

A GENERAL ANALYSIS ON CIVIL AIRCRAFT HUMAN FACTOR RELATED REQUIREMENTS OF FAR 25 AND CS25

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ABSTRACT

In the paper, I am going to present an analysis on existing Civil Aircraft human factor related regulation. Study the history of transport category airplane's human factor regulation and also analyzing FAR 25 and CS 25 existing airworthiness compliance verification approaches.

KEYWORDS: FAR, CS, Human Factor, Airworthiness, MOC

1. INTRODUCTION

Aircraft maintenance is a highly regulated sector that requires licensed Maintenance, Repair, and Overhaul specialists to perform a rigorous regimen of planned or preventative servicing, inspection, testing, and overhaul or modification activities on every aircraft in service. Its goal is to keep the plane in good working order so that the crew and passengers, as well as anyone else in its service area, are safe.

Aircraft maintenance is strictly controlled to ensure safe and proper operation while in flight. In civil aviation, national regulations are standardized under the International Civil Aviation Organization's (ICAO) standards (ICAO) [1]. Local airworthiness authorities must implement ICAO regulations to regulate maintenance tasks, personnel, and the inspection system. Maintenance personnel must be licensed to perform the tasks they do.

The FAA (Federal Aviation Administration) and EASA (European Aviation Safety Agency) are two of the most well-known, well-rounded, and modern transportation authorities (European Union Aviation Safety Agency). The Federal Aviation Administration (FAA) is the world's largest contemporary transportation agency and a governmental entity in the United States [2], having authority to regulate all areas of civil aviation within the country as well as over foreign waterways. The European Union Aviation Safety Organization (EASA) is a European Union (EU) agency in charge of civil aviation safety. It is responsible for certification, regulation, as well as investigation and monitoring. It gathers and analyzes data on safety, writes and advises on safety legislation, and collaborates with similar organizations around the world.

2. FAR 25 AND CS 25

Aircraft in the transport category must meet the airworthiness standards stated in CFR Part 25. Transport category aircraft can fall into one of two categories, according to FAA regulations: jets with at least 10 passengers and a maximum takeoff weight (MTOW) of more than 12,500 pounds, or propeller aircraft with more than 19 seats and an MTOW of more than 19,000 pounds. CFR Parts 25 and 26 govern the design and certification of transport category aircraft. CFR Part 25 includes “subparts” spanning flight, structure, design and construction, power-plant, equipment, operating limits, and electrical wiring. In all, CFR Part 25 features more than 1,800 individual regulations[3].

EASA doesn’t have the good opening like FAA in their amendment for part-25. EASA have the type certificate for the APU which FAA doesn’t. CS-25 have more appendix than FAR 25. However all the appendixes is the detailed of subpart A-J requirements. CS-25 applies to all multi-engine jets and multi-engine turboprops with more than 9 passenger seats or a weight of more than 5700kgs. "Large Aero planes" is how they're described.

3. HUMAN FACTOR RELATED REGULATIONS

The existing civil aircraft airworthiness regulations are FAR25 (FAA), CS25 (EASA), among them 25.571-Damage—tolerance and fatigue evaluation of structure, 25.611- Accessibility provisions, 25.783- Fuselage doors, 25.901-Installation, 25.963-Fuel tanks: general, 25.981-Fuel tank explosion prevention, 25.997-Fuel strainer or filter, 25.1101-Carburetor air preheater design,25.1360-Precautions against injury, 25.1711-Component identification: EWIS, 25.1721-Protection of EWIS are maintenance and human factor related requirements . The requirements that are mentioned above FAR and CS both have these requirements except 25.1101. CS doesn’t have this particular requirement [4]. Among these regulations not every single section is related to maintenance. So the section that are related to human factor are given below.

25.571 (a)(3)	25.997 (a)
25.611(a)	25.1360 (a)(b)
25.783(b,e,f,g)	25.1711 (b)(1)
25.901 (a)(3) (b) (1,2,3,4) (c)	25.1721 (b)
25.963 (c) (f)	25.1101 (b)(c)

4. HISTORY

FAA, EASA, have been revised in several editions. FAR-25 has been revised 90 times since the promulgation of Amendment No. 60 in 1986, with an average of 3 revisions per year [5]. Each update will introduce some new requirements

and also some modification will be made in some requirements; CS-25 since the first version of CS-25 was released in 2003, a total of 26 revisions have been made before and after [6]. In this section airworthiness requirements involving human factor in FAR25 and its modification and changes are shown below.

25.611- Accessibility Provision

Background: This provision was modified twice by amendments FAR 25-23 and 25-123 and for CS it was added on the first edition of CS25 on 2003, CS amendment was reviewed 26 times. But for section 25.611 of amendment 5 is still active for CS.

