Trabajo Fin de Grado
Ingeniería Aeroespacial

Development of an Aeronautical Certification Process Focused on Avionics Equipment

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Dpto. de Ingeniería de la Construcción y Proyectos de la Ingeniería
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El tribunal nombrado para juzgar el Proyecto arriba indicado, compuesto por los siguientes miembros:

Presidente:

Vocales:

Secretario:

Acuerdan otorgarle la calificación de:

Sevilla, 2019

El Secretario del Tribunal

Abstract

The Final Degree Project "Development of an Aeronautical Certification Process Focused on Avionics Equipment" aims to introduce to the reader about the current aviation certification framework. Even though both, military and civil domains are tackled, a certification process for avionics equipment is developed under the European civil aviation regulations in force. Using the Ground Based Augmentation System (GBAS) as an example, the process for application of its certification, together with the deliverables that must be issued to the European Union Aviation Safety Agency (EASA) and the Agency's internal application evaluation process are studied.

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List of Acronyms and Abbreviations

AAD: Autoridad de Aeronavegabilidad de la Defensa

AC: Advisory Circular

AD: Airworthiness Directives

ADOA: Alternative Procedures to Design Organisation Approval

AEEC: Airlines Electronic Engineering Committee

AEH: Airborne Electronic Hardware

AESA: Agencia Estatal de Seguridad Aérea

AEW: Airborne Early Warning

AFI: Africa-Indian Ocean

AFM: Aircraft Flight Manual

AL: Alert Limit

AMC: Acceptable Means of Compliance

ANS: Air Navigation Services

AOC: Air Operator Certificate

APU: Auxiliary Power Unit

APV: Approach Procedure with Vertical Guidance

ARINC: Aeronautical Radio, Incorporated

ARP: Aerospace Recommended Practice

ASAP: Aviation Safety Action Program

ASIA: Asia

ASIC: Application Specific Integrated Circuit

ASW: Anti-Submarine Warfare

ATA: Air Transport Association

ATM: Air Traffic Management

ATOS: Air Transportation Oversight System

CAA: Civil Aeronautics Administration

CAB: Civil Aeronautics Board

CAR: Caribbean

CAT: Category

CCA: Common Cause Analysis

CFR: Code of Federal Regulation

CIAIAC: Comisión de Investigación de Accidentes e Incidentes de Aviación Civil

CMA: Common Mode Analysis

CMC: Code-Minus-Carrier phase

CoA: Certificate of Airworthiness

COTS: Commercial Off The Shelf

CP: Certification Programme

CRI: Certification Review Item

CS: Certification Specification

DAL: Development Assurance Level

DAR: Designated Airworthiness Representative

DAS: Defensive Aids System

DDP: Declaration of Design and Performance

DER: Designated Engineering Representative

DGAC: Dirección General de Aviación Civil

DGAM: Dirección General de Armamento y Material

DIGAM: Director General de Armamento y Material

DME: Distance Measuring Equipment

DMIR: Designated Manufacturing Inspection Representative

DO: Document

DOA: Design Organisation Approval

DSP: Digital Signal Processing

EASA: European Union Aviation Safety Agency

EC: European Comission

ED: European Organisation for Civil Aviation Equipment Document

EDA: European Defence Agency

EHSI: Electronic Horizontal Situation Indicator

ELOS: Equivalent Level of Safety

EMAR: European Military Airworthiness Requirement

EMC: Electromagnetic Compatiblity

EMI: Electromagnetic Interference

ENAC: École Nationale d'Aviation Civile

ESF: Equivalent Safety Finding

ESM: Electronic Support Measures

ETSO: European Technical Standard Order

ETSOA: European Technical Standard Order Authorisation

EU: European Union

EUR: Europe

EUROCAE: European Organisation for Civil Aviation Equipment

FAA: Federal Aviation Administration

FAEDIR: Framework Agreement for European Defence Industrial Restructuration

FAL: Facilitation

FANS: Future Air Navigation System

FAR: Federal Aviation Regulation

FAS: Final Approach Segment

FASVAL: Final Approach Segment Vertical Alert Limit

FCMS: Fuel Control and Monitoring System

FFP: Functional Failure Path

FFPA: Functional Failure Path Analysis

FHA: Functional Hazard Assessment

FLIR: Forward Looking InfraRed

FMEA: Failure Modes and Effects Analysis

FMES: Failure Modes and Effects Summary

FMS: Flight Management System

FOM: Figure of Merit

FQIS: Fuel Quantity Indication System

FSDO: Flight Standards District Offices

FTA: Fault Tree Analysis

GAD: Ground-Based Augmentation System Accuracy Designator

GAST: Ground-Based Augmentation System Approach Service Type

GBAS: Ground-Based Augmentation System

GLS: Global Navigation Satellite System Landing System

GM: Guidance Material

GNP: Gross National Product

GNSS: Global Navigation Satellite System

GPA: Glide Path Angle

GPIP: Glide Path Intercept Point

GPS: Global Positioning System

GPWS: Ground Proximity Warning System

HIRF: High-Intensity Radiated Field

HMI: Hazardous Misleading Information

HUD: Heads-Up Display

HUMS: Health and Usage Monitoring Systems

ICA: Instructions for Continued Airworthiness

ICAO: International Civil Aviation Organisation

IFR: Instrument Flight Rules

ILS: Instrument Landing System

IMS: Inertial Measurement System

IMU: Inertial Measurement Unit

INTA: Instituto Nacional de Técnica Aeroespacial

IODE: Issue of Data, Ephemeris

IR: Implementation Rule

ISC: Internal Safety Committee

ISO: International Organization for Standardization

JAA: Joint Aviation Authorities

JAR: Joint Aviation Requirements

LAAS: Local Area Augmentation System

LADGPS: Local Area Differential GPS

LoA: Letter of Acceptance

LoI/FAEDIR: Letter of Intent/Framework Agreement for European Defence Industrial Restructuration

LRU: Line Replacable Unit

MAWA: Military Airworthiness Authorities

MID: Middle East

MIL-STD: Military Standard

MLS: Microwave Landing System

MMR: Multi-Mode Receiver

MOA: Maintenance Organisation Approval

MOC: Means of Compliance

NAA: National Aviation Authority

NAM: North America

NAT: North Atlantic

NSE: Navigation System Error

OCCAR: Organisation Conjointe de Coopération en Matière d'Armement

PAC: Pacific

PANS: Procedures for Air Navigation Services

PCM: Project Certification Manager

PERAM: Publicación Española de requisitos de Aeronavegabilidad Militares

PL: Protection Level

PLD: Programmable Logic Devices

POA: Production Organisation Approval

POE: Production Organization Exposition

PRA: Particular Risks Analysis

PRC: Pseudorange Correction

PRN: Pseudo Random Noise

PSSA: Preliminary System Safety Assessment

RAD: Reglamento de Aeronavegabilidad de la Defensa

R&D: Research and Development

RNAV: Area Navigation

RNP: Required Navigation Performance

RRC: Range Rate Correction

RTCA: Radio Technical Commission for Aeronautics

SAE: Society of Automotive Engineers

SAIB: Special Airworthiness Information Bulletins

SAM: South America

SAR: Search and Rescue

SARPs: Standards and Recommended Practices

SBAS: Satellite-Based Augmentation System

SDR: Service Difficulty Reports

SESAR: Single European Sky Air Traffic Management Research

SIS: Signal-In-Space

SL: Slant Distance

SMS: Safety Management System

SSA: System Safety Assessment

SSP: State Safety Programme

STC: Supplemental Type Certificate

TAWS: Terrain Avoidance and Warning System

TC: Type Certificate

TCAS: Traffic Alert and Collision Avoidance System

TCCA: Transport Canada Civil Aviation

TCDS: Type Certificate Data Sheet

TIP: Technical Implementation Procedure

TTA: Time to Alert Technical Implementation Procedure (TIP)

TSO: Technical Standard Orders

UERE: User Equivalent Range Errors

UN: United Nations

USA: United States of America

VAL: Vertical Alert Limit

VDB: Very High Frequency Data Broadcast

VFR: Visual Flight Rules

VHF: Very High Frequency

VOR: Very High Frequency Omnidirectional Range

VPL: Vertical Protection Level

WAAS: Wide Area Augmentation System

XLS: Mixed Landing System

ZSA: Zonal Safety Analysis

1 Introduction and Objectives

The aim of this Final Degree Project is to develop a certification process for an aeronautical product. This aeronautical product can be an aircraft, engine, propeller or other equipment or component. Apart from describing and analysing the certification procedure, it will be explained how companies nowadays work, how they apply for a product certification, which documents they have to deliver to the different Authorities, and how they must deal with unexpected problems. The project will be tackled using and describing the European regulations in force. However, along the different sections and chapters there will be references to other Authorities' regulations which are also needed throughout the process. Finally, the Military regulations are also going to be seen, as the specifications and requirements needed to be complied are similar, but the Airworthiness Authorities are different. In addition, the case of the Spanish Military Authorities is going to be specified and detailed.

Furthermore, and taking the general certification process of products as a base, certification of avionics equipment will be seen. In order to fully understand their function, a brief introduction will be made on their role on the aircraft and their different types. Subsequently, the general processes, documents and activities involved in their certification procedure are explained, detailing the case of one specific avionics equipment. As a result, this project will give an overview of certification processes in aviation, of the variety of regulations that can be applied depending on the different cases, and of the way they must be applied. Consequently, this Final Degree Project is going to be made with the objective of helping companies, manufacturers and suppliers when having to certify a new product or a change in an already existing product or equipment.

The project has been structured in a way the certification process can be followed by someone with no knowledge about the subject. This is the reason why firstly, an introduction of the different Civil Authorities affecting European regulations is done. Secondly, the different types of documents and requirements included in these regulations are going to be explained, detailing their role on the procedure. In addition, the general process for product certification is described, as the he main steps of this procedure will also be used for the equipment certification organization. Once the equipment certification processes is clear, these steps will be applied in avionics equipment. Therefore, one chapter or section cannot be understood without the presence of the former one.

With respect to the scope and limitations of the project, they will depend on the development and improvements on the products tackled. Normally, certification procedures are very long and tedious, and can take up to several years. As a consequence, Authorities are aiming to reduce the bureaucratic processes as much as possible, in order to simplify the certification tasks to the applicants. Systems will also tend to be simpler, easier to manage and more globalized. This is why future works will probably be focused on the harmonization of the different Authorities' regulations, so that processes could be validated in, at least, several countries at the same time. Finally, it is also important to mention the development of avionics equipment, which will have an important role in the next generation aircraft.

For the duration of this Project, I have been at the École Nationale d'Aviation Civile (ENAC), in Toulouse, France. The Major 'Air Operations and Safety', chosen to follow my studies at this French Aviation School led me to choose this topic for my Final Degree Project. In France, I had several projects and subjects on certification, increasing my interest in this area of the aviation industry that was unknown for me. In addition, I

also had a very extensive course and project on avionics equipment, especially navigation equipment and satellite-based equipment. Therefore, all these experiences led me to choose this theme for the development of my Final Degree Project.

2 State of Art

The remainder of this chapter on certification processes is structured as follows. Firstly, we analyse the basic principles of safety regulations and the considerations on airworthiness that must be taken into account when undergoing a certification process. Secondly, a description of the Civil Airworthiness Authorities is included, detailing the role of the International Civil Aviation Organisation (ICAO), the European Union Aviation Safety Agency (EASA) and the Federal Aviation Administration (FAA), for then providing a description of the European Aviation Authorities regulations. Finally, the military domain is tackled, introducing the European Military Aviation Authorities. Furthermore, the Spanish Military Aviation Authority is shown as an example. Finally, a small introduction on how companies proceed nowadays when starting a certification process in included.

2.1 General Considerations

2.1.1 Basic Principles on Safety Regulation

As it is commonly known, Safety is a public right for every citizen. Therefore, laws and regulations are needed in order to assure the compliance of this human right. Both national and international legal frameworks regulate all aspects and entities involved in the Civil Aviation industry, guaranteeing international cooperation and setting global standards. In addition, authority may limit, suspend or revoke any approval or certificate if the holder no longer complies with regulations. These approvals and certificates issued by the authorities, detail prerequisites to ensure and preserve Airworthiness and Safety, and are subjected to continuous or periodic supervision. Some examples of these regulations and documents which will be described in detail in subsequent sections are:

- Type Certificate (TC)
- Certificate of Airworthiness (CoA)
- Noise Certificate
- Certificate of Registration
- Design Organisation Approval (DOA)
- Production Organisation Approval (POA)
- Maintenance Organisation Approval (MOA)
- Continuing Airworthiness Management Organization Approval
- Air Operator Certificate (AOC)

2.1.2 Considerations on Airworthiness

Airworthiness can be defined as a measure of an aircraft's ability to operate in safe conditions. This capacity is reflected in the Certificate of Airworthiness, granted by the competent Aviation Authority of each country and valuable while the aircraft meets its specifications. Therefore, Aircraft Airworthiness means compliance with applicable Aviation Authorities' Regulations that define the minimum safety levels for an aircraft when:

- Designed and built according to applicable requirements;
- operated within its intended environment and within its quantified and declared limitations;
- maintained in accordance with procedures acceptable to the responsible Authority.

