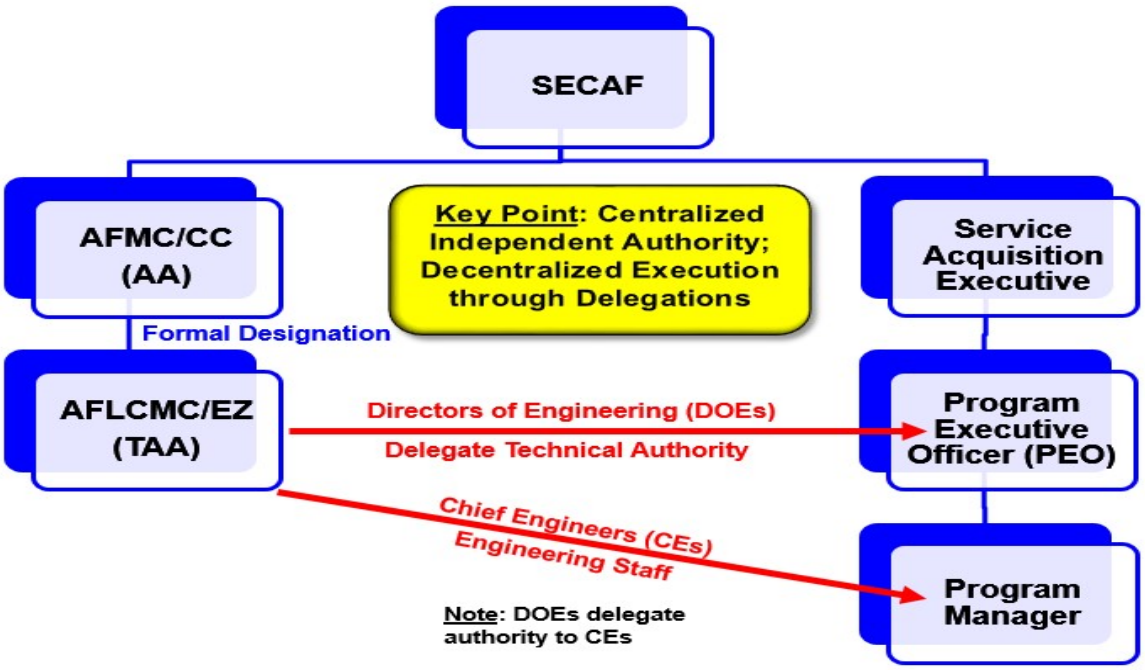

Figure 2. TAA and DTA top level organizational structure (Keil, 2017)

- Configuration Management (CM) personnel are key supporters of the airworthiness process. CM personnel oversee the implementation of the Military Type Certificate/Military Flight Release (MTC/MFR) numbering scheme to ensures incorporation of airworthiness decisions into Configuration Control Board (CCB) charts; supports review of airworthiness documentation and abutment in finalizing the directorate Annual airworthiness Determination Summary Report.

- System Safety personnel are responsible for the Safety processes within the Program Offices. The System Safety personnel Provide information and comments to Section 14 of MIL-HDBK-516 used by USAF and other forces within DoD to establish and develop Airworthiness Certification Criteria, the initial Hazard Risk Assessment during the Compliance Review, preparing any airworthiness risk assessments, obtaining airworthiness risk acceptance using the USAF safety process, and tracking airworthiness risk status in accordance with the USAF policy.

2.4 Airworthiness Publication

The airworthiness processes and standards are different according to the project and types of platforms. To understand these types of standards and policies a comprehensive documentation is essential to implement the airworthiness processes that will improve the overall effectiveness of the process.

The TAA is the responsible and authorized authority to develop and issue standards, processes and guidance documents to ensure the airworthiness as shown in Figure 3 to satisfy the DOD and USAF directives and instructions. The airworthiness publications according to USAF Airworthiness Bulletin (AWB)-210A *"USAF Airworthiness Publications"* [16] published in 2017 are:

• Airworthiness Bulletin (AWB): are mandatory documents to explain in detail all procedures and requirements to implement the Department of Defense and USAF directives and instructions for airworthiness.

• Airworthiness Advisory (AA): it is not mandatory, it is Cross-platform information distributed as needed to mitigate current or potential significant flight safety technical issues in response to external (AA).

• Airworthiness Circular (AC): it is not a mandatory, it is more about information, Guidance, and recommended practices to implement the requirements and criteria governing airworthiness.

• Airworthiness Directive (AD): it is mandatory, it is direction explaining the activities of DTA to achieve airworthiness.

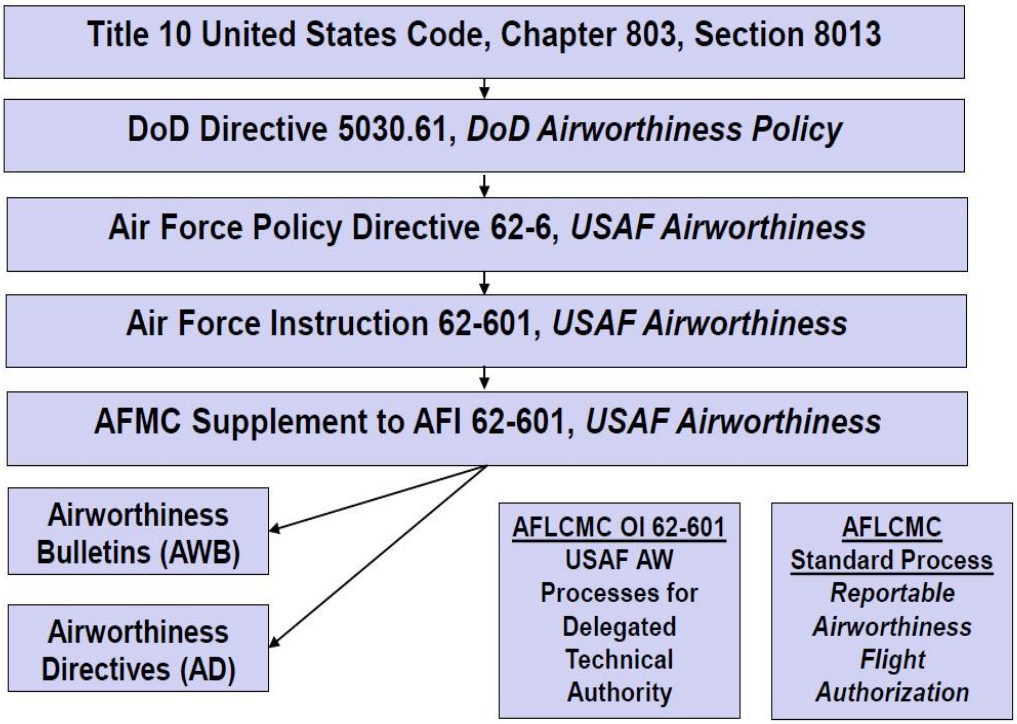

Figure 3. USAF airworthiness Policy Structure (Keil, 2017)

2.5 The Technical Airworthiness Authority (TAA)

In this section the researcher will explain in detail the TAA and DTA to capture their influence in the airworthiness process. The TAA is an independent organization who is organizationally located outside of the Acquisition/ sustainment and operational direct chain of command, and the technical leader responsible to perform different activities to ensure the best practices of the airworthiness according to AIR FORCE INSTRUCTION 62-601[4] "The Commander, HQ Air Force Material Command (AFMC), designates the TAA as directed by Air Force Policy Directive AFPD 62-6[3]". USAF Identifies the TAA as the Director of AF Life Cycle Management Center /Engineering and Technical Management / Services (AFLCMC/EZ). The responsibilities of the TAA is to execute the airworthiness process with three tents:

1. Standardized process and tools:

A. MIL-HDBK-516C is the checklist and defines the set of airworthiness Criteria, Standards and Method of Compliance.

B. Airworthiness documentations including AWB, AA, AC, and AD to ensure the airworthiness of the system and to provide details to the process and guidance behind the policy and Instructions of USAF which direct AF Airworthiness to meet the DoD directives.

2. Qualified personnel

A. Delegations to enhance the execution of the process through decentralized DTA where CE/DTA classify modifications as airworthiness related or not airworthiness related; and approve final MACC for aircraft undergoing none-reportable modifications. DOE/DTA have the authority to classify modifications as reportable or none-reportable.

B. Endorsed Subject Matter Expert (SME) to clarify and resolve issues during the

execution of the process, Review focuses on the technical adequacy and completeness of the criteria applicability, standards and methods of compliance and provide support to Airworthiness Board (AB) in reviewing program airworthiness efforts.

3. Independence

A. Segregated from the Acquisition/operational direct chain of command to avoid any potential conflict between program execution and airworthiness certification. Figure 4 shows the TAA and DTA hierarchy and their relationship.

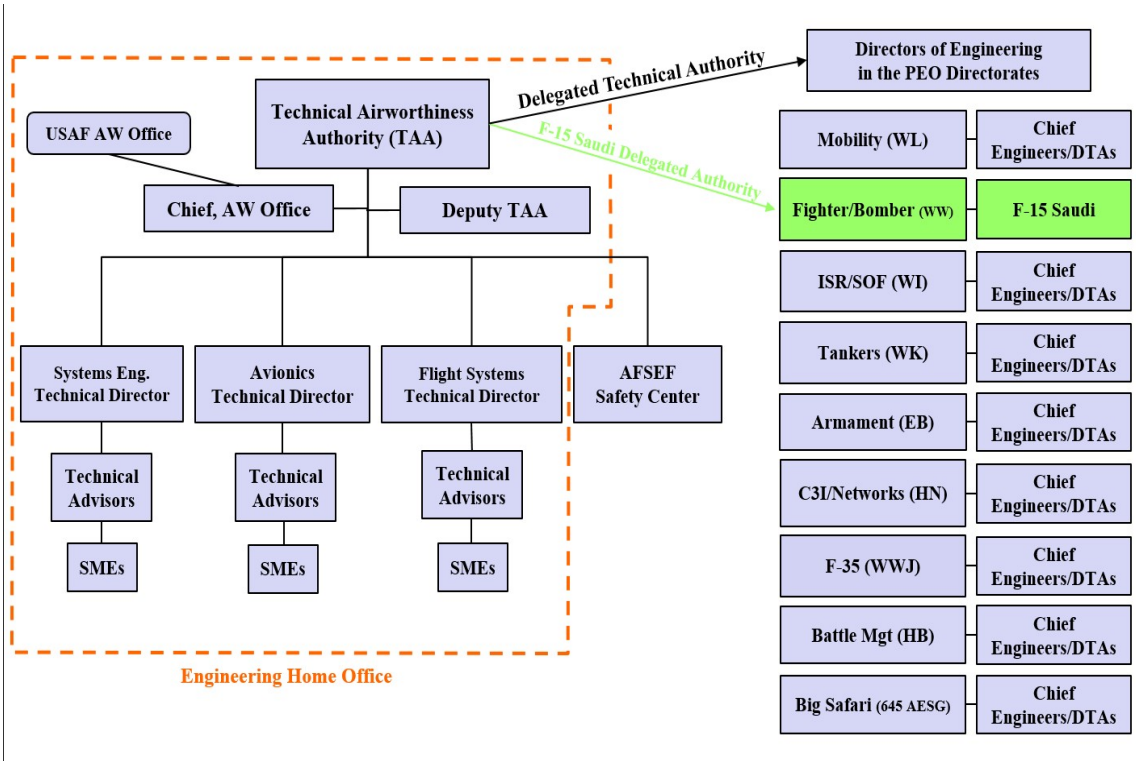

Figure 4. TAA and DTA hierarchy (Keil, 2017)

The TAA, or DTA is responsible for determining the airworthiness impact and approve the airworthiness certification basis for air system according to the airworthiness assessment and the modification . The TAA conducts organizational airworthiness audits to verify ongoing adherence to airworthiness policies and processes. The TAA develop the tailored airworthiness certification criteria (TACC) and reportable modification airworthiness certification criteria (MACC) documents; make

findings of compliance for program airworthiness certification applications; and issue Military Type Certificates (MTC), Military Experimental Flight Releases (MEFR), Military Restricted Flight Releases (MRFR), and non-design-based special flight releases. Regardless of the reportibility decision, the airworthiness process outlined in Figure 5 is followed by both the DTA and TAA office. All of the same products required and the same level of data is expected. The green line including the criteria, standards, methods of compliance, data to show analysis, inspection, test, and demonstration, compliance assessment, hazard and mitigations, and system safety assessment to represents the data which forms the decision for any flight authorization issuance.

Figure 5. USAF design based Airworthiness assessment (Mueller, 2018)

2.6 Airworthiness Certification Steps

The USAF airworthiness certification process is predicated upon having basic knowledge of an aircraft or modification design. Once top level design configuration concepts are determined, the certification basis may be developed and approved

to provide the tailored set of criteria against which the design will be assessed using approved standards and methods of compliance. Throughout the engineering development process, the design will be subjected to various analysis, testing, demonstrations, inspections, and simulations to assure the approved certification basis. When compliance to the certification basis is shown an independent authority may issue the appropriate design approval documentation.