Section	Title	amdt	Eff Date	Current
FAR 25.611	Inspection provisions	25-0	02/01/1965	
FAR 25.611	Accessibility provisions	25-23	05/08/1970	
FAR 25.611	Accessibility provisions	25-123	12/10/2007	✓
CS25.611	Accessibility provisions	5	05/09/2007	✓

Revision of amdt 25-23: The FAA has changed the revision recommendations in NPRM 68-18 to include requirements that allow the use of non-destructive checks. The amendment was intended to require adequate measures, mainly proximity to access, to ensure that the necessary checks were carried out in a practical manner [7].

Revision of amdt 25-123: Amendment FAR 25-123 adds division H which is for EWIS.

25.571(a) (3) - Damage Tolerance and Fatigue Evaluation of the Structure

Background: This provision was modified 9 times by FAA. EASA first added this regulation in their first amendments but CS 25 was modified 26 times so far but this specific regulation was modified in amendment 19.

Section	Title	Amdt	Eff date	Current
FAR25.571	Fatigue evaluation of flight structure	25-0	1965.02.01	
FAR25.571	Similar	25-10	1966.10.10	
FAR25.571	Similar	25-23	1970.05.08	
FAR25.571	Damage-tolerance and fatigue evaluation of structure.	25-45	1978.12.01	
FAR25.571	Similar	25-54	1980.10.14	
FAR25.571	Similar	25-72	1990.08.20	
FAR25.571	Similar	25-86	1996.03.11	
FAR25.571	Similar	25-96	1998.03.11	
FAR25.571	Similar	25-132	2011.01.14	✓

CS 25.571	Damage-tolerance and fatigue evaluation of structure	ED Decision 2003/2/RM	2003.10.17	
CS 25.571	Similar	Admt 19	2017.05.12	✓

Amdt 25-132: This amendment was published in 2011. 25.571 section was highly modified in this amendment [9].The rule requires design approval holders to examine their airplanes in order to determine the engineering evidence that supports the structural maintenance program's validity limit (LOV) [10]. The LOV must be included in the maintenance program of any concerned airplane, according to the rule. Unless an expanded LOV is permitted, operators cannot fly an airplane beyond its LOV.

25.997- Fuel strainer or filter (a)

Background: This clause was modified four times by FAA. List will be down below and all the amendments summarization related to 25.997 is given in this paper[11]. EASA first added this clauses in their first edition of CS-25

Section	Title	amdt	Eff Date	Current
FAR 25.997	Fuel strainer or filter	25-0	1965.02.01	
FAR 25.997	Similar	25-23	1970.05.08	
FAR 25.997	Similar	25-36	1974.10.31	
FAR 25.997	Similar	25-57	1984.03.26	✓
CS 25.997	similar	ED Decision 2003/2/RM	2003.10.17	✓

Amdt 25-23: When the engine-driven positive displacement pump is utilized, this amendment changes section 25.997 (a) (1) to require that an oil filter or screen be positioned between the outlet of the fuel tank and the input of the pump [12]. The amendment's goal is to raise the criteria of airworthiness for transport aircraft [13].

25.1711(b) (1):Component identification: EWIS

Background: This provision was first added in 25-123 amendment. 25.1711 section of amendment 25-123 still active and no changed has been made and for EASA this clause was first added in their 6th amendment

Section	Title	Amdt	Eff date	Current
FAR 25.1711	Component identification: EWIS	25-123	2007.12.10	✓
CS25.1711	Similar	Amdt 6	2009.07.06	✓

Amdt 25.123: In 1996, a Boeing 747 carrying 230 people crashed in the air, killing everyone on board. The electric spark created by the electrical circuit is the most likely cause. All 229 people aboard a Swiss Airlines MD-11 jet were killed when it caught fire in 1998 [14]. Solidified copper was discovered on the wire of the cabin entertainment system, which was

discovered in the cabin where the fire started. This indicates that the cable had an arc, causing the copper conductor to melt and subsequently solidify[15]. The plane fire and crash are thought to have been triggered by an arc caused by a cable fault. After a long time of research finally on 2007 the new amendments add a new section 25.1711.

25.1721 (b): Protection of EWIS

Background: This provision was first added in 25-123 amendment. 25.1721 section of amendment 25-123 still active and no changed has been made and for EASA this clause was first added in their 6th amendment.

Section	Title	Amdt	Eff date	Current
FAR 25.1721	Protection of EWIS	25-123	2007.12.10	✓
CS25.1721	Similar	Amdt 6	2009.07.06	✓

Amdt 25.123: Similar with 25.1711

25.1101 (b)(c)- Carburetor air preheater design.

Background:Amendment 25-0 formulates section far25 of the airworthiness standard for transport aircraft, with a total of 348 clauses, and references to car4b and sr422b in various clauses.Among them, car4b.462 is transformed to far25.1101, which specifies the design and construction criteria for the vaporizer's air preheater.