These minimum safety levels are established in terms of safety of the aircraft, of the transported passengers and of the overflown territories. Therefore, an airworthy aircraft is one where the likelihood of any incident or accident as a result of malfunction, performance or handling of the aircraft is kept to the acceptable levels defined by the regulations in force.

2.2 Civil Aviation Authorities

2.2.1 International Civil Aviation Organization (ICAO)

The Chicago Convention, signed the 7th December 1944, established the ICAO. The main objective of this entity is the safe and orderly development of International Civil Aviation. It is considered a specialized agency of the United Nations (UN) and, in order to undertake International Air Transport, each of the 191 nations, are represented by their National Aviation Authorities (NAA) or Ministries of Transport. In Figure 2-1 the initial Member States are shown signing the Chicago Convention.

Figure 2-1. Initial ICAO Member States signing the Chicago Convention in 1944 (1)

Furthermore, Standards and Recommended Practices (SARPs) for international air transport are technical specifications established by the ICAO and which can be found across the numerous ICAO Annexes to the Chicago Convention on International Civil Aviation. Among the Member States' obligations is to participate in developing standards and practices, to adopt ICAO Standards and, if possible, Recommended Practices in their laws and regulations, or to notify about differences. The nineteen currently existing annexes are the following (2):

- Annex 1: Personnel Licensing: Annex where the licensing of "*flight crew members (pilots, flight engineers and flight navigators), air traffic controllers, aeronautical station operators, maintenance technicians and flight dispatchers*" (2), is discussed together with other related disciplines. In addition, training manuals are created in order to guide the different States.
- Annex 2: Rules of the Air: consisting of general rules, Visual Flight Rules (VFRs) and Instrument Flight Rules (IFRs) which guarantee safety and efficiency in terms of air travel. These rules are applied over the high seas and national territories and the pilot-in-command of the aircraft is the one in charge of complying with them.
- Annex 3: Meteorological Service for International Air Navigation: dealing with the information about

the meteorological conditions along the routes, territories overflown and destination aerodromes that must be provided "*to operators, flight crew members, air traffic services units, search and rescue units, airport management and others concerned with aviation*." (2)

- Annex 4: Aeronautical Charts: they are considered the medium by which information similar to that provided by maps in ground transportation is shown in a "*manageable, condensed and coordinated manner*" (2) They are a source of information available at any time.
- Annex 5: Units of Measurement to be Used in Air and Ground Operations: this Annex includes an ICAO table of units to be used mostly on the metric system. There are also four more tables of units which are useful for States that are not able to use the primary table.
- Annex 6: Operation of Aircraft: where safe and efficient international air transport is set to be as standardized as possible. The first provisions have already been and are being constantly updated in order to follow the evolution of aviation.
- Annex 7: Aircraft Nationality and Registration Marks: in this Annex it is tackled how aircraft are classified and identified, and how it is possible to know their nationality. Additionally, a classification on how aircraft maintain sustained flight in the air is included in a separated table.
- Annex 8: Airworthiness of Aircraft: in terms of safety, "*an aircraft must be designed, constructed and operated in compliance with the appropriate airworthiness requirements of the State of Registry of the aircraft*." (2) As a consequence, the Certificate of Airworthiness is issued with the aim of easing the exportation and importation of aircraft.
- Annex 9: Facilitation: includes provisions on Facilitation (FAL) including customs, immigration, quarantine and clearance procedures.
- Annex 10: Aeronautical Telecommunications: this Annex includes the following volumes regarding aeronautical communication, navigation and surveillance systems:
    - Volume I: Radio Navigation Aids.
    - Volume II: Communications Procedures including those with Procedures for Air Navigation Services (PANS) status.
    - Volume III: Communication Systems.
        - Part 1: Digital Data Communication Systems
        - Part 2: Voice Communication Systems
    - Volume IV: Surveillance Radar and Collision Avoidance Systems.
    - Volume V: Aeronautical Radio Frequency Spectrum Utilization
- Annex 11: Air Traffic Services: these services include air traffic control, flight information and alerting services. They are considered essential in terms of ground support facilities.
- Annex 12: Search and Rescue (SAR): organization, management and procedures are set together with SAR services establishment, maintenance and operation in the Contracting States' territories and over the high seas.
- Annex 13: Aircraft Accident and Incident Investigation: includes the international requirements for the identification and investigation of aircraft accidents and serious incidents based on prevention.
- Annex 14: Aerodromes: "*It extends from the planning of airports and heliports to such details as switch-over times for secondary power supply; from civil engineering to illumination engineering; from provision of sophisticated rescue and fire fighting equipment to simple requirements for keeping airports clear of birds*." (2)
- Annex 15: Aeronautical Information Services: uniform and consistent aeronautical information and data is ensured in this Annex by defining the reception and/or origination, collation or assembling, edition, format, publication or storage and distribution of it.
- Annex 16: Environmental Protection: this Annex tackles specially the harmful effects of aircraft noise and aircraft engine emissions on the environment.

- Annex 17: Security: Safeguarding International Civil Aviation Against Acts of Unlawful Interference: sets the main issues of the Civil Aviation security programme and specially deals with unlawful seizure of aircraft.
- Annex 18: The Safe Transport of Dangerous Goods by Air: comprises dangerous cargo such as explosive, corrosive, flammable, toxic or radioactive goods.
- Annex 19: Safety Management: is the latest Annex developed by the ICAO, and which its first edition became applicable since the 14th November 2013. This first edition encompasses the Phase 1 of the Annex's establishment, which aims to consolidate the safety management provisions currently in force in other Annexes. Once the 1st edition became applicable, the Phase 2 is aimed to tackle the development of these improved requirements. Therefore, this Annex is in charge of the safety management processes under the direct responsibility of States, including the State Safety Programme (SSP) framework, the essential elements of a safety oversight system, the general and business aviation activities and the Safety Management System (SMS) requirements.

ICAO has a sovereign body, the Assembly, and a governing body, the Council. The Assembly meets at least once every three years and is convened by the Council. Each Contracting State has the right to one vote, and the decisions of the Assembly shall be taken by a majority of these votes. On the other hand, the Council is a permanent body, responsible for the Assembly and composed, for a period of three years, of representatives of 36 Contracting States. In addition, the Council and its subsidiary bodies set the directives for the work done by the Organization. One of its main functions, as mentioned before, is to work on the aforementioned Annexes, which cover all aspects of international civil aviation. Finally, the ICAO Council is supported by a General Secretariat based in Montreal.

ICAO has regional offices in order to facilitate the planning and implementation of basic services for air transport. The different regions in which ICAO has established them are the following:

- Africa-Indian Ocean (AFI),
- Asia (ASIA),
- Caribbean (CAR),
- Europe (EUR),
- Middle East (MID),
- North America (NAM),
- North Atlantic (NAT),
- Pacific (PAC),
- South America (SAM).

Spain has a Permanent Representative in the Council, a member in the Air Navigation Commission. Additionally, it participates with a large number of experts in the panels where the regulations in the different areas are developed. (3)

2.2.2 European Union Aviation Safety Agency (EASA)

Once the ICAO has established the SARPs for international aviation, is the turn of the EASA, regional organization, and of the NAAs, state-owned organizations, to constitute specific and distinct regulations which take the ICAO SARPs as a reference and try to follow these recommendations. The EASA was formally established in September 2002 and is active since the 28th September 2003. With its headquarters located in Cologne (Germany), this entity presents a series of advantages as it fits readily into the European Union (EU) legal system, it is fully compatible with EU aims and objectives, is connected to other EU institutions, and implements uniform rules in all EU Member States. In addition, the EASA gradually superseded the Joint Aviation Authorities (JAA) and a proportion of the NAAs activity and authority when created. Some important facts and figures of the Agency are shown in Figure 2-2.

Therefore, the EASA's mission comprises the insurance of the highest common level of safety and environmental protection for EU citizens, the creation of a unique regulatory and certification procedure for all

the Member States, the guarantee of an internal aviation single market with fair concurrence and the easy communication with other international aviation organisations and Authorities. The list of EASA's Member States is included in Annex A of this TFG, and the Agency's four international permanent representations are shown in Figure 2-3.

Figure 2-2. Some facts and figures provided by the EASA. (4)

With respect to the EASA's tasks, they include the creation of a first draft including rules regarding the aforementioned Agency's missions, the airworthiness (and other fields where it has exclusive competence) certification and approval of products and organisations, the advice and support in areas where EASA has shared competence, for instance, Air Operations or Air Traffic Management (ATM), and the cooperation with international regulators with the aim of achieving the highest common safety level (e.g. EU safety list, Third Country Operators authorisations). In Figure 2-4, is shown the EASA's budget in 2018, and how the different stakeholders contribute to this budget.

Figure 2-3. EASA's international permanent representations. (4)

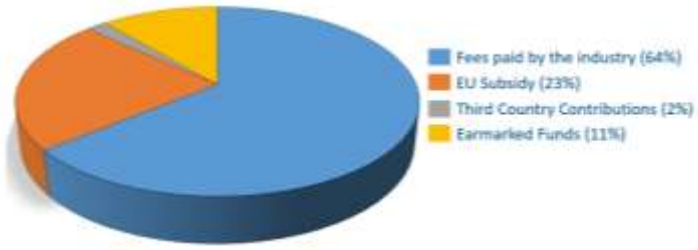


Figure 2-4. EASA's budget in 2018. (4)

There are three levels of decision and ownership in the EASA system. Firstly, the European Parliament and

Council are in charge of the Basic Regulation and its corresponding amendments. Secondly, the European Commission (EC) adopts rules for the implementation of the Basic Regulation. Finally, the Agency introduces the Certification Specifications (CS), Acceptable Means of Compliance (AMC) and Guidance Material (GM), documents that will be explained in more detail on the following sections. In Figure 2-5 the Agency's organization structure is shown, indicating every area of aviation covered by its organisms. Finally, it is important to mention that the EASA is the competent Community Aviation Authority for the safety of aviation since the entrance into force of the Basic Regulation. Additionally, every entity must follow all safety EASA regulations under international and community law.

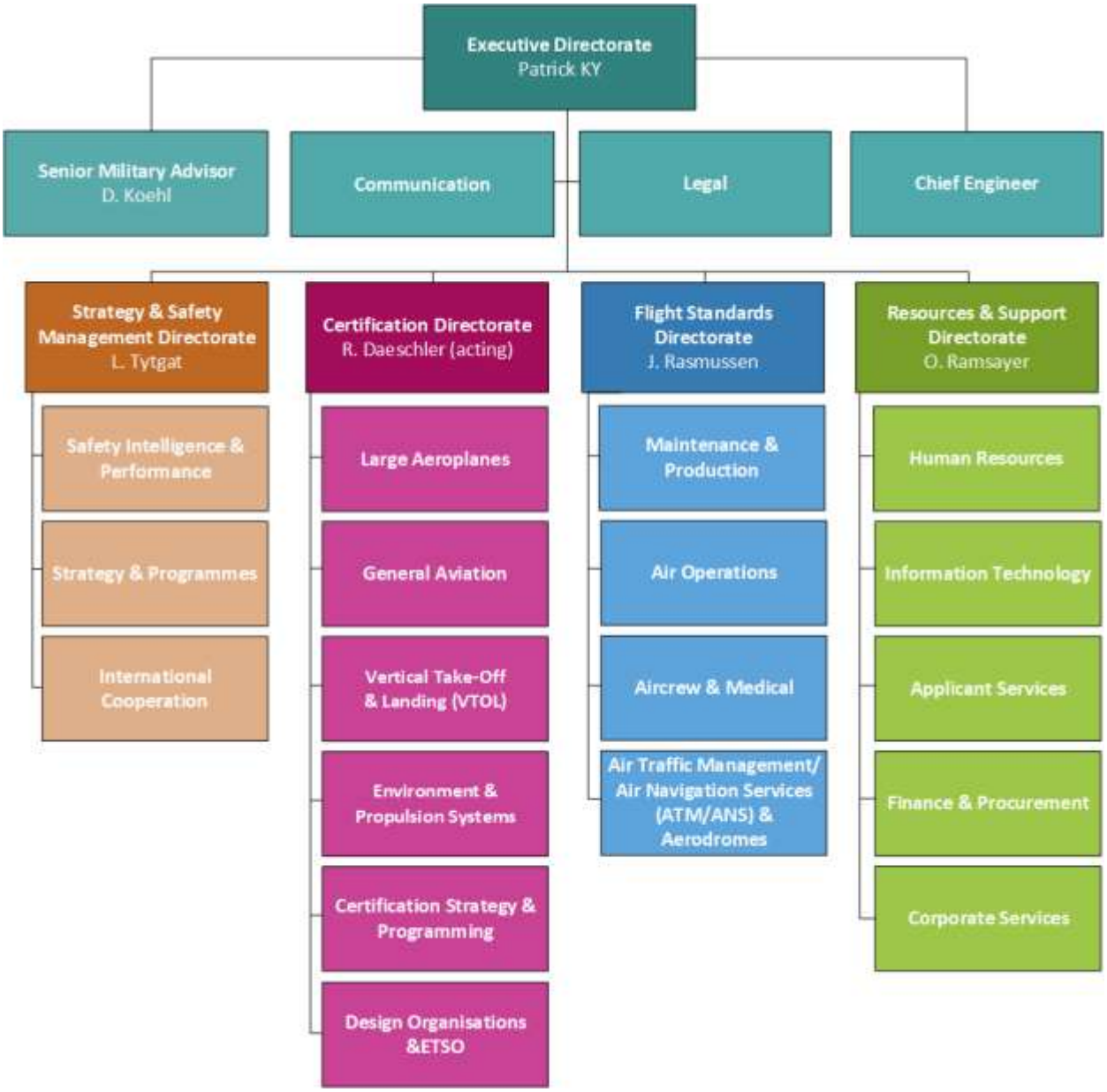


Figure 2-5. EASA organization structure. (5)