Airworthiness Planning

The planning of airworthiness needs to take place early in the air system development cycle for both new system development and legacy system major modifications. The airworthiness planning is an essential technique to define the overall strategy and approach to maintain the air system airworthy during all phases of its life. According to AFI 62-601 *"USAF AIRWORTHINESS"*[4] published in 2010 explaining airworthiness planning by "Airworthiness planning shall be accomplished early in the acquisition cycle for new aircraft programs and for modification programs which impact the airworthiness of existing aircraft". The planning stage create the framework with airworthiness planning and execution to identify the overall program approach to achieve and keep air system airworthiness within the limits and the acceptable criteria. The system Life Cycle Management Plan (LCMP) is used to document the top level airworthiness plan to be implemented during the program acquisition strategy. The PM is the office in charge to ensure airworthiness tasks and data to verify compliance are included in the program schedule and development contract. For new aircraft type (Initial Certification) a program's airworthiness plan documents the airworthiness plan and approach, and is documented in the program Systems Engineering Plan or equivalent. For modification of existing aircraft type an Airworthiness Determination Form (ADF see Appendix 1) documents the airworthiness

plan approach, Aircraft shall be assessed for airworthiness, and determinations made, before approving any flight authorization. Figure 6 shows the main elements of airworthiness planning.

PM is responsible to request the TAA to make a determination to proceed with one of two possible alternative assessment processes: a design-based airworthiness assessment or a non-design-based airworthiness assessment. Design-based assessments are the preferred approach and it can be done according to Air Force Instruction 62-601 *USAF AIRWORTHINESS"* [4] Published in 2010 when:

"1. An airworthiness certification basis can be established consisting of a specified set of design criteria.

2. The design of an air system can be assessed for compliance with the specified criteria.

This is the only path which will lead to military certification of the type design and airworthiness certification of individual aircraft".

Non-design based assessments are typically performed on a by-exception basis for unique aircraft or situations when it has been determined by the TAA that a design-based airworthiness certification cannot reasonably be accomplished, but when there is a compelling military need to operate the air system. This would typically be the case for a system in which design and/or airworthiness criteria compliance information is prohibitively difficult or costly to obtain. When followed to a successful conclusion, the result of this process is TAA issuance of a special flight release. This allows operation of aircraft for which the design based certification basis and/or certification compliance status is unknown or indeterminate. The non-design-based special flight release process is used to identify and assess the inherent risks of operating these aircraft and the organization responsible for their flight operations will formally acknowledge acceptance of these risks[7].

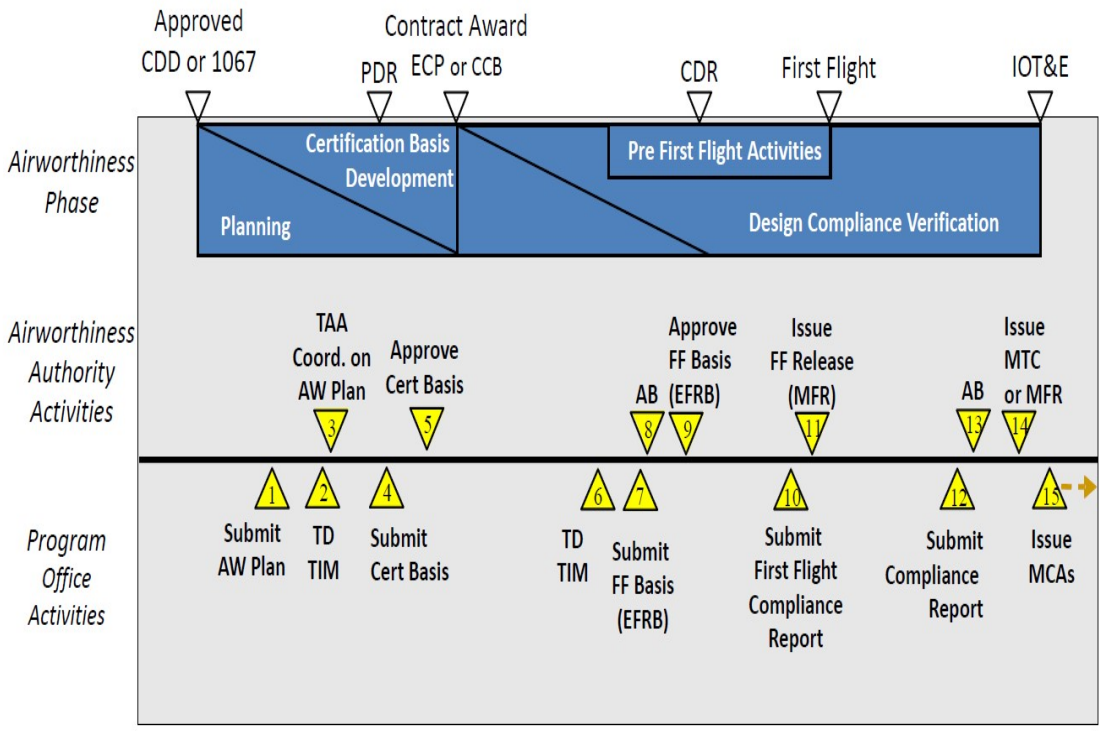

Figure 6. Key Elements of Airworthiness Planning (AWB-002A, 2011)

Certification Basis

The Certification Basis is the key stone of the process where the primary office will be responsible for all the processes to be included to obtain the flight release with the best airworthiness practices including the criteria, standards, and methods of compliance that are applied to assess the airworthiness of new aircraft type or modifications to an existing aircraft type. Typically created from *MIL-HDBK 516C* [18] Airworthiness Certification Criteria unless Program Office is using FAA Certification or US Army/US Navy Airworthiness Approvals. The ADF is utilized to document the reportability determination as well. When the CE/DTA determines the modification has an airworthiness impact they are required to complete the Modification Assessment Matrix. The matrix is aligned with MIL-HDBK-516 Expanded to define the credible hazards associated with the design prior to any proposed miti-

gations. Currently available data can be utilized in defining the hazard. Ultimately an overall Modification Airworthiness Hazard Index (AWHI) is identified. The value of examining the design risk without mitigation is that it emphasizes the intent for a robust primary architecture, assigns an early weighting to the resources required for the design and facilitates attention to the problematic aspects of the change. The CE/DTA will recommend the final AWHI for the accumulation of hazards for that section. Neither the CAE nor PEO are required to accept risk associated with the ADF. This information is a tool to support the reportability assessment[9].

The overall modification AWHI is typically the worst of all the sections; however, the result could become more severe due to the integration/interaction between system/subsystems. The overall AWHI associated with the program/modification will determine whether the program/modification is reportable or non-reportable, which determines the level of approval required for airworthiness plans, certification basis, and flight authorization, i.e., TAA for reportable vs. DOE/DTA for non-reportable. The modification is consider reportable if the overall AWHI is 1 to 9, if the AWHI is 10 to 20 the modification is non-reportable[15] see Figure 7.

HAZARD CATEGORIZATION		SEVERITY*			
		CATASTROPHIC (1)	CRITICAL (2)	MARGINAL (3)	NEGLIGIBLE (4)
FREQUENCY	FREQUENT (A) = or > 100/100K flt hrs	1	3	7	13
	PROBABLE (B) 10-99/100K flt hrs	2	5	9	16
	OCCASIONAL (C) 1.0-9.9/100K flt hrs	4	6	11	18
	REMOTE (D) 0.01-0.99/100K flt hrs	8	10	14	19
	IMPROBABLE (E) = or < 0.01/100K flt hrs	12	15	17	20

HIGH	CAE Risk Acceptance HRI = 1 through 5	MEDIUM	PM Risk Acceptance HRI = 10 through 17
SERIOUS	PEO Level Risk Acceptance HRI = 6 through 9	LOW	Risk Acceptance As Directed HRI = 18 through 20

Figure 7. USAF Airworthiness Hazard Index (AWB-013A, 2011)

Upon completion of the ADF, the CE/DTA will seek approval from the DOE/DTA. The DOE/DTA may choose to submit any ADF to the TAA for coordination. The certification basis for new aircraft programs and reportable modification programs contained in the TACC or MACC documents require TAA approval prior to contract award. The certification basis for non-reportable modifications follows the same process but is approved by the Chief Engineering/Delegated Technical Authority (CE/DTA)[14]. The DOE/DTA will perform the CE/DTA non-reportable certification basis approvals and the associated final MACC compliance finding and approval function see Figure 8.

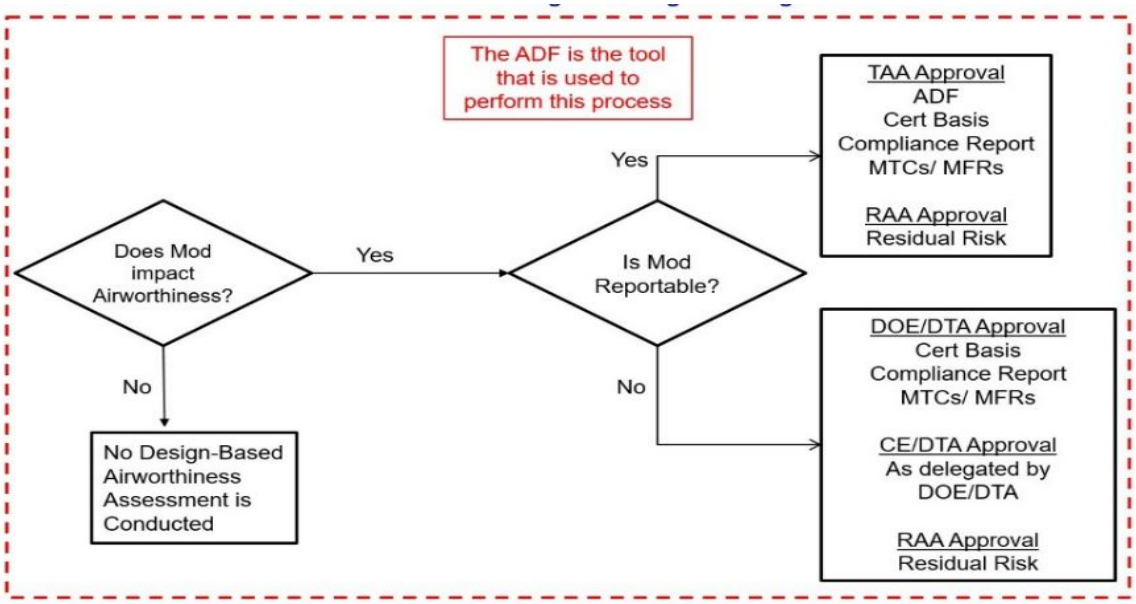

Figure 8. Reportability determination (AWB-007, 2011)

Compliance Review

The compliance report shows that aircraft design documentation accurately defines the configuration, the level of compliance to the approved certification basis, and the severity of risk associated with non-compliances. Mitigations required to eliminate or reduce risks associated with the design package including all necessary technical

information required to construct, maintain, and operate the aircraft system within the approved conditions of operation throughout its approved service life. Identifying the mission usage, and the flight manual accurately describes the permissible flight envelope. Showing that the service life limit has been established and approved for the type design. Figure 9 shows the required data needed to be included in the compliance report to be viewed by the appropriate risk acceptance authority[8].

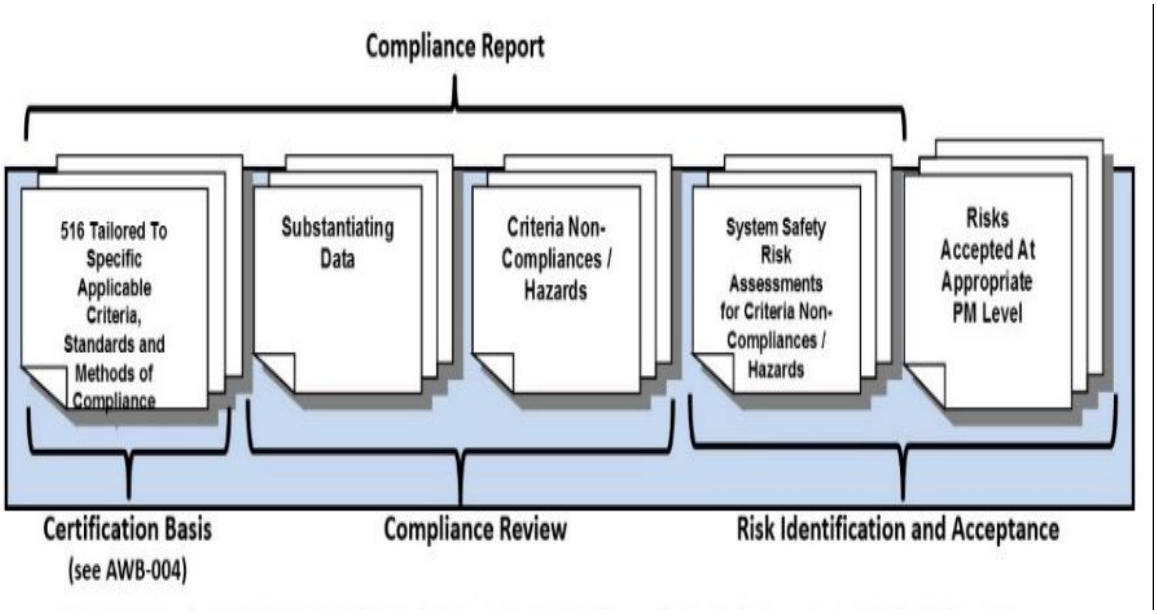

Figure 9. The Compliance Report (Mueller, 2018)

Risk Assessment and Acceptance

The system safety is an important element to identify the hazard in according to MIL-STD-882E *"SYSTEM SAFETY"* [19] published in 2012 defining Hazard as "any real or potential condition that can cause injury, illness, or death to personnel; damage to or loss of a system, equipment, or property; or damage to the environment". And Mishap as "an unplanned event or series of events resulting in death, injury, occupational illness, or damage to or loss of equipment or property, or damage to the environment". The goal is always to eliminate the hazard if possible but some time

the hazard cannot be eliminated, the associated risk must be reduced to the lowest acceptable level. The risk assessment for non-compliance criteria will determine the severity category and probability level of the potential mishap for each hazard across all system see Figure 10.