Section	Title	Amdt	Eff date	Current
FAR25.1101	Carburetor air preheater design	25-0	1965.02.01	✓

25.1360 (a) (b) - Precautions against injury

Background: This clause was first added by EASA in their first edition of CS-25, Since then till now CS-25 amendments was reviewed 26 times but 25.1360 is still intact and nothing changed eversince. FAA first introduced 25.1360 in their amendment 25.123 which was published in 2007.

Section	Title	Amdt	Eff date	Current
CS25.1360	Precautions against injury	ED Decision 2003/2/RM	2003.10.17	✓
FAR25.1360	Similar	25-123	2007.12.10	✓

Amdt 25-123: FAA stated in NPRM05-08 that there was no requirement for the protection of injury from electric shock and burning in far25 before to the issuance of this amendment 25-123. Considering the coordination with JAR [16], it is also advised that 25.1360 be added, which states that the electrical system and equipment must be designed to reduce the hazards of electric shock and burning to the crew, passengers, and maintenance and service employees during normal operation [17].

25.783(b,e,f,g)- Fuselage doors

Background: This requirement was modified 7 times by FAA. It was last modified on 2004 and CS their latest modification was made in their amendment 4th which was published 2007.

Section	Title	amdt	Eff Date	Current
FAR25.783	Doors	25-0	1965.02.01	
FAR25.783	Doors	25-15	1967.10.24	
FAR25.783	Doors	25-23	1970.05.08	
FAR25.783	Doors	25-54	1980.10.14	
FAR25.783	Doors	25-72	1990.08.20	
FAR25.783	Doors	25-88	1996.12.09	
FAR25.783	Fuselage doors	25-114	2004.06.12	✓
CS25.783	Fuselage doors	Amdt 4	2007.12.27	✓

Amdt 25-15: The amendment adds paragraph 25.783 (g), which states that each fuselage entrance must be an emergency exit for class I or class II passengers, and that the effectiveness of emergency evacuation at the boarding gate must not be harmed if the entire slide is subjected to emergency landing load and aircraft landing gear strut failure. The amendment's goal is to improve the criteria for transport aircraft emergency evacuation equipment [18].

Amdt 25-23: The amendment modifies paragraphs 25.783 (b) and (f) to amend "mechanical failure" to "mechanical failure or failure of any single structural element", and stipulates that the failure of any single structural element will not cause the fuselage compartment door to open in line.

Amdt25-54: The amendment modifies article 25.783 by replacing article 25.783 (f) with article 25.783 (g), replacing the first sentence of article 25.783 (g) with article 25.783 (H), and replacing the second sentence of article 25.783 (g) with article 25.783 (I). In order to refine the requirements for fuselage hatch and toilet door, paragraphs 25.783 (E) and 25.783 (I) are revised and paragraphs 25.783 (f) and 25.783 (J) are added [19].

Amdt 25-114: The amendment amended article 25.783, changed the title of article 25.783 from "hatch" to "fuselage hatch" to accurately reflect the applicability of this article, and further refined the contents of each paragraph to make the contents more clear.

25.901(a)(3)(b)(1-4)(c) – Installation

Background : This requirement was modified 4 times by faa. EASA first include this requirement on their first edition of CS.

Section	Title	amdt	Eff Date	Current
FAR25.901	Installation	25-0	1965.02.01	
FAR25.901	Installation	25-23	1970.05.08	
FAR25.901	Installation	25-40	1977.05.02	
FAR25.901	Installation	25-46	1978.12.01	
FAR25.901	Installation	25-126	2008.12.23	✓
CS25.901	Installation	ED Decision 2003/2/RM	2003.10.17	✓

25-23: Paragraph 25.901 (c) is added to the amendment to consider the safety of the power plant system itself. In order to ensure that no single failure or possible failure combination of any power plant system will endanger the safe operation of the aircraft, FAA proposes to add paragraph 25.901 (c) in this amendment, requiring that the power plant installation must meet the requirements of article 2.1309 [20].

25-40: The amendment modifies paragraphs 25.901 (b) and (c), in which the reference to article 25.1309 is deleted and the reference to part far33 is added. The purpose is to clarify the terms of far33 involved and enhance the compatibility of aircraft / engine [21].

25-126: For the issue of original and updated type certificates for airplane propellers, the FAA updates the airworthiness requirements [22]. The prior propeller standards did not fully accommodate the twenty-year technology advancements. The revised standards take into account these advancements in technology and standardize propeller certification criteria between the FAA and the European Aviation Safety Agency [23], making airworthiness clearances for imports and exports easier.