2.2.3 Federal Aviation Administration (FAA)

The FAA is the United States of America (USA) governmental entity responsible for the regulation of all aspects of civil aviation. The 20th May 1926, through the Air Commerce Act, the United States Department of Commerce created a division specialised on aeronautics and including licensing of pilots, certification and safety issues. In 1934, it was given the name of Bureau of Air Commerce and later, in 1940, President Franklin D. Roosevelt separated its competences into two agencies, the Civil Aeronautics Administration (CAA) specialised in ATM, and the Civil Aeronautics Board (CAB) in charge of safety and accidents follow-up. In 1958 the duties of the CAA were given to the FAA, while the CAB functions were transferred to the National

Transportation Safety Board in 1967. Therefore, nowadays "*Certification of aircraft by the FAA ensures that commercial and general aviation aircraft meet the highest safety standards, from initial design to retirement*." (6)

Some of the documents and areas tackled by the FAA are the following:

- Registration and Certification: which comprise the aircraft registration, the Airworthiness certification, the design approvals and the Flight Standards District Offices (FSDO);
- Advisories and Guidance: including Aircraft Safety Alerts, Airworthiness Directives (ADs), Aviation Maintenance Alerts, Service Difficulty Reports (SDR), Special Airworthiness Information Bulletins (SAIB) and the Aviation Safety Action Program (ASAP).
- Regulations and Policies: where we can find Advisory Circulars (ACs), Inspection and Oversight such as the Air Transportation Oversight System (ATOS).

Moreover, the FAA prescribes the Federal Aviation Regulations (FARs), rules which are part of the Title 14, *Aeronautics and Space*, of the Code of Federal Regulations (CFR), composed of 50 other titles. The FARs are organized into Parts within the CFR, as it can be seen in Figure 2-6.

Title	Volume	Chapter	Browse Parts	Regulatory Entity
Title 14 Aeronautics and Space	1	I	1-59	FEDERAL AVIATION ADMINISTRATION, DEPARTMENT OF TRANSPORTATION
	2		60-109	
	3		110-199	
	4	II	200-399	OFFICE OF THE SECRETARY, DEPARTMENT OF TRANSPORTATION (AVIATION PROCEEDINGS)
		III	400-1199	COMMERCIAL SPACE TRANSPORTATION, FEDERAL AVIATION ADMINISTRATION, DEPARTMENT OF TRANSPORTATION
	5	V	1200-1299	NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
		VI	1300-1399	AIR TRANSPORTATION SYSTEM STABILIZATION

Figure 2-6. Structure of the Title 14 of the CFR. (7)

A wide variety of activities are regulated, each one corresponding to a different Part. These activities include certification of pilots, schools, or aircraft, additionally to aircraft design and maintenance, or airline flights. Some of these sections or Parts are listed below, especially those related to airworthiness and certification:

- Part 1 – Definitions and Abbreviations
- Part 13 – Investigation and Enforcement Procedures
- Part 21 – Certification Procedures for Products and Parts
- Part 23 – Airworthiness Standards: Normal, Utility, Acrobatic and Commuter Airplanes
- Part 25 – Airworthiness Standards: Transport Category Airplanes
- Part 27 – Airworthiness Standards: Normal Category Rotorcraft
- Part 29 – Airworthiness Standards: Transport Category Rotorcraft
- Part 33 – Airworthiness Standards: Aircraft Engines
- Part 35 – Airworthiness Standards: Propellers
- Part 36 – Noise Standards: Aircraft Type and Airworthiness Certification
- Part 39 – Airworthiness Directives
- Part 43 – Maintenance, Preventive Maintenance, Rebuilding, and Alteration
- Part 61 – Certification: Pilots, Flight Instructors, and Ground Instructors
- Part 63 – Certification: Flight Crewmembers Other Than Pilots
- Part 65 – Certification: Airmen Other Than Flight Crewmembers
- Part 67 – Medical Standards and Certification

- Part 119 – Certification: Air Carriers and Commercial Operators
- Part 139 – Certification of Airports

Part 21 is one of the most relevant Parts related with this project and later on it will be seen that tackles nearly most of the areas which are studied in the Regulation (EU) No. 748/2012 of the EASA. It is divided into the following chapters or subparts:

- Subpart A—General
- Subpart B—Type Certificates
- Subpart C—Provisional Type Certificates
- Subpart D—Changes to Type Certificates
- Subpart E—Supplemental Type Certificates
- Subpart F—Production Under Type Certificate
- Subpart G—Production Certificates
- Subpart H—Airworthiness Certificates
- Subpart I—Provisional Airworthiness Certificates
- Subpart J [Reserved]
- Subpart K—Parts Manufacturer Approvals
- Subpart L—Export Airworthiness Approvals
- Subpart M [Reserved]
- Subpart N—Acceptance of Aircraft Engines, Propellers, and Articles for Import
- Subpart O—Technical Standard Order Approvals
- Subpart P—Special Federal Aviation Regulations

The Technical Standard Order (TSO), which approvals are seen in Subpart O of FAR Part 21, is a minimum performance standard for materials, parts, and appliances applied in civil aviation. The TSO authorization is equivalent to both design and production approval for the specific material, part, or appliances, and does not mean an approval to install and use the article in the aircraft. Other related TSO regulations and policies are also seen in ACs 20-41 and 21-43, types of documents seen before.

2.2.4 Spanish Civil Aviation Authorities

Apart from the EASA and the FAA , each NAA has prerogatives to develop its own regulatory system on the basis of the ICAO SARPs. Nevertheless, as mentioned in the previous section, both FAA and EASA have an important role on the global regulatory system. Therefore, bilateral agreements are done between governments, not involving aviation industry companies, with the aim of producing equivalent results despite procedures differ depending on the aviation safety system. These agreements are complemented by implementation procedures which define reciprocal acceptance and reliance.

With respect to the Spanish Authorities, the work of the Ministry of Public Works and Transport regarding aviation is to widely define the policies on airport infrastructures and air navigation, services, professionals, and passengers. It also supervises air safety and other related areas such as passenger rights. These functions are exercised mainly by the Agencia Estatal de Seguridad Aérea (AESA) and the Dirección General de Aviación Civil (DGAC). (8) In addition, within the aforementioned Ministry, but with full functional independence, there is the Comisión de Investigación de Accidentes e Incidentes de Aviación Civil (CIAIAC) which carries out the technical investigation of air accidents.

The AESA is the State's agency in charge of ensuring compliance with the Civil Aviation regulations concerning all aeronautical activity in Spain. It is considered an agency assigned to the Ministry of Public Works and Transport through the DGAC. Among its missions are the supervision, inspection and management of air transport, air navigation and airport security. It also assesses the risks in the security of air transport by detecting threats, analyzing and evaluating risks and a continuous process of control and mitigation of risks. Furthermore, it has the power given by the Ley de Seguridad Aérea, the Aviation Safety Law, to impose penalties in case of infractions of civil aviation regulations.

AESA is governed by the Law on State Agencies and by its own Statute. It has financial and Human Resources management autonomy, it is considered an Aeronautical Authority and it assumes the competences

over the areas indicated in Annex B of this project. Additionally, the AESA's tasks are listed in Annex C of this TFG. (9) In Figure 2-7 it is shown the structural organization of the AESA.

Figure 2-7. Structural organization of the AESA. (9)

Concerning the Spanish functions in the European Union, Spain as a member country, participates in the process of creating and modifying all the community's aeronautical matters. Representatives of Spain participate in the committees related to air transport and in the deliberations of the Council groups prior to the adoption of resolutions by the Transport and Energy Ministers. This process involves both officials of the Ministry of Foreign Affairs and officials of the Ministry of Public Works and Transport, mainly from the DGAC and the AESA. Depending on subject to be discussed, people from other Departments or Organizations can be consulted.

The main function of the DGAC in relation to these tasks is, on collaboration with the rest of interested organizations, to define national positions which are compatible with the common good of the EU and Spanish citizens. For this, a constant follow-up of the different legislative processes in progress is carried out, and efforts are made to have the greatest number of opinions from those interested in the aforementioned processes.

Additionally, Spain has a Representative in the EASA Council, and attends the numerous meetings that the EASA holds for national experts in their fields of activity. In addition, the AESA has signed contracts to perform services on behalf of the EASA and collaborates with the Agency in aeronautical product type certification, in the surveillance of organizations that design aeronautical products, and in the approval and monitoring of organizations that maintain aeronautical products in third countries. (9)

2.3 European Civil Aviation Regulatory Framework

2.3.1 The Basic Regulation and Implementation Rules (IRs)

As a result of the work of the European Parliament and Council, we obtain the Basic Regulation that rules Civil Aviation, which can be structured as shown in Annex D of this project. (10) Moreover, as mentioned before, the EC also establishes necessary measurements for the implementation of the Basic Regulation such as the Regulation (EU) No. 748/2012. In it, issues on airworthiness and environmental certification of the aircraft and other related parts and products, together with the certification of design and production entities are addressed. These documents are all encompassed in what are called IRs.

Probably, the most relevant part of the Regulation (EU) No. 748/2012 for the present project is the Annex I, commonly known as Part 21 (11). This part of the document is divided into:

- General
- Section A: detailing specific requirements for the Aviation Industry.
- Section B: including procedures for the corresponding authorities to use in order to grant approval and regulate once the approval is in place.
- Appendices: contain EASA Forms.

Likewise, both Section A and B are divided into the same Subparts, which are the following:

- Subpart A: General Provisions: to be considered regarding the rights and obligations of applicants and holders of certificates issued under Section A. Includes information about how to proceed with failures, malfunctions and defects, about Airworthiness directives and about coordination between design and production.
- Subpart B: TCs and Restricted TCs: subpart which establishes the issuance of a TC and Restricted TC, together with the rights and obligations of their applicants and holders. Subjects such as the demonstration of capability, the application, the special conditions, the Type Certification Basis, the operational suitability, the applicable environmental protection requirements, the compliance, the inspections and tests, the transferability, the validity or the record-keeping of these certificates are tackled. It is the most extensive subpart.
- Subpart C: Not Applicable.
- Subpart D: Changes to TCs and the Restricted TCs: includes the procedure for the approval of those changes, and describes standard changes which do not need an approval process under Subpart A. Additionally, a classification of changes is included.
- Subpart E: Supplemental Type Certificates (STCs): tackles the procedure for approvals of major changes to the TC under STC processes. It also takes into account the changes to a part of a product covered by a STC or the instructions for continued airworthiness.
- Subpart F: Production without POA: shows the "*procedure for demonstrating the conformity with the applicable design data of a product, part and appliance that is intended to be manufactured without a POA under Subpart G*" (11) and the obligations of the manufacturer. In addition, it comprises the issue of a letter of agreement, the production inspection system, the different tests on aircraft, propellers and engines or the state of conformity.
- Subpart G: POA for Products, Parts and Appliances: explains the procedure to show conformity of the products, parts and appliances with the applicable design data in order to issue a POA. This subpart includes points such as the quality system, the changes to an already approved production organization, how to proceed with location changes and the privileges of applicant and holders.
- Subpart H: Certificate of Airworthiness and Restricted Certificate of Airworthiness: indicates the procedure for the issuance of these types of certificates. Subjects such as the classification, the language, the existence of an amendment or modification or the transferability and re-issuance within Member States are included.
- Subpart I: Noise Certificates: establishes the procedure for issuing Noise Certificates. It includes the same points as Subpart H, but in this case specified for this type of cerficate.
- Subpart J: DOA: establishes the DOA procedure and rights and obligations of holders and applicants. Points such as the design assurance system and its changes, the terms of approval or the privileges are discussed.
- Subpart K: Parts and Appliances: establishes how to approve parts and appliances and explains how to comply with applicable requirements, or the release of parts and appliances for installation.
- Subpart L: Not Applicable
- Subpart M: Repairs: this subpart includes the classification of repairs, how to issue a repair design approval, the production of repair parts or a repair embodiment. When talking about repairs, it is important to take into account that the elimination of damage by replacing certain parts or appliances without needing a design process is defined as a maintenance task, meaning that it will not need any

approval under Annex I.