RISK ASSESSMENT MATRIX				
SEVERITY / PROBABILITY	Catastrophic (1)	Critical (2)	Marginal (3)	Negligible (4)
Frequent (A)	High	High	Serious	Medium
Probable (B)	High	High	Serious	Medium
Occasional (C)	High	Serious	Medium	Low
Remote (D)	Serious	Medium	Medium	Low
Improbable (E)	Medium	Medium	Medium	Low
Eliminated (F)	Eliminated			

Figure 10. Risk Assessment Matrix (AFI62-601, 2011)

Noncompliance with an applicable airworthiness certification criterion is an indication of a potential safety hazard or other limitation in the design of the system and may have airworthiness ramifications. A key factor in the decision process that may lead to airworthiness certification is the successful resolution of individual safety hazards or the acceptance of their residual risk by the appropriate decision authority prior to the submittal of the airworthiness application to the TAA. according to DODI 5000.02 *"Operation of the Defense Acquisition System"*. "The Component Acquisition Executive (CAE) is the acceptance authority for system safety risks classified as high; the PEO level is the acceptance authority for serious safety risks; and

the PM is the acceptance authority for medium and low safety risks"[2]. the USAF uses MIL-STD-882 to describes the process for classification of high and serious risks and provides further guidance on the risk acceptance requirements for individual Hazards[13] see Figure 11.

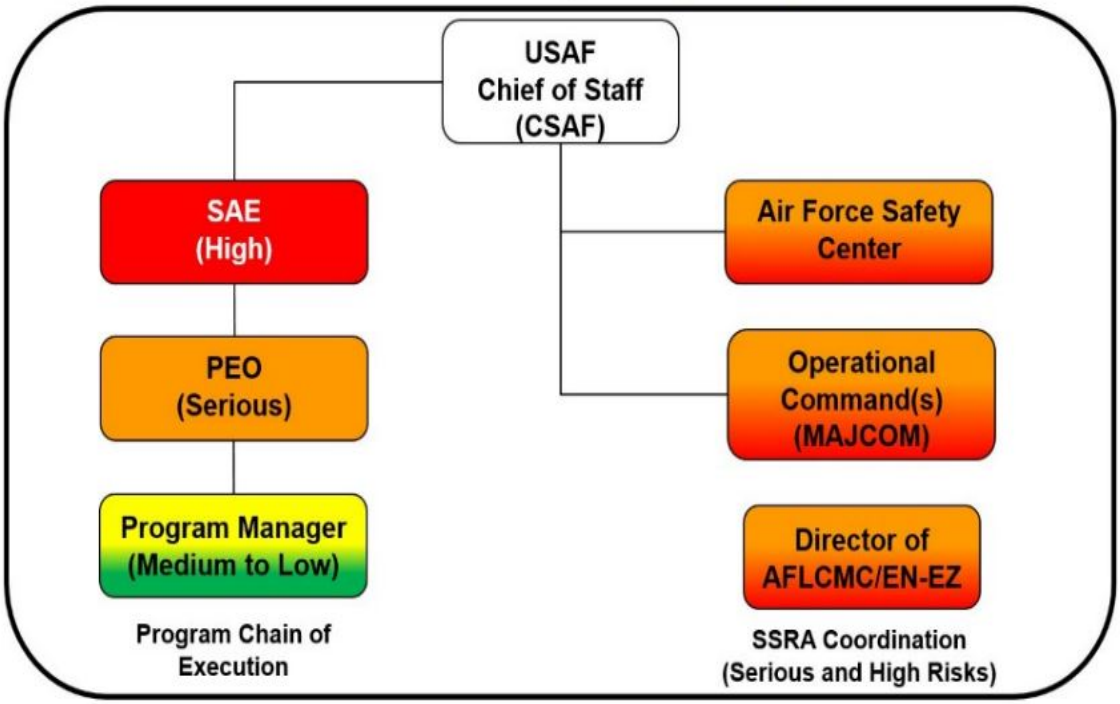

Figure 11. Risk acceptance authority (Keil, 2017)

Flight Authorization Issuance

A flight authorization is the recognition by the TAA that the technical design is safe to fly considering the documented restrictions, limitations, intended usage and accepted risks. Upon risk acceptance and documentation of appropriate limitations/restrictions, a flight authorization will be issued by the Airworthiness Authority or DTA, as appropriate. A flight authorization will only take one of two forms: Military Type Certificate (MTC see Appendix 2) or Military Flight Release (MFR see Appendix 3). The MTC approves a production type design for the intended usage and

Service Life Limits and the design was determined to be significantly compliant with MIL-HDBK-516B Expanded with any residual risk acceptance by the appropriate authorities. A MFR is an approval to fly a design configuration for a defined period of time that may not meet the full standards and or intent of the MTC as shown in Table 1. For example an MFR would be issued for flight test, temporarily modified aircraft, aircraft which are outside of their type design or systems which have a significant level of non-compliance with MIL-HDBK-516B Expanded, and/or the associated risks are generally High/Serious requiring future mitigation. A flight authorization with the lowest reasonable level of risk is the ultimate goal. The issuance of the final MTC/MFR for operational use is required before the Full Rate Production decision. The AF special flight release process is based on an assessment of overall system risk in the planned operating environment and risk handling to acceptable levels primarily through imposition of special operating limits/restrictions and procedures. A special flight release permits air system operations for a finite duration under limited operating circumstances in fulfillment of specific military missions at specified locations. According to the USAF roles and regulations the USAF passenger carrying aircrafts are not allowed to fly under special flight release[11].

Table 1. Flight Authorization Types (AWB-1009, 2016)

Flight Authorization Type	Operations/ Flight test	Certification Basis	Authorization Risk Level	Process/product
MTC	Operations	MIL-HDBK 516	Low Medium Serious	Certification Basis Compliance Report Risk Assessment Substantiating Data
MTC		Per FAA,US Army, US Navy (MIL-HDBK 516 for any difference)		Per Approved Process Certification Basis Compliance Report Risk Assessment Substantiating Data as Required
MFR	Operations	MIL-HDBK 516	Serious High	Certification Basis Compliance Report Risk Assessment Substantiating Data
		Per FAA,US Army, US Navy (MIL-HDBK 516 for any difference)		Per Approved Process Certification Basis Compliance Report Risk Assessment Substantiating Data as Required
MFR	Flight Test	MIL-HDBK 516	Low Medium Serious High	Certification Basis Compliance Report Risk Assessment Substantiating Data
		Per FAA,US Army, US Navy (MIL-HDBK 516 for any difference)		Per Approved Process Certification Basis Compliance Report Risk Assessment Substantiating Data as Required

2.7 Exemptions and Waivers

In conjunction with issuance of an MTC, the TAA or DTA may issue a permanent exemption to an applicable airworthiness certification criterion if the PM provides adequate substantiation and risk acceptance documentation. If the TAA cannot ap-

prove an exemption request and issue an MTC, the PM can request a temporary waiver to the airworthiness criterion to allow limited aircraft operations until a permanent solution can be completed. For none-reportable modifications, authority to approve exemptions and waivers is delegated to CE/DTA. "For each non-compliant criterion, the PM must provide the following data: reason for non-compliance; hazard associated with the non-compliance, hazard risk assessment; risk mitigation and/or closure plans; and proposed restrictions or operating limitations"[12].

2.8 Product Acceptance Process

Programs are required to implement a formal product acceptance process to ensure that individual aircraft are built and delivered in accordance with the approved engineering baseline and the MTC. The TAA may conduct audits according to AFI 62-601 to verify program adherence to acceptance processes[4]. The product acceptance process include the Implementation of a formal configuration management process to ensure control of the product definition baseline at all levels of the supply chain, implementation of quality assurance processes at all levels of the product supply chain and use of explicit product acceptance criteria based on characteristics of the system design at all levels of the supply chain. If the CE/DTA finds that all requirements of the product acceptance process have been met at the time of delivery of each new or modified aircraft, the CE/DTA will coordinate on the acceptance documentation or it can be delegated in writing. The PM may then issue a Military Certificate of Airworthiness (MCA) for that aircraft. If the product acceptance process finds noncompliance with approved MTC, the CE/DTA may approve deviations for individual aircraft. All deviations for a particular aircraft must be approved before the PM may issue an MCA for that aircraft. The programs usually maintain a record of exemptions, waivers, and deviations approved by the CE/DTA.

2.9 Issuance of Military Certificate of Airworthiness (MCA)

Coincident with issuance of the MTC, the TAA will authorize the PM to issue MCA (see Appendix 4). The MCA are issued by the PM for individual aircraft in the type design covered by the MTC typically at acceptance of new or modified aircraft when the delivered aircraft is in compliance with the MTC and in accordance with the program product acceptance process. The MCA remains in effect for the approved service life as long as the air system configuration is in a condition for safe operation, properly maintained in accordance with approved maintenance documentation, and the system is operated in accordance with the approved flight manual and within the approved mission usage. "The TAA may rescind or restrict the PM's authority in this regard if issues with the MTC warrant such action"[10]. Table 2 and Table 3 summarize the USAF airworthiness process responsibilities of the PM, TAA, CE/DTA, and the DOE/DTA related to the products and activities during the execution of the airworthiness life cycle.

Table 2. Airworthiness Process Responsibilties-1 (AFI 62-601, 2010)

Product/Activity	**Responsibility**			
	PM	**TAA**	**Chief Engineer/ DTA**	**Wing Director of Engineering/ DTA**
Airworthiness Assessment Process Determination	Requests	Approves	Coordinates	Coordinates
Airworthiness Related Modification Determination	Requests		Approves	
Reportable/ Nonreportable Modification Determination	Requests		Recommends	Approves
Certification Basis	Requests Approval	Approves	Coordinates	CE/DTA Alternate
Final TACC/MACC (Reportable Modification)	Shows Compliance and Requests Approval	Finds Compliance and Approves	Coordinates	CE/DTA Alternate
Final MACC (Nonreportable Modification)	Shows Compliance and Requests Approval		Finds Compliance and Approves	CE/DTA Alternate
Military Experimental Flight Release (FFEIRT Required)	Shows Compliance and Requests Approval	Finds Compliance and Issues	Coordinates	Coordinates
Military Experimental Flight Release (FFEIRT Not Required)	Shows Compliance and Requests Approval		Finds Compliance and Issues	CE/DTA Alternate

Table 3. Airworthiness Process Responsibilties-2 (AFI 62-601, 2010)

Product/Activity	Responsibility			
	PM	**TAA**	**Chief Engineer/ DTA**	**Wing Director of Engineering/ DTA**
Military Type Certificate	Shows Compliance and Requests Approval	Finds Compliance and Issues	Coordinates	CE/DTA Alternate
Military Certificates of Airworthiness	Finds Compliance and Issues	Delegates	Coordinates	CE/DTA Alternate
Military Restricted Flight Release	Requests Approval	Approves & Issues	Coordinates	CE/DTA Alternate
Military Restricted Flight Release (One- Time Flight)	Requests Approval		Approves & Issues	CE/DTA Alternate
Exemption to Certification Basis (TACC, FAA FARs, Reportable MACC)	Requests Approval	Approves	Coordinates	CE/DTA Alternate
Exemption to Certification Basis (Nonreportable MACC)	Requests Approval		Approves	CE/DTA Alternate
Waiver to Certification Basis	Requests Approval	Approves	Approves	Coordinates
Waiver to MTC/Acceptance Process	Requests Approval		Approves	CE/DTA Alternate
Aircraft Acceptance	Approves or Delegates		Coordinates or Delegates	CE/DTA Alternate
Non-design-based special flight release)	Requests Approval	Approves & Issues	Coordinates	Coordinates

2.10 USAF Airworthiness Board (AB)

The USAF Airworthiness Board (AB) provides advice and recommendations to the TAA regarding the disposition of airworthiness actions requested by all air system PM. Membership of the AB consists of The TAA, or DTA, who chairs the USAF Airworthiness Board, senior engineering functional organization representatives, an Air Force Safety Center (AFSC) representative, and a representative from owning AFMC engineering organizations if requested by the TAA. The TAA may elect to include representatives from the Federal Aviation Administration (FAA) and applicable test organizations. The Wing Commander/Director and PM of the air system under consideration, an operational MAJCOM representative, and other program stakeholders may also be invited to participate as advisors. Figure 12 shows the Airworthiness Board core members.