25.963(c)(f)- Fuel tanks: general

Background: This requirements was modified four times by faa. EASA first include this regulation on their first amendment, CS was reviewed many times over the years but section C and F is intact

Section	Title	Amdt	Eff Date	Current
FAR25.963	Fuel tanks: general	25-0	1965.02.01	
FAR25.963	Fuel tanks: general	25-40	1977.05.02	
FAR25.963	Fuel tanks: general	25-69	1989.10.30	
FAR25.963	Fuel tanks: general	25-139	2014.01.12	✓
CS 25.963	Fuel tanks: general	ED Decision 2003/2/RM	2003.10.17	✓

Amdt 25-40: This amendment moves the requirements of clause 25.963 (E) on the tank capacity of thrust or power increase system to clause 25.945 (E); Add a new 25.963 (f) requirement on preventing excessive pressure difference inside and outside the booster oil tank. Because the former clause 25.963 of amendment 25-40 does not consider the consequences of overpressure of booster oil tank that may occur in actual operation [24], FAA amended amendment 25-40 to require

measures with damage safety characteristics of booster oil tank to avoid excessive pressure difference inside and outside the oil tank.

General comparative analysis on existing requirement of FAA and CS

Section	FAA vs CS
25.571 (a)(3)	According to AMC25.571 and AC 25.571, the main difference is FAA specifies criteria for certain inspection thresholds and a limit of validity (LOV) to be mentioned in instructions for continued. But for EASA doesn't
25.611(a)	No difference
25.783(b) (e)	(b)(2) of 25.783: When body auxiliary devices are used to prevent someone from intentionally or unintentionally opening the hatch, FAR specifies that these devices and their control systems be built in such a way that the failure that prevents the exit from opening after landing is improbable (1×10^{-5} / flight hour). It is not necessary for CS to be more likely than remote 1×10^{-5} / flight hour). The words are dissimilar and necessitate equivalency. (E)(3) of 25.783: The visual measures required by far to send a signal to the driver that the door is not fully closed, locked in the cockpit must be designed in such a way that any failure or combination of failures will not result in a false closing latch and locking indication (1×10^{-5} / flight hour). This visual measure must be built so that any failure or combination of failures resulting in inaccurate closing, latching, or locking indication is rare (1×10^{-5} flight hours), according to CS. The words are dissimilar and necessitate equivalency.
25.901(a)(3)(b) (1,2,3,4)(c)	14 CFR 25.901(b) refers to 14 CFR parts 33 and 35 for engines and propellers, respectively. For engine installation instructions, CS solely refers to CS E20 (d) and (e). CS 25 compliance does not guarantee that the power plant installation is compliant. The FAA mandates the fail-safe approach, which states that no failure(s) will risk the airplane's safe operation. The "fail-safe" standards are included in 14 CFR 25.901(c) as part of the regulation. The CS25.1309 standard must be followed. Because guidance in 25.1309 applies fail-safe, 25.1309 is not necessary.
25.963 (c) (f)	No difference
25.997 (a)	No difference
25.1101(b) (c)	CS doesn't have this requirement
25.1360 (a)(b)	No difference
25.1711 (b)(1)	CS require to meet the reliability requirement of 25.1309 and 25.1709 and FAR requires only 25.1709.
25.1721 (b)	No difference

Airworthiness Compliance Verification approaches of FAR and CS

In the process of type certification, in order to satisfy the certification requirement in the FAR 25 and CS 25, manufacturer shall need select different or combined means of compliance for each rule in the regulation. EASA provides six general acceptable means to demonstrate compliance. Now the result of compliance verification method of human factor related regulation are given below.

Regulations	MOC of FAR	MOC of EASA
25.571 (a)(3)	Inspection, ground test	Inspection, ground test
25.611 (a)	Inspection, Documentation	Inspection, Documentation
25.783(b,e,f,g)	Analysis/ Lab test Safety assessment Inspection	Analysis/ lab test, safety assessment, Inspection
25.901(a)(3)(b) (1,2,3,4)(c)	Documentation, Analysis, Inspection, Safety assessment	Documentation, analysis, Inspection, safety assessment
25.963 (c) (f)	Inspection, analysis,	Inspection, analysis
25.997 (a)	Inspection, Equipment qualification	Inspection, Equipment qualification
25.1360 (a)(b)	Lab test, inspection, equipment qualification	Lab test, Inspection, equipment qualification
25.1711 (b)(1)	Inspection	Inspection
25.1721 (b)	Inspection	Inspection
25.1101 (b) (c)	Inspection	CS doesn't have

5. CONCLUSIONS

There are total 1800 requirements included in both FAR and CS. So identifying maintenance human factor related requirements might be challenging. So In this paper I identified all the regulations that are related to maintenance related human factor and showed a general comparative analysis of existing regulation between both EASA and FAA, the result is mentioned above in the paper including compliance verification approaches of each requirements. This paper may not give the deep analysis of each regulation but it provide the basic guidance for researchers to understanding the general difference between EASA and FAA and also general understanding of requirements.

6. REFERENCES

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