- Subpart N: Not Applicable
- Subpart O: European Technical Standard Order Authorisations (ETSOAs): in this subpart the procedure for an ETSOA issuance is established, including ETSOAs for Auxiliary Power Units (APUs). Additionally, the data requirements, the authorisation privileges, the approval of deviation, the design changes, or the inspections by the Agency are included areas.
- Subpart P: Permit to Fly: authorisation under the aircraft state of registry applicable regulations, and which can be supported by the Agency or an appropriately approved design organisation technical assistance. "*The process allowing a flight under a permit to fly can be described as follows:*

    1. *Overview.*
    2. *Approval of flight conditions.*
    3. *Issue of permit to fly.*
    4. *Changes after first issue of permit to fly*." (11)

  In this subpart, it is also established how to proceed with the competent Authority, with the different flight conditions, and with the renewal of the Permit to Fly.
- Subpart Q: Identification of Products, Parts and Appliances: which must include the manufacturer's name, the product designation, the manufacturer's Serial number and other information the Agency finds necessary. The handling of identification data is included, together with the differentiation of products and parts and appliances identification. Critical parts and ETSO articles are also tackled.

The information included in Regulation (EU) No. 748/2012 Annexes is clarified and detailed by some other documents of the Agency:

- AMC: illustrate a means, not necessarily being the only one, by which a requirement in an implementing rule can be met.
- GM: helps to illustrate the meaning of a specification or requirement.

Finally, is essential to indicate that the Member States can propose flexibility measures which will be analysed in terms of safety, and must be justified. Once proposed, only the final decisions taken by the EC will be legally valuable. These decisions will be backed up by the recommendations issued by the Agency.

2.3.1.1 Commission Regulation (EU) No. 748/2012 Part 21 Subpart B

As mentioned formerly, Subpart B establishes the issuance of a TC and Restricted TC for Products, together with the rights and obligations of their applicants and holders. Subjects such as the demonstration of capability and the application from a DOA including the use of Alternative Procedures in special conditions are tackled. The development of a certification plan and the applicable Type Certification Basis in explained. In addition, the need to ensure compliance, the operational suitability, the applicable environmental protection requirements and the inspections and tests done to comply are also explained. In the case of Operational Suitability Data & Testing, to show compliance, flight tests may be included. The applicant must consider all flight tests that the Agency finds necessary in order to determine compliance with the applicable Type Certification Basis and environmental protection requirements and to determine whether the aircraft functions properly to be certificated under the Regulation (EU) No. 748/2012. Regarding the Certification Plan, as indicated in AMC 21.A.20(b):

"*1.For a particular project and as part of the technical familiarisation, the applicant provides a certification programme […]*

2.The certification programme can be developed step by step, when the information needed is not available at the beginning of the project.

3.For a simple project, the certification programme can be proposed with the application.

4.The certification programme can be based on modules that can be updated independently." (11)

Additionally, Means of Compliance (MOC) codes, which will be useful for the compliance demonstration

phase, are stated in this Subpart. They can be classified as follows:

0. Definition, Statement: application of a required factor.
1. Description, Drawings: describes for each system the main architecture, functions performed, controls and flight deck indications.
2. Analysis, Calculations: full range, from oil quantity to structural loads.
3. System Safety Analysis: analyses systems failure modes and establishes criticism of each failure. The probability of the failure must be below a level corresponding to the criticism.
4. Laboratory Tests: includes any testing performed on components, or subassemblies, except testing on the Airplane itself. It is used for structure testing (static, fatigue, on partial or complete structure), and also for systems.
5. Aircraft Ground Tests: including extinguishing agent concentration, test in fire zones, vibration tests…
6. Flight Tests: used to establish performances, handling qualities, systems normal functioning and performances, assess failure cases criticalities…
7. Inspection by the Authorities: in case of complex installation features. May be made first on a mock up and final inspection on Airplane.
8. Simulator Session: used to evaluate failure cases too dangerous to be flight tested, or to save flight tests. Used to establish automatic landing system performances (autoland).
9. Equipment Qualification: equipment are classified as :
   a. Critical (class A): could cause a catastrophic failure.
   b. Essential (class B): could cause a major or hazardous failure.
   c. Non-essential (class C): may cause not more than a minor failure.

Furthermore, requirements on Instructions for Continued Airworthiness (ICAs) and European Part Approval are given. The transferability, the validity or the record-keeping of these certificates are also tackled. These certificates are only transferred to a natural or legal person who has already demonstrated capability of having it, and the duration of them is unlimited.

2.3.1.2 Commission Regulation (EU) No. 748/2012 Part 21 Subpart D

Subpart D refers to changes in TCs, also including restricted TCs. These last types of certificates are issued for aircraft operating in restricted category, which include limited operational scenarios specified in the applicable Type Design. For instance, some of these special operations include agricultural operations, forest and wildlife conservation, aerial surveying, patrolling, weather control, or aerial advertising (12)

Changes excluded from those approvals are indicated. Additionally, the GM states that the term ‘changes to the TC’, which is used in this Subpart D and in Subpart E, applies to changes in the Type Design and in following areas:

- Operating limitations;
- Type Certificate Data Sheet (TCDS) for airworthiness and emissions, and TCDS for noise ;
- Applicable type certification basis and environmental protection requirements used by the Agency to demonstrate compliance;
- Other conditions or limitations prescribed for the product in the applicable CS and environmental protection requirements;
- Applicable certification basis (only referred to changes to aircraft TCs, not including engine and propeller TCs).

2.3.1.3 Commission Regulation (EU) No. 748/2012 Part 21 Subpart O

In the case of a new equipment or component approval, ETSOAs must be issued. They must be in accordance with Regulation (EU) No. 748/2012 Annex I, Section A, Subpart O. The ETSO is also considered as a detailed airworthiness specification. For instance, in the case of avionics equipment, there are CS-ETSO chapters

dedicated to flight-deck instruments, communications radios, navigation equipment, collision avoidance systems, or flight data recorders among others (see Annex F). Normally, requirements on each chapter are related to:

- Explanation of applicability
- Exceptions and updated formulation
- References to related regulations, data, and publications
- Requirements for environmental testing
- Requirements for software design assurance
- Requirements for the marking of parts
- Operating instructions
- Equipment limitations
- Installation procedures and limitations
- Schematics and wiring diagrams
- Equipment specifications
- Parts lists
- Drawings list
- Equipment calibration procedures
- Corrective maintenance procedures

In terms of Production, the ETSOA holder must have either a POA, produce under compliance with Subpart F, or be related with an independent POA through an agreement. In terms of Design, the holder must hold an Alternative Procedures to DOA (ADOA), or a DOA in case of an APU, as it is considered in 21.A.604. It is also important to know that in third countries which have signed a full bilateral agreement with the EU, applications are not subjected to the organisational requirements.

There is a very important document that contains all the relevant references of the article and its definition, the Declaration of Design and Performance (DDP). As it is described in 21.A.608, in this document it must be shown that the article is designed, tested and manufactured complying with the applicable sections of the Regulation (EU) No. 748/2012 and CS-ETSO. Therefore, it must refer to the point 21.A.31 (a) and (b) regarding the Type Design, and must include information about the appropriate Maintenance, Overhaul and Repair Manuals.

In case the article design deviates from the requirements of the applicable ETSO standard, a deviation request needs to be approved by the EASA and the Applicant needs show an “equivalent level of safety (ELOS)”. The EASA provides a list of previously approved and rejected deviations sorted by ETSO standard, in order for the applicant to check if the request is needed. To conclude, for completing the ETSO data package, the following documents should be available:

- DDP
- Description of the article
- Compliance check list including means of methods used such as test, analysis etc.
- Project time schedule
- Matrix/report for the requirements not covered by testing or analysis based on test.
- Applicable test and qualification plans/reports

Moreover, EASA does not have the legal competence for approving articles which are designed only for military used. If the article has military embedded functions, it must be demonstrated from an ETSOA point of view, that these functions do not interfere with the CS-ETSO functions. However, the EASA will not work with those military functions or ensure special access and protection for the military data. Normally, this technical investigation is delegated to the NAAs.

Regarding the 21.A.619, where the duration and continued validity of the ETSOA is described, it is said that it has an unlimited duration. Some conditions that could affect its validity are established, including the holder obligations, unacceptable hazards, or applicable administrative procedures designed by the Agency. Furthermore, in the 21.A.621 it is specified that an ETSOA is not transferable, except for a

change in ownership of the holder. Finally, the reciprocal acceptance is addressed. Currently, and since March 2016, the American FAA will accept an EASA ETSOA and inversely, the EASA will accept the FAA's TSO Authorization for an article from the United States.

2.3.2 European Union Aviation Safety Agency Certification Specifications (EASA CSs)

With respect to the Agency decisions, they are also in charge of the CS, considered as Airworthiness codes, and of the associated AMCs. We can find numerous CS which are included in the different regulatory areas that the EASA is in charge of (Initial Airworthiness, ATM/ Air Navigation Services (ANS), Air Operations, Air Crew, Additional Airworthiness Specifications and Aerodromes). For the case of this project, only CS considering Initial Airworthiness will be useful. These titles can be found in Annex E of this TFG. (13)

2.4 Military Aviation Authorities

2.4.1 European Defence Agency (EDA)

Normally in Europe, military and state operated aircraft do not follow the processes explained in the former section under the EASA's regulation. Therefore, military airworthiness has been historically considered only at a national level. However, and with the objective of creating a European harmonized military regulation, the European Defence Agency (EDA) was created the 12th July 2004 under the Joint Action of the Council of Ministers. The EDA, which headquarters is in Brussels, is considered an intergovernmental agency of the EC and it is composed of 27 countries, all the EU Member States except Denmark. In addition, Administrative Arrangements have been done with non-EU members such as Norway, Switzerland, the Republic of Serbia, and Ukraine, which led them to collaborate in the Agency's projects and programmes. Member States can decide upon their participation in these projects depending on their national needs, and they contribute to the Agency's annual budget in accordance with a Gross National Product (GNP)-based formula.

The Agency structure, shown in Figure 2-8, "*brings together each aspect of the defence process, from cooperation planning, through capabilities, research & technology, armaments cooperation, to industry and market, as well as wider European policies*." (14) Therefore, the EDA fosters collaborations, issues new initiatives and proposes measurements to improve defence capabilities (15)Furthermore, the EDA's Military Airworthiness Authorities (MAWA) Forum created harmonized European Military Airworthiness Requirements (EMARs). Even though these are just requirements, not having as a consequence legal power, they are followed as guidelines by a number of states, not only European states, but also from outside Europe. Therefore, the EDA is just an organism that provides advice on military certification requirements. EMAR 21 is the equivalent of the EASA's Regulation (EU) No. 748/2012. It has the same structure and addresses the following areas and processes (16):

- Subpart A - General Provisions
- Subpart B - Military TCs and Military Restricted TCs
- Subpart D - Changes to Military TCs and Military Restricted TCs
- Subpart E - Military STCs
- Subpart F - Production without Military POA
- Subpart G - Military POA
- Subpart H - Military Certificates of Airworthiness and Military Restricted Certificates of Airworthiness
- Subpart J - Military DOA
- Subpart K - Parts and Appliances
- Subpart M - Repairs
- Subpart O - European Military Technical Standard Order Authorisations
- Subpart P - Military Permit to Fly
- Subpart Q - Identification of Products, Parts and Appliances.

The most important factors and benefits foreseen with the creation of the EMARs are (16):

- Improvement of the security of military aviation.

- Allowance for greater military-military and civil-military cooperation.
- Reduction in time and cost of developing new aircraft.
- Increase in competitiveness of the European defence industrial and technological base.
- Introduction of a common approach for maintenance and repair.
- Enabling an approval process and common training program for maintenance personnel.
- Enabling recognition among the different airworthiness authorities.
- Improvement of prospects for outsourcing maintenance and repair.
- Facilitation of cross-border maintenance.
- Improvement in cooperation of armaments through the harmonization of airworthiness.
- Improvement in recognition by civil aviation authorities.
- Improvement of interoperability when carrying out joint air operations.