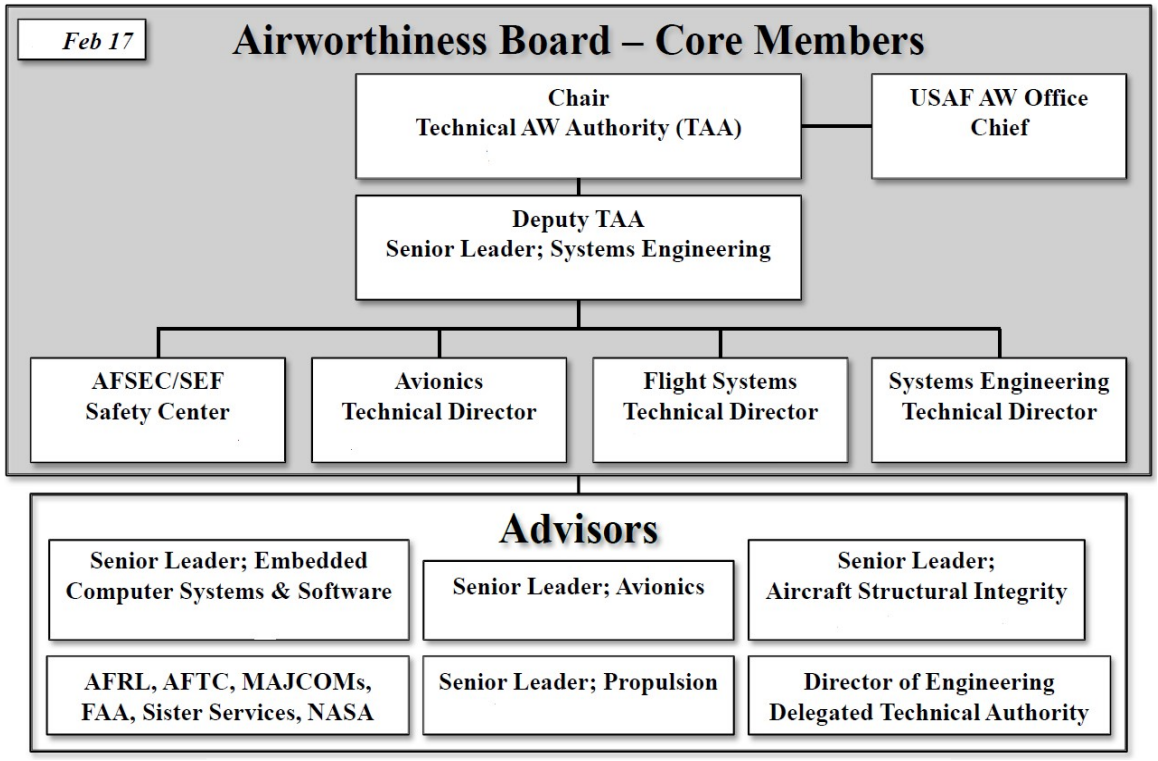

Figure 12. Airworthiness Board Members (Keil, 2017)

2.11 Operational Airworthiness

The MAJCOMs have responsibility for continued airworthiness which mean maintaining aircraft configuration control and ensuring that no unauthorized changes are made by their activities. This is accomplished by establishing Continuing Airworthiness for implementing aircrew and maintenance personnel training and evaluation requirements and by defining and adhering to approved operating procedures for each type design. If unauthorized configuration changes happen within any fleet, the MAJCOM is responsible to take appropriate action to ensure the safety of the affected aircraft and notify the PM. The PM may revoke the MCA but may reissue the certificate after the aircraft has been returned to an approved configuration.

2.12 How Does the USAF Airworthiness Process Work?

USAF airworthiness process is a responsibility of the PM where he establish, execute and maintain the airworthiness during the entire air system life cycle. It is a core task for the PM to guarantee the Operational Safety, Suitability and Effectiveness of the air system. The airworthiness of an airplane determines the flying status (GO/NO-GO), which indicates continues activities of this procedures. When there is a need to work on air system involving any airworthiness activities there are different procedures to ensure the air system is fully meeting certification type criteria. According to the certification criteria and types of modification, temporary or permanent, and according the airworthiness assessments design and none design based to ensure that either all airworthiness certification criteria has been met or there is an exception for that system. The tool used to determine the airworthiness program is mainly the ADF where it is divided into five sections to explain the steps needed to determine the airworthiness impact then the reportability determination, where if it is a reportable modification will be handled by TAA, if it is none-reportable

modification the DTA will handle the program. The process for finalizing the process is the same by TAA and DTA as long as it has an airworthiness impact then the certification criteria basis is establish using the MIL-HDBK-516C to mention what certification criteria needed to be consider then the compliance report to show how these criteria is satisfied. In case of non compliance for any risk, the risk acceptance process will explain the hazard with the frequency and severity of none compliance report and according to the level of the hazard acceptance to be accepted or not. The final step for this process is issuing MTC and MFR to show that platform meet the certification criteria for the type design. Figure 13 shows the USAF airworthiness process for new aircraft and modification to existence aircraft.

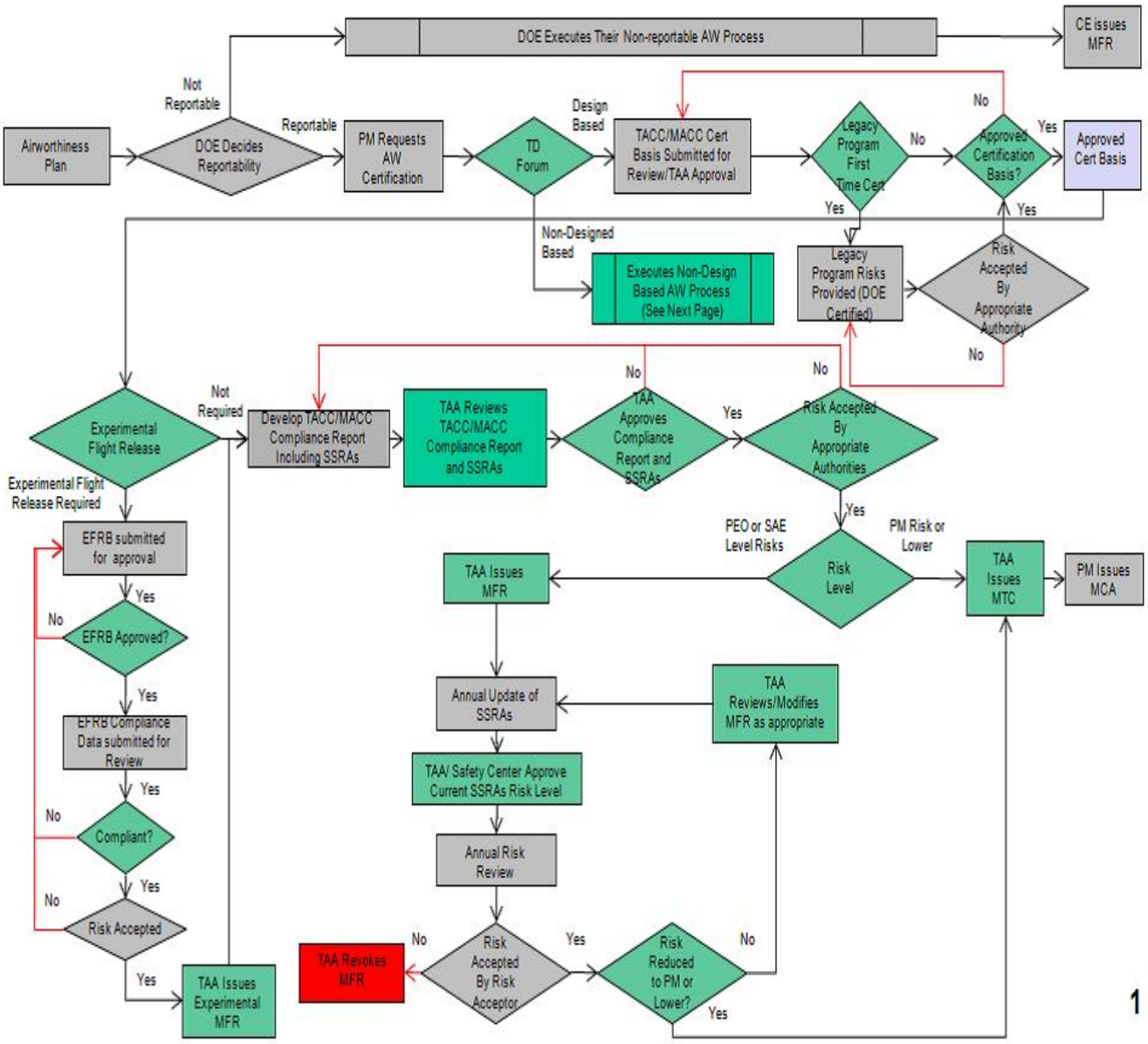

Figure 13. USAF Airworthiness process (Mueller, 2018)

2.13 RSAF Airworthiness Overview

The RSAF commander has overall responsibility for RSAF airworthiness Regulation. RSAF commander delegates airworthiness functions to Chief Air Force Operations to fulfill the role of Aircraft Operating Authority in his capacity as Officer of Prime Responsibility for the utilization of the weapon system. He is responsible for preserving airworthiness by ensuring that air platforms are operated in accordance with RSAF instructions, and Chief Air Force Logistics and Supply as Airworthiness Authority who has the responsibility for ensuring that air platforms are correctly maintained. From the safety side, the Director of Safety, reports directly to RSAF commander managing the RSAF's Safety Management Systems providing independent safety assurance and regulatory oversight. From technical point of view, the DoAE, reporting to Chief Air Force Logistics and Supply, heads an office that supplies specialist technical and engineering services throughout the RSAF[1].

The RSAF Engineering Authority Change Process is the technique used to ensure the continued airworthiness for RSAF fleet[6]. The EACP is used by a Weapon System Support Manager to embody modifications when the Design Organization Modification procedure will not meet the required time frame, or where a WSSM believes that it is more cost-effective to introduce and support an RSAF EA Change /Service Modification. Further, this process may be necessary to facilitate the introduction of change that cannot be readily supported by an industry supplier, such as Clearances with Limited Evidence and War Clearances that are perceived to be mission critical to the RSAF.

2.14 How Does the RSAF Airworthiness Process Work?

All change for a Weapon System and its associated equipment and services is managed under the authority of a Technical Change Control Board (TCCB) at which technical changes are prepared and approved. Where necessary, changes may require authority from the Directorate of Programs/Project Office and RSAF commander if there is a financial commitment that requires endorsement. Any change is instigated through the submission of RSAF Form EA 001 Weapons System Improvement Request (WSIR) to the WSSM. The WSSM will, under the authority of the TCCB, confirm whether it is an EA initiated change or a DO initiated change and provide initial approval whether or not to proceed. The WSSM will assign a unique reference number differentiating whether it is a DO or EA initiated change. The TCCB is responsible to make an informed judgment on whether or not to proceed with EA Change and the DoAE is responsible for the Management of the overall EACP. The EACP consist of four phases which include twelve forms to achieve the desired outcome as shown in Figure 14 and Figure 15. Phase one of the EACP includes the proposal, registration and preliminary investigations that will lead to a (GO/NO-GO) decision by the TCCB. If RSAF funding is required, a formal Change Request (CR) will be presented as necessary to the appropriate Project Office for their approval to proceed to full development. Phase two of the EACP, following approval to proceed by the TCCB and if further information or analysis is needed on the proposal to identify a feasible solution to meet the requirement, the EA may undertake, or task a competent organization to conduct a feasibility study.Phase three includes the initiation, development and preflight review elements of the EA Change progression. All applicable elements of this Phase are to be addressed prior to entering into the final phase. Phase four of the EACP includes the final clearance approval, embodiment and the review procedures.

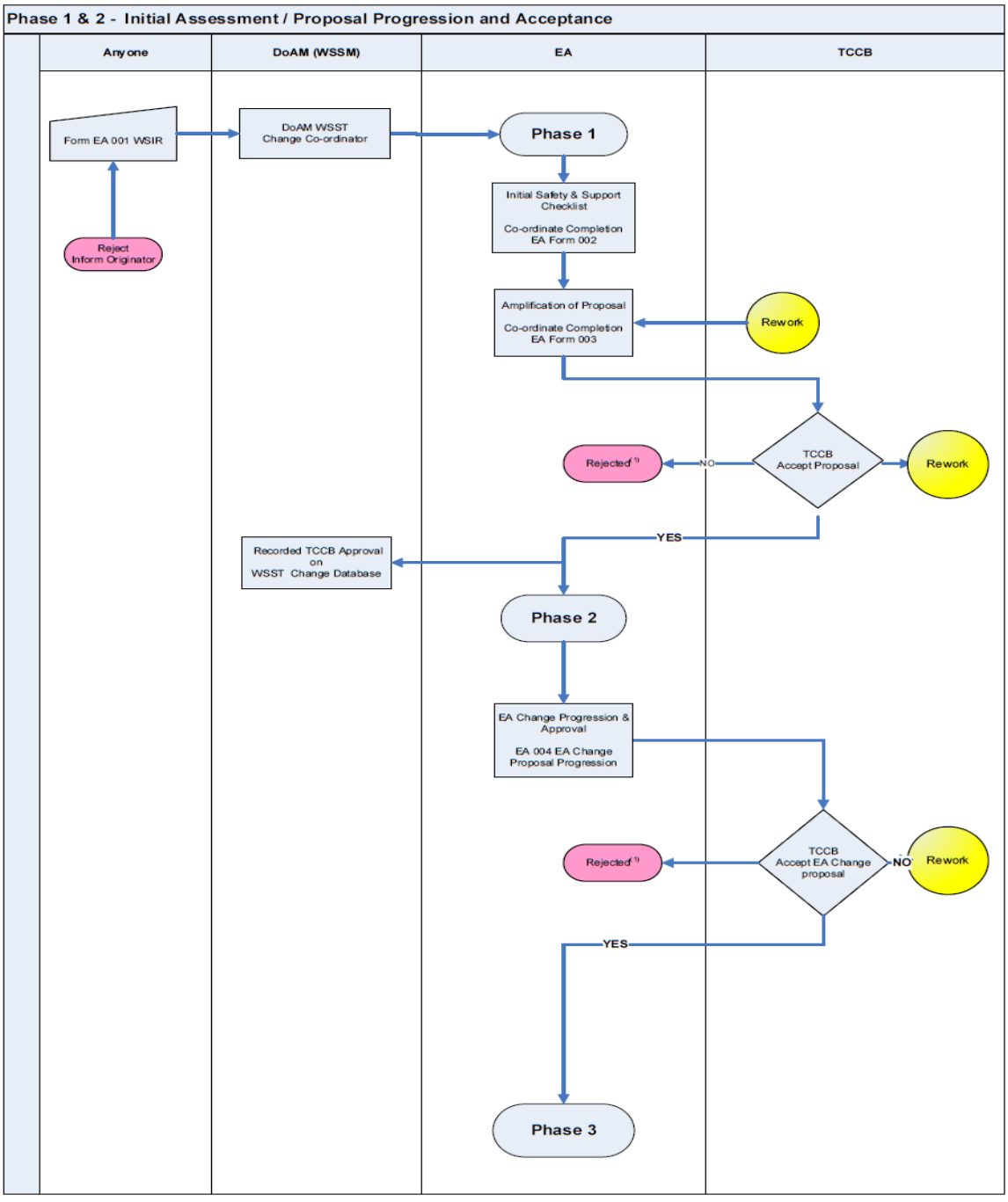

Figure 14. Engineering Authority Change Process (EACP) Flowcharts-1 (RSAF EACP, 2014)

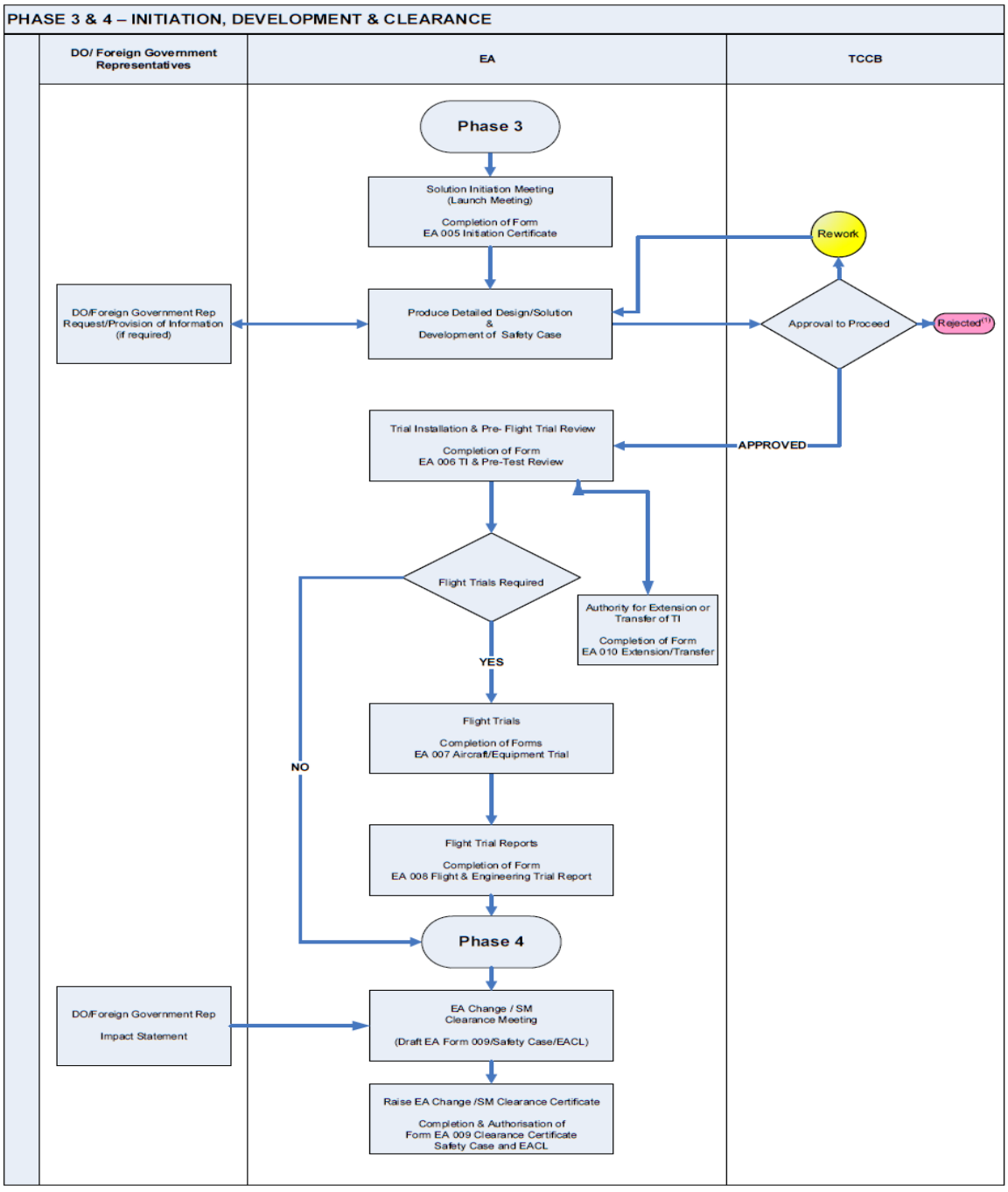

Figure 15. Engineering Authority Change Process (EACP) Flowcharts-2 (RSAF EACP, 2014)

Throughout the EACP, all approvals and clearances are to be provided by a Suitably Qualified and Experienced Person (SQEP) who holds an appropriate Letter of Delegation (LOD) or Letter of Airworthiness Authority (LOAA). The change process identifies the organization responsible for each process step and tasking of any organization required to deliver evidence or documentation to support that step. On completion of RSAF Engineering Authority tasks result will be one of the following outcomes:

1. Service Modification.
2. Clearance with Limited Evidence in the release to service.
3. Service Deviation in the release to service.
4. Operational Supplement In the Flight Manual.
5. Temporary Clearance (TC) within the RTS and War Clearance.

The DoAE will submit all of these to Chief Air Force Logistics and Supply for endorsement and forwarding to Headquarters RSAF Operations for RSAF commander final authorization.

2.15 Chapter Summary

This chapter reviewed the current USAF Airworthiness processes,organization,functions and Airworthiness tools. After that,the RSAF Airworthiness process are stated. In the following chapter, the methodology and solution technique of the problem will be discuss.

III. Methodology

3.1 Chapter Overview

This chapter explains the research methodology, the problem statement, research questions and the importance of this thesis. In order to improve the performance of the RSAF airworthiness enterprise it is first important to define the problem. Through a qualitative study, this research will suggest the general problem, frame it with questions, and utilize previous RSAF / USAF studies, data, and interviews to identify enterprise level problems, recommend actions, and suggest additional research. The expected outcome will support the RSAF continuous process improvement objectives for airworthiness planning, execution and operational readiness.

3.2 Research Objectives and Research Questions

Saudi Arabia's Vision for the future 2030 is aiming to expand the diversity of the economy and transform Saudi Arabia to an industrial country in all fields. The aviation industry is one of the most important fields where this vision will apply. It is the first step for such transformation in aviation in particular, and military in general, to know how the other leading countries are working on such programs. RSAF diversity of requirements and capabilities is one of the most important part of this process to achieve the goals of Vision 2030, and the concentration of the Kingdom's orientation towards a strong and effective strategy to localize major industries. That include the aviation industry to improve the manufacturing capabilities in the Kingdom of Saudi Arabia to be amongst developed countries.

Prince Mohammad bin Salman, Crown Prince, Minister of Defense and Chairman of the Public Investment Fund said: "While the kingdom is one of the world's top five spenders on security and defense overall, only around two percent of our mili-

tary procurement is domestic"[17]. His Royal Highness emphasized that the aviation industry will be a major contributor in achieving the goals set out in Vision 2030, which states that at least 50% of Saudi Arabia's military procurement spending will be localized. For more understanding about this research and the following chapters of the analysis and conclusion, the military aviation manufacturing activities that will take place in KSA soon need to be under an airworthiness authority to ensure the best engineering practices to develop, assemble and manufacture air system are available. In order to perform any in kingdom military aviation manufacturing activities, different set of questions arise, to evaluate RSAF airworthiness a comparison with USAF airworthiness will take place in the following area:

1. The airworthiness organization structure.
2. The planning and execution of the airworthiness.
3. The product of the airworthiness process.

These three criteria involve the main elements needed to establish and execute airworthiness processes. The researcher will investigate in detail what are the differences and commonality between RSAF and USAF In organization, responsibilities, execution, flight authorization and relationships with external organizations.

The following are the research questions that need to be answered by the end of this research

Q1: What airworthiness processes does the RSAF currently use?

Q2: What airworthiness processes does the USAF currently use?

Q3: What are the similarities and differences between RSAF and USAF in the airworthiness aspects including initial airworthiness, continued airworthiness, counting airworthiness, processes, organizational structures, and products of the airworthiness processes?

3.3 Methodology

The purpose of this study is to capture the activity undertaken by the USAF airworthiness organization who is responsible for issuing the flight authorization for USAF aircrafts and to find the similarity and differences with RSAF in this regard. Following are the steps done by the researcher to complete this research.

Data Gathered

The researcher reviewed different documents to collect the data and information presented in this research including the DoD directives, the USAF/RSAF policies, directives, instructions, and the airworthiness publications. The researcher interviewed the Director of DoAE/HQ RSAF, RSAF SME, USAF SME, and attended the Advanced Airworthiness Certificate Course.

A meeting was held with Maj. Gen. Abdulaziz Alzaidi (Director of DoAE/HQ RSAF) to explain the objective of this research and the desired result in supporting the Saudi Vision 2030, and how airworthiness process can be implemented within RSAF. Maj. Gen. Alzaidi mentioned that the current RSAF airworthiness process is carried out in accordance with origin equipment manufacture (OEM) manuals and RSAF instruction to ensure that the continued and continuing airworthiness of the air platforms. The initial airworthiness process is carried out in accordance to the contracted government to ensure the airworthiness of the air system before delivery to the RSAF. He mentioned the RSAF initiative to develop and establish an independent TAA within the RSAF to be internationally recognized and to support the best engineering practices to ensure airworthiness processes are in place to aid in issuing different types of flight authorization.

The meeting was held with Mr. Suhail (SME from DoAE/HQ RSAF) to understand the current RSAF Regulatory Framework for Logistics (RFL) adopted to

perform common technical requirements and logistic administrative procedures to ensure the continuing airworthiness of aeronautical products, parts and appliances subject to the RFL, which aligns RSAF military airworthiness regulation with that used within other air forces and civil aviation. Figure 16 shows the regulatory organization of the RSAF. The European Aviation Safety Agency (EASA) model for continuing airworthiness has been selected, which has been determined as meeting or exceeding most other international standards. In adopting the EASA model, RSAF logistics therefore embraces a growing trend amongst other world-leading air forces to be as civil as possible and as military as necessary.