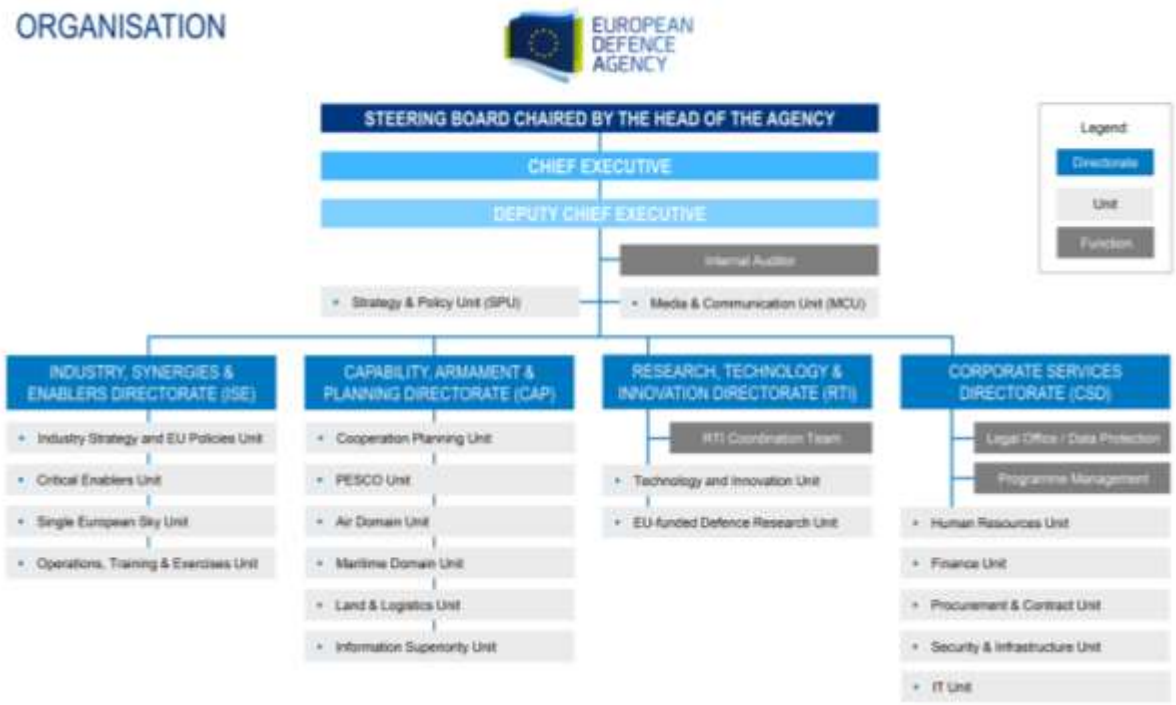


Figure 2-8. EDA's organisation. (14)

2.4.2 Spanish Military Aviation Authorities

In Spain, the equivalent to the EMAR 21 is the Publicación Española de Requisitos de Aeronavegabilidad Militares (PERAM) 21, which tackles the certification of military aircraft, products, components and equipment used for design and production. (17) In addition, in Spain there is the Dirección General de Armamento y Material (DGAM), responsible for the preparation, planning and development of the Arms and Materiel policy, as well as the supervision and direction of its execution. Its main objective is to provide the Armed Forces with the best weapons systems and equipment they need for the fulfillment of their missions. Its director and maximum authority is the Director General de Armamento y Material (DIGAM), currently Admiral Santiago Ramón González Gómez. The Royal Decree 866/2015, by which the Reglamento de Aeronavegabilidad de la Defensa (RAD), Defense Airworthiness Regulation, is approved, establishes that the Autoridad de Aeronavegabilidad de la Defensa (AAD), Defense Airworthiness Authority, is the DIGAM and it will be assisted for the exercise of its power by the Consejo de Aeronavegabilidad, Airworthiness Council, which is the DIGAM's technical working organism. (18) The Airworthiness Council works with the personal, technical and budgetary resources assigned to the DGAM. The functions of this Council are the following (18):

a) Approve the certification bases for obtaining the Type, Provisional and STC.

b) Inform previously about the issuance of the type, provisional and STCs as well as their revisions.

c) Propose to the AAD the airworthiness directives that are considered necessary, as well as establish the procedure for their preparation.

d) Report previously to the authorization by the AAD of the aeronautical engineers that issue and renew the airworthiness certificates contemplated in the Royal Decree 866/2015.

e) Establish the approval procedures for documents of foreign origin related to the maintenance of the airworthiness of domestic and imported products.

f) Develop in relation to airworthiness, general guidelines and procedures issued by the AAD for the development and interpretation of the regulations included in the Royal Decree 866/2015, and harmonize their application within the scope of each Army, institute, agency or service dependent or linked to the Ministry of Defence or Civil Guard.

g) Support the AAD in relationships with international civil and military airworthiness organizations, in order to know and propose the application of international norms and practices of general interest and, in particular, of those coming from the scope of the EDA.

h) Promote training in airworthiness issues of personnel that may be considered affected by the application of the Royal Decree 866/2015.

Additionally, the Airworthiness Council has the following members (18):

- President: the AAD.
- Vice-president: the DGAM's Inspection, Regulation and Industrial Strategy for Defence General Subdirector.
- Vocals
- Secretary: named by the AAD and who, in case of a Council's meeting, will not have the authority to vote.

Regarding Research & Development (R&D), the Ministry of Defence has the power to promote and coordinate scientific and technical research on matters that affect national defence. The Instituto Nacional de Técnica Aeroespacial (INTA), is considered as a Public Research Agency dependent on the Ministry of Defence. In addition to carrying out activities of scientific R&D of systems and prototypes in its field of knowledge, it provides technological services to companies, universities and institutions. Therefore, its main functions include (19):

- The performance of various types of tests for the verification and certification of materials, components, equipment, systems and subsystems.
- Technical advice and provision of services to official entities and agencies, as well as to industrial or technology-based companies.
- The performance as a technological centre of the Ministry of Defence.

Moreover, for its operation and administration, the INTA is divided into General Subdirectorates under the authority of the General Director. With the integration of the INTA, the DGAM, as a directive organ, carries out the planning of the investigation, development and innovation of the Ministry of Defense, and the INTA, as an autonomous body, participates along with other entities in its execution. Furthermore, the INTA is represented by a vocal in the Airworthiness Council.

In terms of bilateral cooperation, the DGAM aims to generate the best conditions for the acquisition of weapons and material of interest to our Armed Forces and for meeting common and complementary needs. This policy is carried out through the strengthening of bilateral relationships with allied countries with who fluid and stable contacts are maintained and, in many cases, at multilateral level in international forums and organizations. Particularly, Spain has signed a large number of bilateral agreements with more than 50 countries. The majority of them involve quality assurance, cooperation in the cataloging of articles of defense material, and technical agreements related to a specific weapon program or system. For instance, some of the main areas of relationship with Europe nowadays are (20):

1. The Maastricht Treaty: by which the EDA in terms of defense capabilities, research, procurement and arms, will determine the operational needs, promote measures to meet them, help define and apply any measure, and assess the EC in the improvement of military capabilities.
2. The Letter of Intent/Framework Agreement for European Defence Industrial Restructuration (LoI/FAEDIR): an agreement between Germany, Spain, France, Italy, Sweden and the United Kingdom, which objective is the implementation of a series of measures aimed at facilitating and restructuring the European defense industry.
3. The Organisation Conjointe de Coopération en Matière d'Armement (OCCAR): established with the objective of improving the efficiency and cost of armament cooperation programs.

2.5 How do companies work?

Nowadays, all the certification processes, especially if it does not require the certification of a whole aircraft, can be started online through the EASA Applicant Portal, which is available for EASA member states, the US and Canada. (21) It helps applicants to monitor their application, checking their status and level of advancement. They can also easily manage their own contact details and user credentials, reducing administrative transactions. Through the Applicant portal, the following applications can be made:

- Major Change
- Major Repair
- Derivative
- Minor Change (including Minor Change to the STC)
- Minor Repair
- STC– Initial
- STC– Major Change
- ETSOA – Initial
- ETSOA – Minor Change

3 General Certification Process

In this chapter, the basic steps of a general certification project in the aeronautical sector under European legislation are detailed. As it has been seen in the former chapter, and taking as a basis the EASA's Regulation (EU) No. 748/2012 Annex I, these certification processes can be divided into the following areas for Civil domain:

- Products:
  - Fixed-wing and rotary-wing Aircraft
  - Engines
  - Propellers
- Emissions
- Noise
- APU
- ETSO
- Avionics equipment
  - Hardware
  - Software

In the case of Military Aviation, also the area of Weapons is tacked. As a result, and due to the differences in processes and legislation, these fields are going to be analysed separately. Firstly, we are going to introduce the certification of Products, including aircraft, engines and propellers, as this general process will serve as a basis for the other areas. Secondly, the certification of equipment and components is described, including the ETSO, APU and avionics equipment. It is important to mention that this chapter will only comprise Civil Aviation certification processes, not making reference to the Military domain.

3.1 General Certification Process for Products

As mentioned in the former chapter, regarding the certification of new products, the EASA is responsible for the EU and for some European non-EU countries. In terms of manufacturers, two approvals based on the EASA's Regulation (EU) No. 748/2012, have to be issued by the Agency: the DOA and the POA. It is important to consider that an ADOA can also be issued instead of the normal DOA. However, it does not contain some privileges as a consequence of its simplified nature. It can be considered as a starting phase for a Subpart J DOA, meaning that depending on the Design Organisation criteria, it could later on be completed to a full Subpart J DOA by adding missing elements. Once these approvals have been issued by the Agency, the Certification of Airworthiness is delivered by a State to an individual Aircraft after:

- Type Design definition approval: involves documents defining the aircraft design characteristics including drawings, processes, limitations…
- The Type Certification: involves the TC delivered by the Authority to a company designing a product which attests that the generic product defined by a Type Design complies with the relevant technical airworthiness requirements.

So far, only the European regulations were explained and analysed. Even though the FAA processes are very similar, there are some big differences in the certification process. In the case of the EASA, Members States are the ones that, through their national authorities, carry out the actions imposed by the Agency. This is the case of TCs issuance for new product, issued by the Member State authority after the EASA Team approval. In addition, the FAA has an individual delegation mechanism, the FAA Designee system, while in the EASA certification tasks are performed directly by their specialists or together with their counterparts when it is the case of non-civil air authorities. The FAA Designees are individuals who meet certain specific qualifications and can act on behalf of the FAA, taking part in different activities and roles. For instance, in the case of avionics developers, they normally work with FAA Designated Engineering Representatives (DERs) and either Designated Manufacturing Inspection Representatives (DMIRs) or Designated Airworthiness Representatives (DARs). Finally, an important difference is that the EASA charges fees for the certification work done to the applicants, while the FAA does not.

The European Type Certification Process can be divided into four steps (22):

1. Technical Familiarisation and Certification Basis
2. Establishment of the Certification Programme (CP)
3. Compliance demonstration
4. Technical closure and issue of approval

3.1.1 Technical Familiarisation and Certification Basis

Firstly, an application letter must be sent to the EASA when the project has reached a sufficient degree of maturity. After its acceptance, the nomination of the EASA Team takes place, designating a Project Certification Manager (PCM) and the rest of team members. The general presentation of the project and Certification Objectives is done during the first meeting between the Authorities and the Applicant. Secondly, during the specialists' meeting, a detailed presentation of the systems subjects is done, with the identification of attention items. This will include potential special conditions or anticipated compliance demonstration difficulties.

Following the former procedures, the establishment of the Certification Basis starts. This set of rules includes:

- Airworthiness Codes: including CS documents.
- Special Conditions: applied when Airworthiness requirements of the relevant CS do not contain adequate or appropriate safety standards for the product.
- Equivalent Safety finding (ESF): used when direct conformity with the requirement cannot be shown.
- Exemption: when particular requirement is not applicable.
- Elect to Comply: in case the applicant wants to comply with later effective amendments.

3.1.2 Establishment of the Certification Programme (CP)

The MOC is the starting element of the CP. They are proposed by the Applicant, discussed with the specialists' teams and agreed. It is the opportunity to identify, discuss and finally agree on specific interpretations, methods of demonstrations (existing or to be developed) and need for possible equivalent safety demonstration. To sum up, the MOC are the way used to show that the proposed design complies with the requirements. After agreement, they are recorded in the Compliance Basis through the conventional coding shown in Section 2.3.1.1.

To conclude, this part of the certification process could be divided into three basic steps:

- Organisation of the certification work per Air Transport Association (ATA) chapter.
- Identification of the applicable Joint Aviation Requirement (JAR)/CS paragraphs for each applicable system or ATA chapter.
- Once Certification Basis and interpretations established, Applicant and Team agree on MOC, for instance, the methods to be used to show compliance for each ATA.

Based upon the agreed MOC, the Applicant proposes a CP for each ATA chapter. It must include details for each applicable JAR/CS paragraph applicable for the system or ATA chapter, the agreed MOC and the corresponding justification documents and reports. It must also contain details on the planning of the certification activities (analyses, test, inspections, etc) and must be agreed by the Team. The Team also defines its "level of involvement" in the compliance finding activities by stating which tests it wants to witness, and which documents it wants to review and approve.