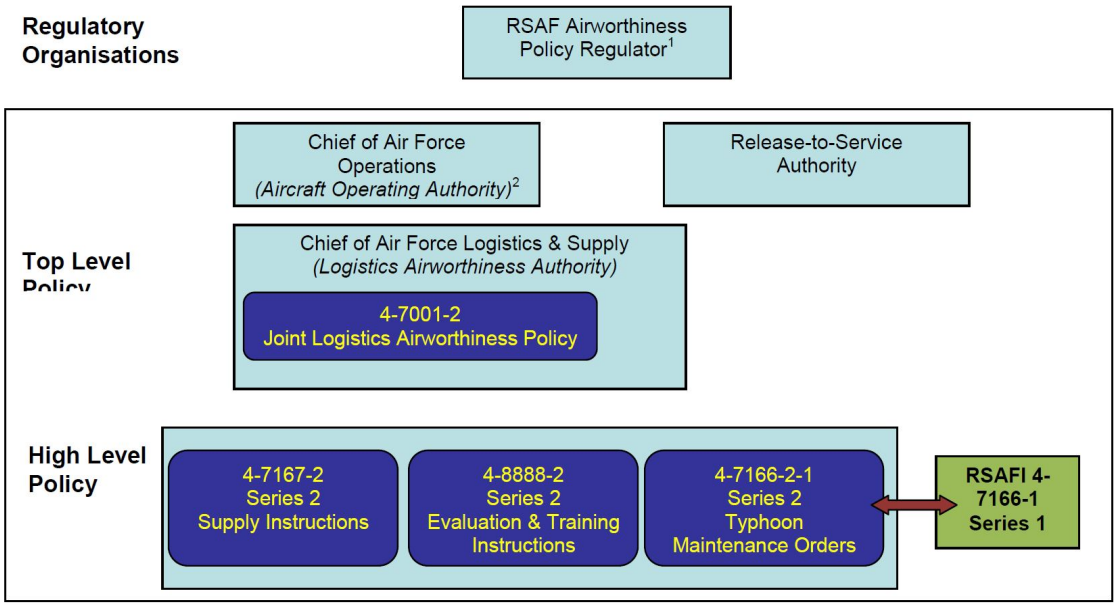

Figure 16. RSAF regulatory organization (RSAFI 4-7001-2, 2015)

RSAF Commander assumes responsibility of Airworthiness Policy Regulator by virtue of his rank and appointment; he may choose to delegate this authority to an appropriately qualified and empowered officer. He discharges his responsibilities through the appointment of Divisional Chiefs. Chief of Air Force Operations (CAF Ops) fulfills the role of Aircraft Operating Authority (AOA) in his capacity as Officer of Prime Responsibility for the utilization of the weapon system, being responsible

for preserving airworthiness by ensuring that air platforms are operated in accordance with RSAF instructions. The responsibility for ensuring that air platforms are correctly maintained is vested in (CAFL&S) as Airworthiness Authority.

Mr. Suhail explained in details how the Engineering Authority Change Process (EACP) works to embody modifications when the DO Modification procedure will not meet the required time frame, or where a WSSM believes that it is more cost-effective to introduce and support an RSAF EA Change /Service Modification. This process may be necessary to facilitate the introduction of change that cannot be readily supported by an industry supplier, such as Clearances with Limited Evidence and War Clearances that are perceived to be mission critical to the RSAF. Also in this meeting, the main members of the EACP are identified and how the four phases are achieved. Phase one of the EACP includes the proposal, registration and preliminary investigations that will lead to a (GO/NO-GO) decision by the TCCB. If RSAF funding is required, a formal Change Request will be presented as necessary to the appropriate Project Office for their approval to proceed to full development. Phase two of the EACP, following approval to proceed by the TCCB and if further information or analysis is needed on the proposal to identify a feasible solution to meet the requirement, the EA may undertake, or task a competent organisation to conduct a feasibility study. Phase three includes the initiation, development and pre-flight review elements of the EA Change progression. All applicable elements of this phase are to be addressed prior to entering into the final phase. Phase four of the EACP includes the final clearance approval, embodiment and the review procedures.

A meeting was held with Mr. Deken Keil (from USAF Airworthiness office in WRAFB), Lt Col Amy Cox and the researcher at AFIT. Mr. Deken Keil introduced the importance of this study and how it would help in the Recognition of the RSAF airworthiness process. He mentioned that the new plan is to have recognized air-

worthiness authorities with the US partners. Recognition agreements form the basis for approval for flight in foreign-owned aircraft by US DoD personnel as required by the DoD Airworthiness Directive. Recognition agreements can also offer an efficient means to establish an airworthiness basis for aircraft bought or leased from these countries by a US Service and as a basis for airworthiness support in FMS cases.

Mr. Deken Keil explained in details how the airworthiness process works and the tool used to achieve this process. Also in this meeting, the main members of the airworthiness process where identified and how they are empowered to make airworthiness decision. The airworthiness office provided top level airworthiness organization structure including the TAA office and the AB to support the airworthiness activities, and how they are related to other functions within the USAF to delegate authority, and assess the airworthiness.

The researcher attended the Advanced Airworthiness Certificate Course (SYS-316) at AFIT[20]. The course provide the researcher with the knowledge to properly assess a new weapon system's airworthiness; a weapon system modification, its impact to airworthiness, reportability determinations, and assess the technical interrelationships of MIL-HDBK-516 to develop the certification basis and compliance report. During the course a real example were used, case studies and exercises based on actual experiences with USAF weapon system were featured to allow the students understand how the process work and develop the skills required to support the airworthiness certification process.

The course explained in detail how the airworthiness process works and the tool used to achieve this process. In this course the relationship between the TAA and DTA were explained in details to identify different tasks and section within of MIL-HDBK-516 to develop the certification basis. It was Explained that the CE/DTA determine the airworthiness impact and makes recommendation about reportability

to DOE/DTA for approval based on a risk assessment of the potential safety hazard risk. If the risk exceeds established threshold value, modification is classified as reportable; otherwise it is none-reportable.

Data Analysis

the researcher utilized an assessment to compare between USAF and RSAF airworthiness precesses including initial, continued, and continuing airworthiness to capture the main differences and commonality between both processes. This technique focus on organizational structure, planning, execution, and the final products of the airworthiness process including MTC and MFR.

3.4 Chapter Summary

In this chapter, the research objectives and questions introduced in detail. After that, the research methodology is explained. In next chapter, analysis and result of the study will be explained.

IV. Analysis

4.1 Chapter Overview

This chapter will contribute to a better understanding of how the RSAF Airworthiness Authority works in conjunction with USAF Airworthiness Authority. The researcher will investigate in detail what are the differences and commonality between RSAF and USAF In the airworthiness aspect initial, continued, and continuing airworthiness for their aircrafts including organization, responsibilities, execution, flight authorization and relationships with external organizations. The researcher also interviewed Airworthiness SMEs from RSAF and USAF, and received useful information that contributed to this study.

4.2 Initial Airworthiness

The primary assumption of air safety goal is that the military organization have a single, overarching Airworthiness Authority, responsible for assuring initial, continued, and continuing airworthiness for their aircrafts. The USAF designate Air Force Material Command (AFMC/CC) as USAF Airworthiness Authority(AA) who is responsible to establish and implement DoD airworthiness requirement. The USAF AA delegate technical authority to TAA who is independent of the Program chain of execution and the Major Commands that operate the aircraft. The USAF TAA delegate technical authority to Directors of Engineering and Chief Engineers that the USAF TAA places in the Program Offices in order to effectively manage airworthiness workload.

The initial Airworthiness assessments for new aircraft and major or complex modifications to existing aircraft are assessed for airworthiness by TAA. The CE/DTA is responsible for completing an Airworthiness Determination Form recommending his

determination of airworthiness impact and reportability of the changes and submitting the recommendation to the DOE/DTA for approval. The USAF TAA establishes and approves certification bases for new aircraft types and for existing aircraft types undergoing major reportable modifications using MIL-HDBK-516 *"Airworthiness Certification Criteria"*as the primary source of airworthiness certification criteria to develop airworthiness certification basis. The standards to which compliance must be shown and the associated method of compliance are accepted through establishment approval of the airworthiness certification basis. Tailoring of the standard or method of compliance associated with each criterion in the airworthiness certification basis is allowed, when the Program Manager can demonstrate the USAF TAA or DTA's satisfaction that an equivalent level of safety can be maintained if the design were shown to comply with the tailored standard or compliance to the standard was demonstrated through a different method. The airworthiness subject matter experts accredited by the USAF TAA that reside in the Engineering and Technical Management/Services Directorate conduct the actual evaluations, document their findings in the Compliance Report, and make recommendations to the USAF TAA at the USAF Airworthiness Board.

The product of the initial airworthiness is the flight authorization including MFR and MTC. In order to authorize aircraft types to perform flight test and to authorize aircraft types with Serious or High risks associated with non-compliances to their airworthiness certification basis to perform operational flights. The USAF TAA issues Military Flight Releases. Issuance of MFR occurs after all airworthiness risks associated with non-compliance to the airworthiness certification basis have been accepted by Program Management at the appropriate level. For new aircraft types and existing aircraft types undergoing major reportable modifications at the system level. The USAF TAA issues Military Type Certificates. The USAF TAA does not issue MTC or

design certificates for sub system including Engines, propellers, parts or appliances. The CE/DTA is responsible to ensure the requirements of the product acceptance process have been satisfied at the time of delivery of each new or modified aircraft and coordinates on the acceptance documentation so that the Program Manager may then issue an MCA for that aircraft. Minor aircraft modifications are delegated to the DTA for airworthiness assessment and issuance of flight authorizations.

MCA are only issued for USAF operational aircraft. However, the USAF production oversight for newly produced aircraft or newly modified existing aircraft remains the same unless the Letter of Offer and Acceptance (LOA) requires something different. Typically, when the standard terms and conditions clause is applied in an LOA, it can be expected that USAF will accomplish the same production oversight for a partner nation aircraft as it would for its own. The TAA authorizes Program Managers to issue MCA for new or modified operational aircraft when the aircraft conforms to the design associated with the MFR or MTC and is in a condition for safe operation. The MCA remains valid as long as the accompanying MFR or MTC remains valid, the aircraft configuration matches the configuration associated with the accompanying MFR or MTC, and aircraft remains in a condition for safe operation.

On the other hand, the RSAF Chief of Air Force Operations fulfills the role of Aircraft Operating Authority in his capacity as Officer of Prime Responsibility for the utilization of the weapon system, being responsible for preserving airworthiness by ensuring that air platforms are operated in accordance with RSAF instructions. The responsibility for ensuring that air platforms are correctly maintained is vested in CAFL& S as Airworthiness Authority. The procurement of new aircraft, equipment and systems for the RSAF is generally by means of collaborative projects with foreign countries. The arrangements for such projects are negotiated both between the Governments of the participating nations, and the contractors of the participating

countries. The airworthiness terms are usually laid down in a Statement of Work (SoW) to ensure that it's the responsibility of the contracted government. Any variations in airworthiness procedure and standards are to be clearly documented in the SoW. Usually the airworthiness process to be followed by the contracted government on RSAF aircrafts is the same production oversight for the partner nation aircraft. Before delivery of aircrafts, The RSAF HQ implement a formal product acceptance process to ensure that individual aircraft are built and delivered in accordance with the approved engineering baseline and design certificate.

4.3 Continuing Airworthiness

The continuing airworthiness is to maintain airworthiness configurations during the operation of the aircraft and it is the responsibility of the Major Commands that operate the aircraft and the Program Managers. Their Operational Safety, Suitability, and Effectiveness role is responsible to ensure that all of the necessary products and processes are in place to assure continuing airworthiness. The USAF TAA does not have authority for continuing airworthiness or transmit information necessary for continuing airworthiness and safe operation of specific aircraft types. This type of data belongs to the Program Office for that aircraft type, and transmittal of this data to other authorities that have the aircraft type on their registers is the responsibility of the Program Office in accordance with the Letter of Offer and Acceptance between the US government and the country acquiring that aircraft type through the Foreign Military Sales case.

On the other hand, within RSAF CAF Ops is responsible for preserving airworthiness by ensuring that air platforms are operated in accordance with approved flight manuals and RSAF instructions. The responsibility for ensuring that aircrafts are correctly maintained is vested in CAFL&S as Airworthiness Authority. Therefore,

RSAF CAFL&S requires Logistic Directors to develop policies and set standards for the maintenance of aircraft, components and equipment and the management of the continuing airworthiness of aircraft that are consistent with internationally accepted standards for these activities. Sometime these activities are delegated to a contractor for service provision to ensure that airworthiness management of the type design and the in-service air systems remain compliant.

4.4 Continued Airworthiness

The continued airworthiness exist when there is need to implement new airworthiness configuration criteria or modifications to the aircraft. The Operational Command is responsible to maintain and operate the aircraft in an airworthy manner in accordance with USAF instructions. The USAF Program Manager and CE/DTA are responsible to assure continued Operational Safety, Suitability, and Effectiveness of their managed configurations. The CE/DTA is responsible for completing an Airworthiness Determination Form recommending his determination of airworthiness impact and reportability of the changes and submitting the recommendation to the DOE/DTA for approval They receive technical data from their aircraft prime contractors and review these information to assess impacts on airworthiness of their managed configurations and implement corrective actions as necessary. For any modification type within the USAF, TAA or DTA follow the initial airworthiness process and criteria using the MIL-HDBK-516 with the compliance report to ensure that the system is airworthy.