3.1.3 Compliance Demonstration

According to what agreed in the CP, the Applicant performs the Compliance demonstration activities which can include calculations, computer simulations, wind tunnel simulations, flight and ground tests or bench and field tests among others. Periodic meetings between the Applicant and the Team are necessary in order to review the progress and discuss the reports. These meetings will be set once the demonstrations have a certain level of maturity, if any deviation from what planned takes place, or depending on the project management approach chosen by the Team. This is the phase of the procedure that takes more time to be completed, and in the case of large aircraft is set to a maximum of five years, which can be extended if necessary.

Therefore, the compliance demonstration can be divided into the following activities:

1. Investigation of compliance demonstration: checking of compliance demonstration documents delivered by the Applicant including, for instance, compliance statements, calculations, assessments, test reports, etc. The Airworthiness Code and corresponding GM and Certification Review Items (CRIs) must also be revised against the criteria of the agreed CP, always taking into account the level of involvement. Finally, the investigation results are communicated to the Applicant, after each Team Member evaluates the acceptability of the data.
2. Issuance of Expert Statement of Technical Satisfaction: issued by each Team Member or panel, if applicable, to the PCM once the investigation has finished.
3. Reception of Declaration of Compliance: which has to be issued by the Applicant and verified by the PCM.
4. Determination of need for postcertification items: which certification will not be finished by the Certificate/Approval issuance.
5. Request of amended compliance data: media by which the Team communicates to the Applicant the reasons for which the Team determines that some compliance demonstrations are not applicable, valuable or acceptable.
6. Documentation of postcertification items.
7. Compilation of Final Report and TCDS (if applicable): presented to the Certification Management in case of a TC or Restricted TC.
8. Presentation of the certification project summary (if asked): decision taken by the Certification Management. It is presented to the Internal Safety Committee (ISC).
9. Issuance of Technical Visa: before the signature, use DOA database or contact DOA Team Leader in order to check the DOA Demonstration of Capability.

3.1.4 Technical Closure and Issue of Approval

At the end of the CP, a TC may be issued when all analyses, testing and justification reports have been delivered by the Applicant and accepted by the Team. In case of a negative decision by the Agency, which will imply a refusal of the TC approval, a justification is provided in writing by the EASA to the Applicant. The Agency can choose to get legal support if it considers necessary for the decision justification. This will be communicated by the Applications Management Section, and no archiving of the application will be needed. The PCM has the option of retaining the documents received throughout the whole certification procedure.

The documents associated to the TC are also issued by the Applicant and approved by the Team, including the Aircraft Flight Manual (AFM), TCDS, or the ICAs. Finally, the Team final report is presented to the EASA which will issue the TC, signing the certificate or approval another person than the PCM but with proper

delegation.

European aircraft models are also being validated at the same time by foreign authorities in terms of operation in their airspaces. This is the case, for example, of the FAA for the USA or the Transport Canada Civil Aviation (TCCA) for Canada. Inversely, the EASA will validate the foreign authorities' certification according to the applicable Bilateral Aviation Safety Agreements mentioned in the previous chapter.

3.2 General Certification Process for Equipment

Taking the certification process of a product as a reference, it can be said that the certification process of equipment has four main steps: definition of the product, establishment of regulatory requirements, compliance demonstration and technical closure. For EASA Member States, the USA and Canada, application for equipment certification can be done online as explained in Section 2.5. As formerly indicated, the ETSO data package for the application of an ETSOA must include the following elements:

- DDP
- Description of the article
- Compliance check list including means of methods used such as test, analysis etc.
- Project time schedule
- Matrix/report for the requirements not covered by testing or analysis based on test.
- Applicable test and qualification plans/reports

This type of certification process, where the aim is to obtain an ETSOA, is based on the PR.CERT.00003-003, internal certification working procedure published by the Certification Directorate which explains how EASA carries out its certification tasks internally. Particularly, this procedure applies to ETSOAs, changes to ETSOAs and approvals of deviation from any performance standard of an ETSO in accordance with Subpart O of Annex I to Commission Regulation (EU) No. 748/2012. In addition, ETSOAs of non-EU products and suspension or revocation of certificates are tackled. (23). Once applied, the ETSOA Application follows internally the process shown in Figure 3-1.

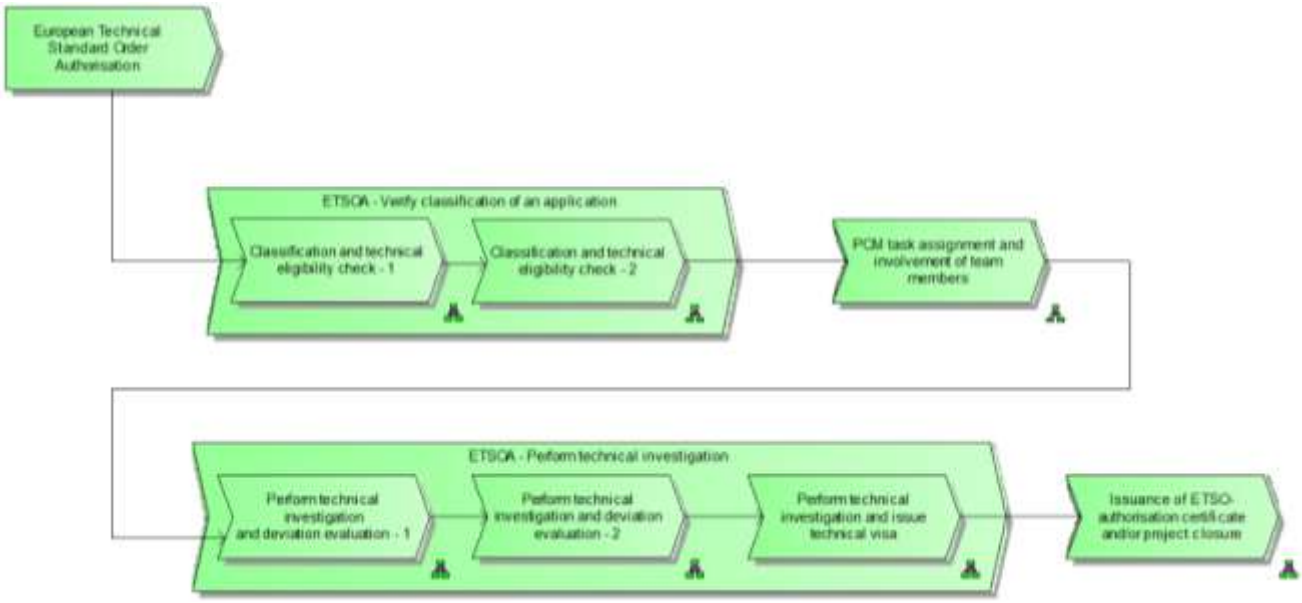


Figure 3-1. EASA internal procedure for issuance of ETSOA certificates. (23)

Obtaining an ETSOA after the applicant has shown compliance with applicable requirements means both, a design data approval and a production approval, being the applicant able to reproduce identical units. In order to encourage mutual understanding between the agency and the applicant, early discussion has to be done on product expectations. However, the ETSOA does not cover approval for installation in the product. These last types of approval are seek through other means and are not even necessarily carried out by the equipment manufacturer.

Aircraft performance, structural and electrical loading, weight and balance, human factors, and other aspects must be analysed as a consequence of the aircraft modification. Every part of the modification must comply with its specifications, and the whole aircraft modification must undergo an installation conformity inspection. On the other hand, in the case of compliance inspections, only physical inspection is needed in order to check if the modification complies with the applicable CSs, for instance, surveying the modified wiring on the aircraft.

Finally, it is important to consider if the new equipment installed involves new crew procedures. If it is the case, an amendment to an approved AFM must be done, and even consider a supplement to an operations manual if it is a complex system. Additionally, an amendment to a maintenance manual must be issued in order to provide instructions for continued airworthiness. Supplements can also be considered in this case of parts catalogues, structural repair manuals, or component maintenance manuals.

3.2.1 General Certification Process for Avionics Equipment

Regarding the ETSOA Application for avionics equipment, the process that has to be followed by the Applicant when doing the certification plan and completing the ETSO data package is schematized in Figure 3-2. Firstly, top level and A/C level requirements have to be considered. For instance, in the case of large civil aircraft, CS-25 AMC 25.1309 is considered, and the corresponding CS-ETSO has to be revised.

Secondly, MOC 9, equipment qualification, needs to take place. We have to make reference to the "Industrial Standards" defined by the European Organization for Civil Aviation Equipment (EUROCAE) in Europe through the EUROCAE Documents (EDs) and by the Radio Technical Commission for Aeronautics (RTCA) in the USA through their Documents (DO). During this phase, a deeper analysis of the specific equipment itself is done. It comprises the safety analysis, the system development, and the software and hardware certification phases shown in Figure 3-2. Finally, the process has to be followed inversely in order to verify and validate that each step has been successfully completed and integrated.

Figure 3-2. Schematic avionics equipment certification process. (24)

3.2.1.1 Certification Specification

Avionics equipment manufacturers and suppliers must establish the system specification basis. This will include details on normal and abnormal operation, functional testing, training or maintenance procedures, covering areas such as performance, safety, maintenance, and continued airworthiness. Normally, the CSs are used for these tasks, for instance, CS-25 for Large Aircraft, CS-22 for Sailplanes, or CS-23 for Normal-Category Airplanes.

In addition, the applicant must demonstrate that these requirements are properly met. Depending on type and complexity of the project, either MOCs are specified manually along with the corresponding requirements, or databases are done in order to control requirements and compliance information.

3.2.1.2 System Safety Assessment (SSA):

The SSA of avionics equipment is one of the most important steps of the product certification, and it has to be done as early as possible in the process. Probably, the determination of the aircraft-level hazards associated to the corresponding equipment is the main aim, among others, of this step. As it is shown in Figure 3-3, there is an inverse correlation between the probability of failure and the severity of failures. Therefore, minor failures are tolerable and more likely to happen, while catastrophic hazards must be extremely improbable to happen. In addition, regulations establish that no single failure must, despite of probability, result in a catastrophic hazard, which could only then be caused by two or more independent failures occurring simultaneously.

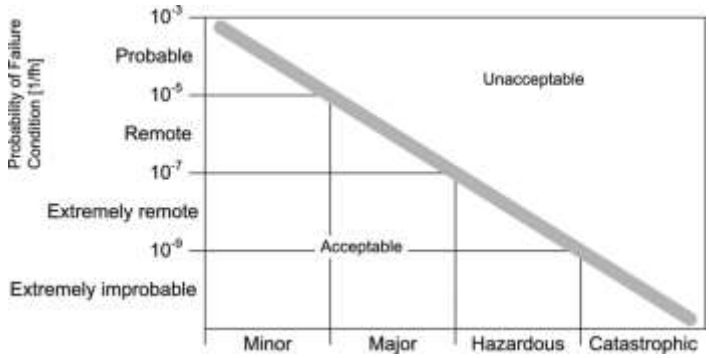


Figure 3-3. Probability vs. severity of failure condition effects. (25)

The Functional Hazard Assessment (FHA) addresses hazards in terms of systems operation. For instance, a display system FHA would consider the hazards of active but misleading displays along different phases of flight. Normally, if an abnormal operation of the system has nearly no effect, o doesn't affect the safe continuation of the flight there's no need of a detailed study in terms of safety assessment. However, if a possible risk is detected, a further work must be done involving:

- Preliminary SSA (PSSA)
- SSA
- Fault Tree Analysis (FTA)
- Failure Mode and Effects Analysis (FMEA)
- Failure Modes and Effects Summary (FMES)
- Common Cause Analysis (CCA), consisting of:
    - Zonal Safety Analysis (ZSA)
    - Particular Risks Analysis (PRA)
    - Common Mode Analysis (CMA)

All these procedures are tackled in the ARP4761, an Aerospace Recommended Practice (ARP) from the Society of Automotive Engineers (SAE). Figure 3-4 shows the different processes included.

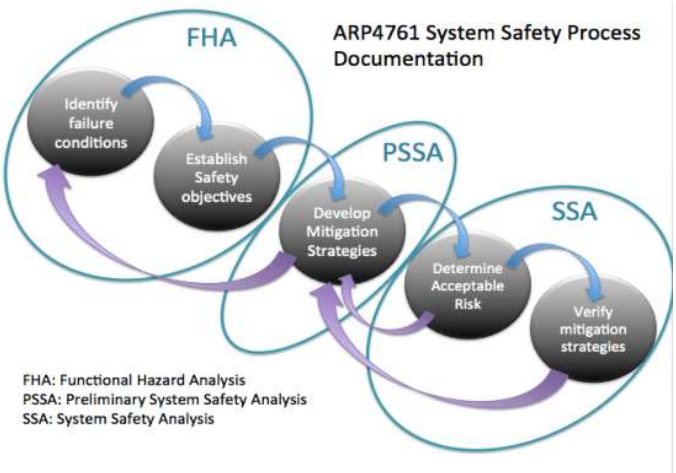


Figure 3-4. System Safety Process Documentation according to ARP4761. (26)

3.2.1.3 System Development:

The ARP4761 together with the ARP4754, is used for compliance demonstration with the FAR 25.1309 from the FAA in the USA and CS 25.1309 of EASA in Europe. The ARP4754 defines what is known as the "*complete aircraft development cycle, from systems requirements through systems verification*" (27) shown in Figure 3-5. It is backed up by other aviation standards such as the RTCA DO-178C and B, and DO-254, which are equivalent to the EUROCAE ED-12B and ED-80 processes. These documents are tackled in the next phase of the process where the software and hardware are analysed.

In the case there is not a clear aircraft installation of the equipment, assumptions must be made regarding avionics operation. Apart from the safety assessment, reliability of the equipment must be analysed in order to determine the frequency of failures.

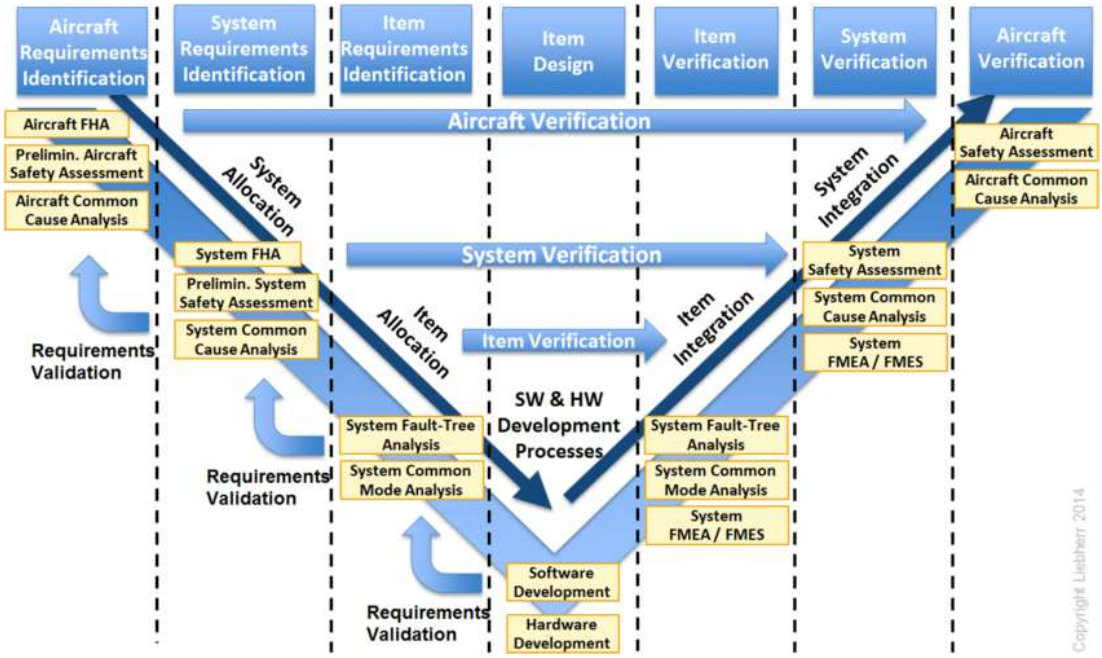


Figure 3-5. Avionics V Model according to ARP4754A. (28)

3.2.1.4 Software and Hardware Certification:

When establishing the certification plan, this step has become very important. As stated in the former point description, regulatory compliance for software is shown through the DO-178B and C, which is considered an assurance standard, meaning that it does not interfere in development methods. As a consequence, assurance criteria regarding planning, requirements definition, coding, integration, verification, configuration management, and quality, can be proved using the manufacturer's own methods.

In addition, the DO-178B/C defines what is known as Development Assurance Level (DAL). It determines corresponding software hazard classifications resulting from the former safety assessment. DAL establishes 5 assurance levels, from A, where malfunction of the software can cause catastrophic failure, to E, where no effect is appreciable. Therefore, it contributes to the mitigation of risks together with the FHA. Two types of DALs are described, Physical DAL related with items, and Functional DAL related with software and systems integration, covering the Functional Safety Process as a part of an Integrated Development Process. One example of a Level A software is fly-by-wire primary control systems, while passenger entertainment software is almost all Level E. Of course, the more critical the software is, the more certification data will generate.

In some cases, avionics customers demand higher assurance levels than those proven by safety assessment. This issue can be solved by separating the customer's contract from the regulatory compliance data submitted to the Agency, which must be based on safety assessments. As a result, proofs needed to demonstrate contractual compliance to the higher level should stay between supplier and customer, not being required for certification. Additionally, the applicant can undergo minor changes to equipment already approved under an

older standard than the DO-178B/C. In these cases, the Agency forces them to follow DO-178B/C without changing the software, and rarely, they are made to rework the product.

Regarding the data collected during the software development process, applicant should decide together with the Agency what has to be necessarily submitted. However, as treated in the DO-178B/C, Section 9.4, the applicant must save all the important and useful data of the process, as the Agency can at any time ask for it. Furthermore, for programmable logic devices, the Agency can tailor its generic issue paper, having to include the tailored version in the certification basis of the corresponding project. Additionally, assurance of all avionics hardware design processes is also made in reference to DO-254.

3.2.1.5 Environmental Qualification:

In the case of avionics equipment, environmental justification is necessary. Documents such as the DO-160D are used, which is equivalent to the ED-14D. In them, test regarding environmental factors such as temperature range, humidity, crashworthiness, vibration, susceptibility to radiated and conducted radio frequencies or lightning tolerance are tackled. In addition, some other documents used for testing are the International Organization for Standardization (ISO) 7137, or the ED-12() (equivalent to RTCA DO-178()), as recognized by AMC 20-115(). On the military field, other documents are followed such as the US Military Standard (MIL-STD) 810. (11)

When testing, the test locations configurations must be controlled and acceptable for the corresponding tests. It is under the applicant's responsibility to decide the environmental test to used, and how to show conformity with an approved test plan, test setup, and formal witnessing of tests by the Agency specialists. If the equipment is not manufactured in accordance with a production approval, inspection of the process may be required. However, it is always necessary to evidence the test results.

4 Certification Process Focused on Avionics Equipment

In Chapter 4, the Certification Process of an avionics equipment is going to be developed. Firstly, a description of avionics equipment is included, followed by the example of the Ground-Based Augmentation System (GBAS). Secondly, the general certification procedure for a real GBAS system is going to be explained step by step, including documents that must be issued, regulations that have to be used, and ways of showing compliance. As the scope of this project is limited to avionics systems which are embedded in the aircraft, the system chosen to be certified is the TLS755 Multi-Mode Receiver (MMR), developed by Thales. Even though the GBAS system is also composed by a ground facility which interacts with the airborne embedded systems, the analysis is going to be limited in order to adjust it to the TFG scope.

The reason why the GBAS has been chosen to be studied instead of other avionics equipment is because it has a very important role nowadays in Next Generation Plans, as it is considered the only cost effective option that will replace in a future the Instrument Landing Systems (ILS). It can provide terminal, non-precision and precision approach capabilities and can cover multiple precision approaches within a local area, instead of having to use separate ILS facilities for each runway. Therefore, this implies important cost savings in maintenance and installation. In addition, GBAS can guarantee curved or complex approaches, improving the aircraft capacities of avoiding obstacles and decreases the noise levels in areas surrounding the airport.

4.1 Avionics Equipment

4.1.1 General Concepts and Examples

Avionics can be defined as the application of electronics to aviation. It encompasses all the electronic systems used in aircraft, artificial satellites and spacecraft, in terms of both communication and navigation systems and their indicators and management components. As a consequence, this term describes a huge number of systems that are used in aircraft to perform different types of tasks.

Many of the progress made in avionics have resulted in much more complex, robust and integrated cockpit as is shown in Figure 4-1. These flight control systems or Flight Management Systems (FMSs), integrate communication and navigation radios, Global Navigation Satellite System (GNSS) sensors, telemetry equipment, transponders, etc. They can be based on an Inertial Measurement Unit (IMU) or Inertial Measurement System (IMS) to give a reference of autonomous navigation, hybridize with GNSS receivers in order to provide accurate navigation data to the crew and autopilots.

Regarding the development of aviation, avionics equipment plays an important role in initiatives such as the Next Generation Air Transportation System project developed by the FAA, or the Single European Sky ATM Research (SESAR) in Europe. Some of the objectives of these projects include the improvement of navigation and routing, the allowance of operations with weather constraints and with less ground infrastructure, the increase in safety during approach and departure phases, or the improvement of ATM processes.

Figure 4-1. Example of avionics systems located at the cockpit. (29)

Normally, most of the avionics systems are located or embedded in the cockpit of the aircraft, including control, monitoring, communication, navigation, weather, fuel and anti-collision systems. In most of the cases, Direct Current electrical systems are used powered by 14-28 W. However, Alternating Current systems can be used in larger and more complex aircraft, operating at 400 Hz, 115 W. The Airlines Electronic Engineering Committee (AEEC) is the one in charge of the International standards for avionics equipment which are published by Aeronautical Radio, Incorporated (ARINC).

With respect to navigation, we can find as mentioned before, satellite navigation systems such as the Global Positioning System (GPS) or Wide Area Augmentation System (WAAS), inertial navigation systems, ground-based radio navigation systems such as Very High Frequency Omnidirectional Range (VOR), and many others which combine some of these systems. Regarding the fuel control systems, the Fuel Quantity Indication System (FQIS) or the Fuel Control and Monitoring System (FCMS) are in charge of monitoring the level of fuel on-board. In case of anti-collision systems, for example the Traffic Alert and Collision Avoidance System (TCAS) detect surrounding aircraft, and can provide instructions for avoiding collision in the regions shown in Figure 4-2. In addition, systems such as the Ground Proximity Warning System (GPWS) or the Terrain Avoidance and Warning System (TAWS) alert about proximity to the ground. Finally, systems such as the Health and Usage Monitoring Systems (HUMSs) are embedded with aircraft computer, working together with measuring devices in order to guarantee early warnings and safety.

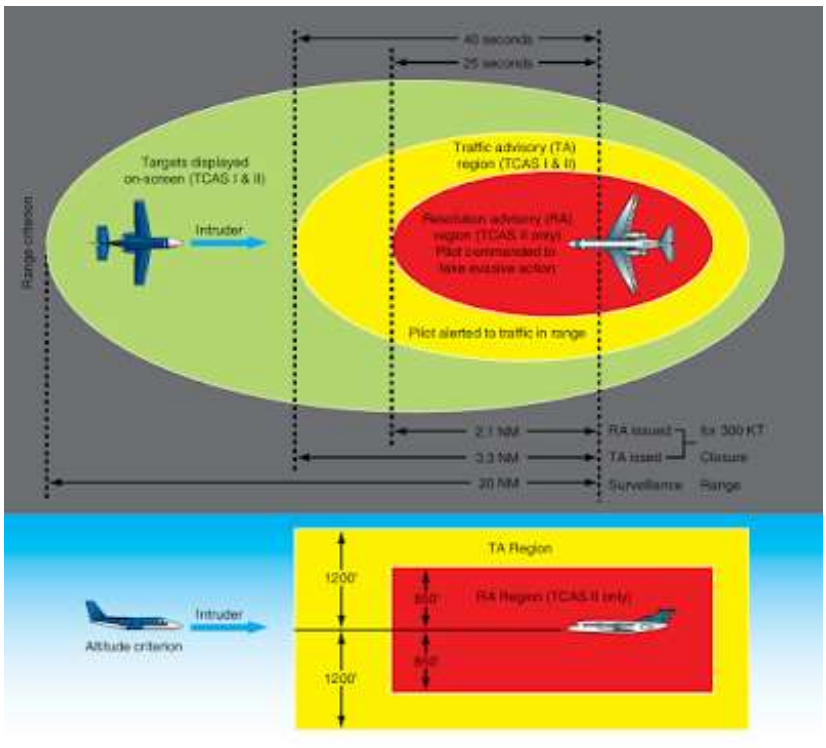


Figure 4-2. TCAS regions and criteria. (30)

Mission or tactical avionics is widely used in military aircraft. For instance, the radar can include Airborne Early Warning (AEW), Anti-Submarine Warfare (ASW), and weather or ground tracking/proximity applications. In addition, maritime support aircraft use active and passive sonar devices which can be used to localize enemy submarines. Electro-optic systems can provide images and information, and cover devices such as the Heads-Up Display (HUD), the Forward Looking InfraRed (FLIR), or other passive infrared devices. Furthermore, the Electronic Support Measures (ESM) and Defensive Aids Systems (DAS) are used to deal with threats.

Regarding GNSS, it can be considered as "*a worldwide position and time determination system that includes one or more satellite constellations, aircraft receivers and system integrity monitoring, augmented as necessary to support the required navigation performance for the intended operation*." (31) The GNSS Signal-In-Space (SIS) performance requirements defined by the ICAO are established assuming the antenna of an aircraft as a fault-free receiver with nominal accuracy and time-to-alert performance. Additionally, this type of receiver has no failures that affect integrity, availability and continuity performance. Therefore, the ICAO requirements on GNSS define 4 parameters:

- Accuracy
- Integrity
- Availability
- Continuity

The SIS requirements are expressed for the Navigation System Error (NSE) which is the difference between the estimated position and the true position of the aircraft as shown in Figure 4-3.