On the other hand within RSAF, the modification of an existing aircraft it is to follow one of the two options The Design Organization Modification procedure route where the Design Organization is fully responsible to execute the modification and ensure that no variation in the airworthiness process. the second option is to imple-

ment RSAF EACP to change the design of their aircraft or equipment in preference to the Design Organization Modification route. The DoAE is responsible to assure continued Operational Safety, Suitability, and Effectiveness of their modified aircraft by following the EACP criteria and TCCB directions.

4.5 Results

This thesis has analyzed and defined the differences of airworthiness process in RSAF in conjunction with USAF airworthiness. The findings of this study suggest the desirability for RSAF to develop TAA and fully participate in the initial airworthiness, which will improve the RSAF airworthiness process and be internationally recognized. This study used a comparison technique to explore the main airworthiness aspects including initial, continued, and continuing airworthiness of air system. This technique made it possible to discover areas of differences between RSAF and USAF while both achieving the ultimate goal of the three aspect of airworthiness with different techniques and organizational structures.

A summary of the result indicating that the main difference between RSAF and USAF in organizational structure is the existence of the TAA and DTA in the USAF, whereas in the current RSAF organizational structure the TAA and DTA do not exist. As consequence, some of the products of these organizations are missing in the RSAF.

Developing TAA and DTA within the RSAF can be achieved according to the need, requirements, and the available resources to be able to participate in the initial airworthiness and issue all different types of flight authorization including MTC, MFR, and MCA. Table 4 Summarizes the similarities and differences between the RSAF and USAF.

Table 4. Summary of RSAF and USAF comparison

Product/Activity	**USAF**	**RSAF**
Airworthiness Authority (AA)	Yes	Yes
Initial Airworthiness	Yes	Yes
Continued Airworthiness	Yes	Yes
Continuing Airworthiness	Yes	Yes
Technical Airworthiness Authority (TAA)	Yes	No
Delegated Technical Airworthiness Authority (DTA)	Yes	No
Military Type Certificate (MTC)	Yes	No
Military Certificates of Airworthiness (MCA)	Yes	No
Military Restricted Flight Release (MRFR)	Yes	Yes
Military Restricted Flight Release (One- Time Flight)	Yes	Yes
Exemption to Certification Basis (TACC, FAA FARs, Reportable MACC)	Yes	No
Exemption to Certification Basis (Nonreportable MACC)	Yes	No
Waiver to Certification Basis	Yes	No
Waiver to MTC/Acceptance Process	Yes	Yes
Aircraft Acceptance	Yes	Yes
Non-design-based special flight release	Yes	Yes
Airworthiness Assessment Process Determination	Yes	No
Airworthiness Related Modification Determination	Yes	No
Reportable/ Nonreportable Modification Determination	Yes	No
Certification Basis	Yes	No
Final TACC/MACC	Yes	No
Military Experimental Flight Release (MERF)	Yes	Yes

4.6 Chapter Summary

In this chapter, the research explain in detail the commonality and difference between RSAF and USAF airworthiness including initial, continued, and continuing airworthiness for their aircrafts to capture what the RSAF need to issue different types of flight authorization for their fleet. the research focus on the organizational structure, responsibilities, execution, and flight authorization . In next chapter,the conclusion of this case study will be explained.

V. Conclusions

5.1 Chapter Overview

This chapter summarizes results and recommendations discovered while completing the analysis and evaluation of the current RSAF Airworthiness in conjunction with USAF Airworthiness. Also, recommendations for future studies on military Airworthiness is introduced.

5.2 Conclusions

This thesis has analyzed and defined the differences of airworthiness process in RSAF in conjunction with USAF airworthiness. The findings of this study suggest ways for RSAF to develop TAA and fully participate in the initial airworthiness, which will improve the RSAF airworthiness process and to be internationally recognized. This study used a comparison technique to explore the main airworthiness aspects including initial, continued, and continuing airworthiness of air system. This technique made it possible to discover areas of differences between RSAF and USAF while both achieving the ultimate goal of the three aspect of airworthiness with different techniques and organizational structures. While gathering information for the thesis, it became clear that relationships, communication between the RSAS Headquarters, DoAE, and the USAF airworthiness office can be improved. Communication, or "flow of information," is missing in initial Airworthiness, where the criteria, standards and compliance report for achieving the initial airworthiness can be used by the RSAF to issue flight release and certifications for their aircrafts under FMS cases. Auditing the airworthiness organizations from both RSAF and USAF can help to identify the gaps in the process and describe the application of legislation for achieving the airworthiness. The RSAF can utilize the available resources to establish and develop an

independent airworthiness organization that is able to oversee and ensure the airworthiness process, issue flight release and certifications for their aircrafts under different types of contracts.

5.3 Significance of the Research

This thesis is the first attempt to perform detailed analyses of RSAF airworthiness, which lead to the next essential step in improving the airworthiness organization. The RSAF and U.S. government program office working toward achieving all interaction with aircraft and aviation systems are correctly over sighted to assure safety of aircraft, personal and territory.

RSAF is one of the Ministry of Defense branches participating to achieve the Saudi future vision 2030, one of the most important goals for the Saudi future vision states that at least 50% of Saudi Arabia's military procurement spending will be localized by 2030. The initiative of the RSAF Headquarter's Chief of logistic and Supply is to have an independent airworthiness organization that is able to oversee all activities related to the airworthiness to ensure initial, continued, and continuing airworthiness of air system and able issue flight release and certifications for RSAF aircrafts under different types of contracts including in kingdom military aviation manufacturing activities.

This research presents the main differences and commonality between RSAF and USAF in the airworthiness aspects. The current RSAF airworthiness process ensure that initial, continued, and continuing airworthiness of air system is carried out according to the available technical data from the Origin Equipment Manufacturer and RSAF instructions. The existence of independent Airworthiness authority will help the RSAF to conduct an overproduction sight according to the criteria and standards of MIL-BK-516 used by the USAF to minimize risks and hazards. The Airworthiness

assurance of any military air system produced in kingdom of Saudi Arabia to achieve the future vision 2030 will be under the responsibility of an independent airworthiness authority. Enhancing relationships between members of the airworthiness process, as well as using new communication, and auditing system presents the greatest opportunities to improve the airworthiness process and reach to a recognition of airworthiness authorities in both countries.

5.4 Research Limitations

The author view do not reflect the official policy or position of the Royal Saudi Air Force, Ministry of Defense, or the Saudi Arabian Government. This study is only a theoretical study. It has not yet been applied to the Royal Saudi Air Force.

5.5 Recommendation for Future Research

It is recommended that RSAF Headquarter Chief of logistic and Supply sponsor further research to expand the comparison with other international military airworthiness authorities. Further studies in military airworthiness might investigate the establishment and development of TAA in the RSAF. Also, a complete evaluation and audit using Military Authorities Recognition Question set (MARQ) may be utilized if analysis are to be properly compared.

The future studies could support the RSAF to establish airworthiness authority that is internationally recognized and able to meet the primary goal of the airworthiness under the RSAF responsibility by utilizing the available resources.

5.6 Summary

This research analyzed the current RSAF airworthiness process to compare it with the USAF Airworthiness. The main differences in the airworthiness aspects including

initial, continued, and continuing airworthiness of air system were identified. The differences in the organizational structure between RSAF and USAF did not limit them from achieving the airworthiness aspects. Within the USAF, the initial airworthiness assessment for new aircraft or reportable modification is the responsibility of TAA to be carried out in accordance with MIL-BK-516 criteria and standards.

On the other hand, the RSAF ensure the initial airworthiness of air system in the contract to be the responsibility of the contracted government. The initial airworthiness for RSAF aircraft under FMS cases to be carried according to the USAF airworthiness process.

RSAF and USAF managers of the airworthiness process are recommended to establish a communication methods and work together to recognize both airworthiness authorities and continue ongoing initiatives of process improvement.

Appendix A. Airworthiness Determination Form (ADF)

1. Project Information.

This form is intended to be filled out electronically and converted to .pdf format. The Word document should be pre coordinated by the signatories before the conversion. Signatures can be added to the .pdf document electronically.

1.1 Date: **Date of Recommendation**

1.2 Prepared By:

1.3 Platform:

1.4 Project Title:

1.5 Requirement: *Cite document driving the change (e.g., UON, ORD, CDD/CPD, AF1067, ECP, LOA or OFP/SW change list)*

1.6 Modification Description *(Applicant should use as much space as needed)*:

2. Airworthiness Impact Assessment.

2.1 Airworthiness impact questions (AWB-007):

A positive response is a good indicator of an Airworthiness impact but is not the final decision.

Yes/No

Y/N	1) Does the approved certification basis (applicable criterion, standards and methods of compliance) need to be updated (*refer to Section 3.1*)?
Y/N	2) Is re-accomplishment of verification activities required to show compliance to the certification basis?
Y/N	3) Have any existing safety hazards been impacted or have new safety hazards been identified?
Y/N	4) Are any safety-/flight-critical items, logic and/or functions impacted?
Y/N	5) Is analysis/test/simulation/demonstration required to assess the change?
Y/N	6) Is formal flight test required?
Y/N	7) Does the operational usage change?
Y/N	8) Does the flight envelope change?
Y/N	9) Does the service life change?
Y/N	10) Does this require a new Mission Design Series (MDS)?

2.2 Does this modification impact airworthiness?

The final impact assessment is a judgment made by the CE/DTA with DOE/DTA oversight.

Y/N

2.3 If there is a "No Impact" determination and a positive response to one of the above questions; provide rationale for decision below.

If "No Impact" the CE must sign Section 5 which makes this form complete and no other signatures are required. This form must then be forwarded to the DOE for record.

If "Yes Impact" leave this area blank and continue with Section 3.

3. Reportability Determination.

Reportability Determination is explained in AWB-007.

3.1 Modification Assessment Matrix:

Col. 2 – *Identify MIL-HDBK-516C sections that will be impacted with modification.*
Col. 3 – *Provide brief description of change that affects criteria within MIL-HDBK-516C.*
Col. 4 - *Identify credible hazards for each section which will be rolled up into one AW Hazard Index (AWHI).*
Col. 5 - *Identify one AW Hazard Index (AWHI) associated with summation of hazards for section as defined in AWB-013.*
Col. 6 - *Identify the name of person making hazard recommendation, per Function.*

Col. 2	Col. 3	Col. 4	Col. 5	Col. 6
Impacted MIL-HDBK-516 Sections	**Description of Impact to MIL-HDBK-516 Criteria**	**Summation of Credible Hazard(s) for Section**	**AWHI**	**Name Subject Matter Reviewer**
4 - Systems Engineering 4.1 ☐ Design criteria 4.2 ☐ Tools and databases 4.3 ☐ Materials selection 4.4 ☐ Manufacturing and quality 4.5 ☐ Op. & maint. manuals/TOs 4.6 ☐ Configuration management				
5 - Structures 5.1 ☐ Loads 5.2 ☐ Structural dynamics 5.3 ☐ Strength 5.4 ☐ Damage tolerance and durability (fatigue) 5.5 ☐ Mass properties 5.6 ☐ Flight release 5.7 ☐ Force Management				

Col. 2	Col. 3	Col. 4	Col. 5	Col. 6
Impacted MIL-HDBK-516 Sections	**Description of Impact to MIL-HDBK-516 Criteria**	**Summation of Credible Hazard(s) for Section**	**AWHI**	**Name Subject Matter Reviewer**
6 - Flight Technology 6.1 ☐ Flying qualities 6.2 ☐ Vehicle control functions 6.3 ☐ Air vehicle aerodynamics and performance				
7 - Propulsion 7.1 ☐ Propulsion risk management 7.2 ☐ Gas turbine engine applications 7.3 ☐ Alternate propulsion systems				
8 - AV Subsystems 8.1 ☐ Hydraulic/pneumatic systems 8.2 ☐ Environmental control system 8.3 ☐ Fuel system 8.4 ☐ Fire and hazard protection 8.5 ☐ Landing gear and deceleration systems 8.6 ☐ Auxiliary/emergency power system(s) 8.7 ☐ Aerial refueling 8.8 ☐ Mechanisms 8.9 ☐ External cargo hook systems (rotary wing) 8.10 ☐ External rescue hoist (rotary wing) 8.11 ☐ Fast rope insertion/extraction systems (FRIES) (rotary wing)				

Col. 2	Col. 3	Col. 4	Col. 5	Col. 6
Impacted MIL-HDBK-516 Sections	**Description of Impact to MIL-HDBK-516 Criteria**	**Summation of Credible Hazard(s) for Section**	**AWHI**	**Name Subject Matter Reviewer**
9 - Crew Systems 9.1 ☐ Escape and egress system 9.2 ☐ Crew/control stations & a/c interiors 9.3 ☐ Air vehicle lighting 9.4 ☐ Human performance 9.5 ☐ Life support systems 9.6 ☐ Transparency integration 9.7 ☐ Crash survivability 9.8 ☐ Lavatories, galleys, and areas not continuously occupied				
10 - Diagnostic Systems 10.1 ☐ Failure modes 10.2 ☐ Operation				
11 – Avionics 11.1 ☐ Avionics architecture 11.2 ☐ Avionics subsystems 11.3 ☐ Air vehicle avionics				
12 - Electrical Systems 12.1 ☐ Electric power generation sys 12.2 ☐ Electrical wiring/power distr.				
13 - EMI/EMC 13.1 ☐ Component/subsystem E^3 qual 13.2 ☐ System-level E^3 qual				
14 – System Safety 14.1 ☐ System safety program 14.2 ☐ Safety design requirements 14.3 ☐ Software safety program				

Col. 2	Col. 3	Col. 4	Col. 5	Col. 6
Impacted MIL-HDBK-516 Sections	**Description of Impact to MIL-HDBK-516 Criteria**	**Summation of Credible Hazard(s) for Section**	**AWHI**	**Name Subject Matter Reviewer**
15 – Computer Resources 15.1 ☐ System processing architecture 15.2 ☐ Design and functional integration 15.3 ☐ Processing hardware/electronics 15.4 ☐ Software development processes 15.5 ☐ Software architecture/design 15.6 ☐ Software qualification/install				
16 - Maintenance 16.1 ☐ Maintenance manuals/checklists 16.2 ☐ Inspection requirements				
17 - Armament/ Stores Integration 17.1 ☐ Gun/rocket integration and interface 17.2 ☐ Stores integration 17.3 ☐ Laser integration 17.4 ☐ Safety interlocks				
18 - Passenger Safety 18.1 ☐ Survivability of passengers 18.2 ☐ Fire resistance 18.3 ☐ Physiology requirements of occupants				

Col. 2	Col. 3	Col. 4	Col. 5	Col. 6
Impacted MIL-HDBK-516 Sections	**Description of Impact to MIL-HDBK-516 Criteria**	**Summation of Credible Hazard(s) for Section**	**AWHI**	**Name Subject Matter Reviewer**
20 – Air Transportability, Airdrop, Mission/Test Equipment and Cargo/Payload Safety 20.1 ☐ Air transportability & airdrop 20.2 ☐ Mission/test equipment operations and installation				

3.2 Based on the above assessment what is the overall risk hazard index for this mod?

The overall modification AWHI is typically the worst of all the sections, however, as several hazards are combined, the resultant overall AWHI could be more extreme due to the interaction between system/subsystem updates as described in AWB-007.

HAZARD CATEGORIZATION		SEVERITY*			
		CATASTROPHIC (1)	CRITICAL (2)	MARGINAL (3)	NEGLIGIBLE (4)
FREQUENCY	FREQUENT (A) = or > 100/100K flt hrs	1	3	7	13
	PROBABLE (B) 10-99/100K flt hrs	2	5	9	16
	OCCASIONAL (C) 1.0-9.9/100K flt hrs	4	6	11	18
	REMOTE (D) 0.01-0.99/100K flt hrs	8	10	14	19
	IMPROBABLE (E) = or < 0.01/100K flt hrs	12	15	17	20

*__Severity__ is the worst credible consequence of a hazard in terms of degree of injury, property damage or effect on mission defined below:

(1) **Catastrophic:** Class A (damage > $2M / fatality / permanent total disability / loss of Aircraft)
(2) **Critical:** Class B ($500K < damage < $2M / permanent partial disability / hospitalization of 5 or more personnel)
(3) **Marginal:** Class C ($50K < damage < $500K / injury results in 1 or more lost workdays)
(4) **Negligible:** All other injury/damage less than Class C

Overall Modification AWHI ☐

Reportable AWHI 1-9

4. Airworthiness Plan.

Airworthiness Plan is explained in AWB-002 if plan is not available then explain why in Section 4.3.

4.1 Airworthiness Schedule.

- Certification Basis Submittal Date (*estimate)* — **Cert Basis**
- Contract Award (M/S B, EMD) — **Contract Award**
- Experimental Flight Release Basis (EFRB) Submittal (*estimate)* — **EFRB**
- EFRB Compliance Submittal (*estimate)* — **EFRB Submittal**
- First Flight Date for testing — **First Flight**
- Is DT/OT combined? — **Y/N**
  - If No, OTRR Date — **OTRR**
  - If Yes, FRP Decision Date — **FRP**
- Final Airworthiness Approval (Final Compliance) *Should be no later than OTRR or FRP Date above* — **Final Approval**
- IOC/RAA — **IOC/RAA**

  To establish the program completion date.

4.2 Describe the Airworthiness Approach.

- *What existing airworthiness certifications will be utilized (i.e. USAF MTC , FAA Cert, cert from other branch of US military, Foreign Military Cert)*
- *How will testing be conducted? Will Operational Testing and Developmental Testing be combined?*
- *Are there other important dates or events that will impact the airworthiness approval schedule?*
- *If Reportable, are there any special arrangements that need to be made for SMEs to review artifacts?*
- *Will cert basis be approved before Milestone B/EMD Contract Award? If not why?*
- *Identify if the certification basis and Experimental Flight Release Basis (EFRB) will be submitted for review with one TACC/MACC*

Airworthiness Approach *(Applicant should use as much space as needed to explain AW approach or if no plan at this time, explain why):*

5. Airworthiness Approvals.

5.1 Impact and Reportability Signature Block

This is my recommendation of the Impact Assessment and Reportability Determination. I also declare that the information provided herein is accurate and complete. This document will be attached to the program LCMP IAW AWB-002 and the EN/EZ Project Tracker will be completed for Reportable Modifications and delivered to USAF Airworthiness office a minimum of 30 days prior to Certification Basis submission.

	Office	Signature	Date
CE/DTA **Y/N** AW Impact **Y/N** Reportable			

5.2 Airworthiness Plan Signature Block.

I concur with the Airworthiness Plan presented herein and will ensure its implementation.

	Office	Signature	Date
SPM Or Delegate			

5.3 Technical Authority Signature Block.

I understand the modification described herein and concur with the assessments.

	Office	Signature	Date
DoE/DTA **Y/N** Reportable			
TAA Only if Reportable			

5.4 Additional comments, restrictions or delegations from signatories.

Appendix B. Military Type Certificate (MTC)

DEPARTMENT OF DEFENSE
UNITED STATES AIR FORCE

MILITARY TYPE CERTIFICATE No. MDS-C####

1. MANUFACTURER / MDS (Program Office):

2. ISSUE DATE: DD-MMM-YYYY

3. EXPIRATION: Service Life Limit (Flight Hours, Cycles…)

4. DESIGN CONFIGURATION:

5. TERMS AND CONDITIONS:

This type certification is issued pursuant to United States Air Force Policy Directive 62-6 and Air Force Instruction 62-601 and authorizes flight in accordance with approved Technical Orders unless rescinded by the Technical Airworthiness Authority (TAA).

The Military Type Certification is issued based upon a (MII-HDBK-516B or C expanded review, Recognized authority) and Section 8 references the limitations, restrictions, authorized configuration, and approved operational and maintenance technical orders and intended usage for this MDS.

All System Safety risks have been accepted by the appropriate authorities in accordance with AFI 62-601.

6. SIGNATURE

X

Jorge F. Gonzalez
Technical Airworthiness Authority

7. ORGANIZATION

AFLCMC/EN-EZ

Appropriate Distro Statement:
Example: DISTRIBUTION STATEMENT D: Distribution authorized to the Department of Defense and U.S. DoD contractors only; Administrative and Operational Use, 31 July 2012. Other requests shall be referred to the Program Office identified in Block 1.
DESTRUCTION NOTICE—Destroy by any method that will prevent disclosure of contents or reconstruction of the data.

Distribution Statement A – Approved for public release; distribution unlimited when not filled in.

MDS-C####	Page 2 of 2
8. SUPPORTING DOCUMENTATION:	DATE:

Appropriate Distro Statement:
Example: DISTRIBUTION STATEMENT D: Distribution authorized to the Department of Defense and U.S. DoD contractors only; Administrative and Operational Use, 31 July 2012. Other requests shall be referred to the Program Office identified in Block 1.
DESTRUCTION NOTICE—Destroy by any method that will prevent disclosure of contents or reconstruction of the data.

Distribution Statement A – Approved for public release; distribution unlimited when not filled in.

Appendix C. Military Flight Release (MFR)

Page 1 of 2

DEPARTMENT OF DEFENSE
UNITED STATES AIR FORCE

MILITARY FLIGHT RELEASE No. MDS-R####

1. MANUFACTURER / MDS (Program Office):	4. SERIAL/TAIL NUMBER(S)/CONFIGURATION:
2. ISSUE DATE: DD-MMM-YYYY	
3. EXPIRATION: (Date, Flight Hours, and/or Alternate Criteria)	

5. TERMS AND CONDITIONS:

This flight release is issued pursuant to United States Air Force Policy Directive 62-6 and Air Force Instruction 62-601. It authorizes flight in accordance with approved operating limits, flight test plans and/or Technical Orders unless rescinded by the Technical Airworthiness Authority (TAA).

The following limitations shall be followed:

(Identify any additional terms/conditions required by this MFR)

Section 8 references the limitations, restrictions, authorized configuration, approved operational and maintenance technical orders, flight test plans and intended usage for this MDS.

All System Safety risks have been accepted by the appropriate authorities in accordance with AFI 62-601.

6. SIGNATURE	7. ORGANIZATION
X Jorge F. Gonzalez Technical Airworthiness Authority	AFLCMC/EN-EZ

Appropriate Distro Statement
Example: DISTRIBUTION STATEMENT D: Distribution authorized to the Department of Defense and U.S. DoD contractors only; Administrative and Operational Use, 31 July 2012. Other requests shall be referred to the Program Office identified in Block 1.
DESTRUCTION NOTICE—Destroy by any method that will prevent disclosure of contents or reconstruction of the data.

Distribution Statement A – Approved for public release; distribution unlimited, when not filled in.

MDS-R####	Page 2 of 2
8. SUPPORTING DOCUMENTATION:	DATE:

Appropriate Distro Statement
Example: DISTRIBUTION STATEMENT D: Distribution authorized to the Department of Defense and U.S. DoD contractors only; Administrative and Operational Use, 31 July 2012. Other requests shall be referred to the Program Office identified in Block 1.
DESTRUCTION NOTICE—Destroy by any method that will prevent disclosure of contents or reconstruction of the data.

Distribution Statement A – Approved for public release; distribution unlimited, when not filled in.

Appendix D. Military Certificate of Airworthiness (MCA)

UNITED STATES OF AMERICA
DEPARTMENT OF DEFENSE – UNITED STATES AIR FORCE

MILITARY CERTIFICATE OF AIRWORTHINESS

1. SERIAL/TAIL NUMBER	2. MANUFACTURER//MDS	3. MTC/MFR NUMBER(S)
Number	MDS Click here to enter text.	Number

4. AUTHORITY AND BASIS OF ISSUE

This airworthiness certificate is issued pursuant to United States Air Force Policy Directive (AFPD) 62-6 and certifies that, as of the date of issuance, the aircraft to which it is issued conforms to the flight authorization cited in Block 3, and is in a condition for safe operation. The service life limit of this aircraft is [limit].

5. TERMS AND CONDITIONS

This airworthiness certificate is effective as long as the technical data is current with regard to configuration, maintenance, preventive maintenance, and modifications are performed in accordance with approved maintenance manuals, Air Force Policy Directives and Instructions, the aircraft is operated in accordance with the approved pilot's flight manual, and the service life limit has not been exceeded. The approving official has the authority to rescind this certificate when any of the above conditions are not met.

6 ISSUE DATE	7. APPROVING OFFICIAL SIGNATURE	8. OFFICE SYMBOL
Date	Name Title	Office Symbol

Page 1 of 2

[redacted]

Distribution Statement A – Approved for public release; distribution unlimited when not filled in. Appropriate Distro Statement required for filled in document..

UNITED STATES OF AMERICA
DEPARTMENT OF DEFENSE – UNITED STATES AIR FORCE

MILITARY CERTIFICATE OF AIRWORTHINESS

9. ADDITIONAL TAIL NUMBERS

List additional tail numbers here if space beyond that available in Block 1 is needed.

Page 2 of 2

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Air Force Institute of Technology
Graduate School of Engineering and Management (AFIT/EN)
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14. ABSTRACT

This research focuses on evaluation of Royal Saudi Air Force (RSAF) airworthiness processes and their applicability. The current RSAF airworthiness process is in accordance with internationally recognized best practice in the area of military aviation, this is achieved by benchmarking against European Aviation Safety Agency (EASA) and International Organization for Standardization (ISO) standards. Air-worthiness policy for the RSAF is developed on the basis that it will be as civil as possible and as military as necessary. For the purpose of this research, the current RSAF airworthiness process will be benchmarked against the United States Air Force (USAF) airworthiness process. That can be done by understanding the current airworthiness process for RSAF and USAF, types of airworthiness certificates and determining the commonality and differences between both processes including the initial airworthiness, continued airworthiness and continuing airworthiness and compare the organizational structure, planning, execution, and the final products of airworthiness process. The main difference between RSAF and USAF in organizational structure is the existence of the Technical Airworthiness Authority (TAA) and Delegated Technical Airworthiness Authority (DTA) in the USAF, whereas in the current RSAF organizational structure the TAA and DTA do not exist. As consequence, some of the products of these organizations are missing in the RSAF. This research suggests that those techniques can help to improve the airworthiness process in the Royal Saudi Air Force.

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