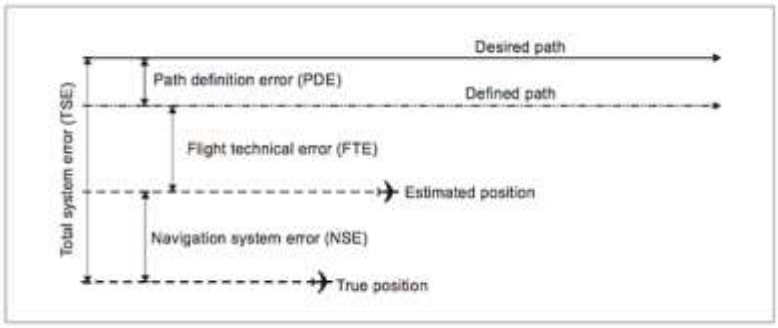


Figure 4-3. Errors definition in GNSS navigation. (32)

With respect to accuracy, for an estimated position at a specific location, the probability of the NSE being within the accuracy requirement should be at least 95% as established by the ICAO. When flying an aircraft, the NSE is unknowm as the true position is unknown, therefore systems rely on the statistical knowledge of the position error. In GNSS, this error is not repeatable as it depends on time-varying parameters such as the constellation geometry, something that does not happen in the case of ILS or Distance Measuring Equipment (DME). As a result, the accuracy SIS requirement is defined for each estimated position. During flight, to test whether the accuracy requirement is fulfilled or not, a 95%-confidence interval of the NSE, known as the Figure of Merit (FOM), is computed.

Concerning integrity, it is considered by the ICAO as a measure of the "*trust that can be place in the correctness of the information*" (31) supplied by the total system. It includes the ability of a system to provide timely and valid warning to the user through the alerts, when the system must not be used for the intended operation. This SIS requirement is defined by three parameters:

- The Alert Limit (AL): in the vertical or horizontal local plane tangent to the WGS-84 ellipsoid, is the radius of a circle in the corresponding plane with its centre being at the true position, which describes the region that is required to contain the indicated vertical or horizontal position with the required probability for a particular navigation mode. A positioning failure occurs if the NSE exceeds the AL, provoking a Hazardous Misleading Information (HMI). The value of the AL depends on the flight operation requirement.
- Time to alert (TTA): is the maximum allowable elapsed time from the onset of an out of tolerance condition where NSE>AL, until the equipment annunciates the alert. As a result, it comprises the delay necessary to detect the positioning failure and transmit the information to the pilot.

- Integrity Risk: quantified by the probability of an integrity event non-detection. Therefore, it is the probability that the NSE exceeds the AL without the user being informed within the TTA.

In practice, detection occurs before the NSE exceeds the AL and the TTA value is mainly allocated to the alert transmission time. With respect to the integrity monitoring in Civil Aviation, it is implemented by the constellation operator, for instance, the USA government commits only to detect a faulty satellite with a probability of missed detection of 10^{-5} per hour in the GPS constellation. This would correspond to 3 undetected satellites failures per year. A typical ICAO requirement for an integrity failure is around 10^{-7} per hour or per approach.

The measure of trust is usually achieved by computing a statistical confidence bound on the position estimation errors called Protection Levels (PLs). Therefore, PLs define a region in the positioning domain where you can ensure that no undetected failure has occurred, within a given integrity risk requirement. Inside this volume, the missed alert and false alert requirements are met for the chosen set of satellites when autonomous fault detection is used. The PL is a function of the satellite and user geometry and the expected error characteristics, therefore it is not affected by actual measurement and it is a predictable value. As a consequence, the PL is a model that can be computed offline thanks to known assumptions. In order to verify if the PL is computed correctly, the Stanford Diagram shown in Figure 4-4 is used.

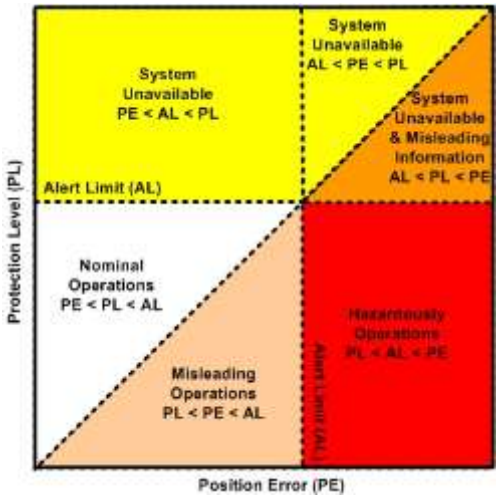


Figure 4-4. The Standford Diagram. (33)

In addition, warnings are provided by Failure Monitors in the event of a Fault Detection. These are particular combinations of measurements used as Test Statistics which are computed in order to detect these failures. Then, the statistical analysis permits to determine the detection thresholds and detection performances of these monitors. The overall integrity risk is allocated to different identified failures through an Integrity Risk Allocation Tree using the Total Probability Theorem. In it, for each identified risk, an integrity monitoring function is implemented under the form of either a Fault Detection Monitor, or a PL computation. The generic ICAO risk allocation tree can be seen in Annex G of this project. (31)

Regarding the availability of a navigation system, it is the ability of the system to provide the required function and performance at the initiation of the intended operation. In other words, the system is claimed to be available whenever it is able to provide a navigation output with the specified level of accuracy and integrity for the intended operation. In the case of the continuity of a system, it is defined as the ability of the total system to perform its function without unscheduled interruption during the intended operation. It is the probability that the specified system performance will be maintained for the duration of a phase operation, presuming that the system was available at the beginning of that phase operation and was predicted to operate throughout the operation. The Fault Exclusion permits to improve the continuity of the positioning system, while the Fault Detection just permits to ensure its integrity.

4.1.2 The Ground Based Augmentation System (GBAS)

GBAS is defined by the ICAO as an augmentation system in which the user receives augmentation information directly from a ground-based transmitter. It relies on a technique known as Local Area Differential

GPS (LADGPS) which depends on correlation of errors between a local ground station and the mobile aircraft. Therefore, a control station, located at an airport for example, precisely measures errors and transmits them to a user, so that he can eliminate them from his own measurement as shown in Figure 4-5. This technique uses a data link in the Very High Frequency (VHF) band of ILSs and VOR systems, 108-118 MHz. The elements transmitted through this VHF Data Broadcast (VDB) link include integrity data of various satellites in view, pseudorange correction, and database for the final approach segment. (34)

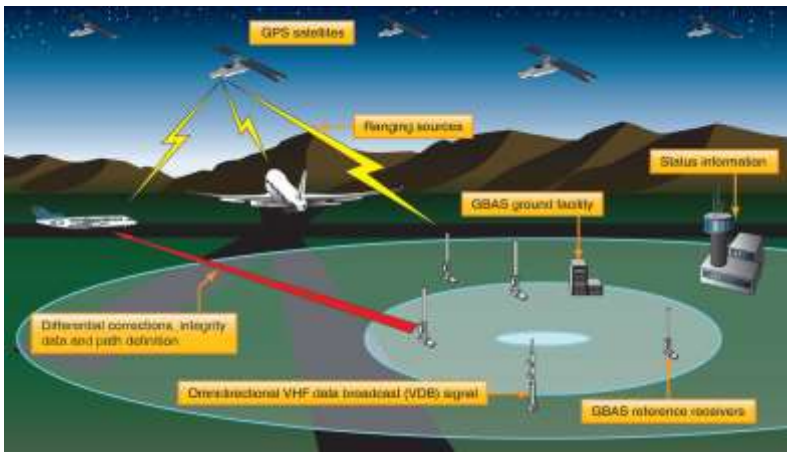


Figure 4-5. Schematic representation of the GBAS architecture and interaction between its components. (35)

Using the broadcast ephemeris and satellite clock data, the reference receiver estimates, thanks to its known location, the reference pseudorange from the satellite to its antenna. Comparing this value with the actual pseudorange measurement made by the ground reference receiver, this receiver deduces a pseudorange correction for each tracked Pseudo Random Noise (PRN). These pseudorange corrections are transmitted to the roving receivers, using proper links and data formats, so that they can correct their measurements.

Only the errors common to the reference and user receiver can be eliminated. This includes all errors, ionospheric, tropospheric, satellite clock and ephemeris error, except the local ones which include multipath, interference or receiver noise. The combined receiver clock offset will be estimated by the airborne receiver. Therefore, although the size of the local errors is increased, the global User Equivalent Range Errors (UERE) after application of correction can be significantly reduced. As a result, it can be shown that the final corrected pseudorange error is of the order of 1 meter when the airborne receiver is close to the reference station (<100km), and the delay between corrections elaboration at reference site and application in the user receiver is short (<5s).

Compatibility of corrections between receivers is called interoperability. In the case of GBAS, the ground reference station and airborne user receiver must use the same algorithms and methods for pseudorange processing. This means, an identical smoothing or filtering process, and the application of identical error models for pseudorange measurements correction. They must also use the same set of ephemeris data. In particular, they must have wait for a confirmation of ephemeris change, indicated in the Issue of Data Ephemeris (IODE). Finally, it is essential that the reference site is not excessively affected by multipath and interference sources. To guarantee this, the reference site must be surveyed.

GBAS Approach Service Types (GASTs) currently defined are GASTs A, B, C and D, which correspond respectively to GBAS for Approach Procedure with Vertical Guidance (APV) I, APV II, Category (CAT) I, and CAT II/III approaches. However, currently only GBAS services types A to C are described in the ICAO SARPs (34). GAST D service type is described in the RTCA documents and in ICAO proposed SARPs revisions for GBAS GAST D. (36) With respect to the minimum GBAS Coverage, which is defined in Figure 4-6 (34), GBAS service may cover multiple runways at a single airport and data may be used for nearby airports and heliports as well, which is a clear advantage of this system as compared to ILS.

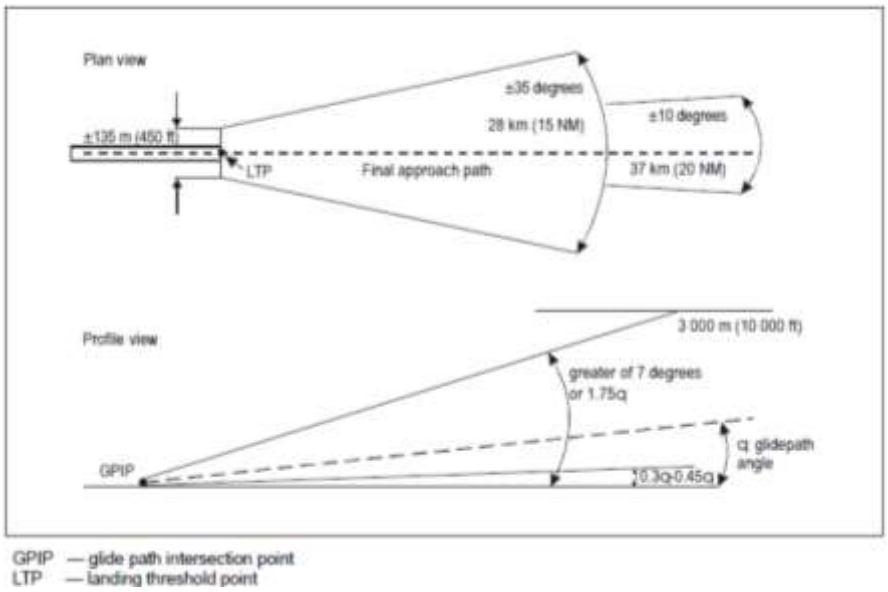


Figure 4-6. Minimum GBAS Coverage volume. (34)

Regarding the GBAS Airborne equipment, the precision approach based on GBAS avionics standards mimic the ILS in terms of aircraft system integration, as it has an ILS-look-alike scaling and deviation output. This minimizes the impact of installing GBAS on existing avionics. In addition, Area Navigation (RNAV) 2D operations may be developed if the ground system supports the Positioning Service, which is optional. Furthermore, due to the ICAO precision approach transition strategy, a mix of systems is possible, combining ILS, Microwave Landing System (MLS) and GNSS Landing System (GLS) into Mixed Landing System (XLS). (37) The MMR offers a great flexibility to users and no hardware update is foreseen, only software one. Additionally, when differential corrections are not applied from a GBAS station, the receiver has the ability to work in GPS or Satellite Based Augmentation System (SBAS) mode if available and suitable.

Due to its aforementioned advantages, GBAS systems are currently being developed and deployed worldwide as it can be seen in Figure 4-7. The USA company Honeywell developed a Non-Federal CAT-I Local Area Augmentation System (LAAS), equivalent to a GBAS system, called Honeywell's SmartPath and which is part of the FAA Research Program for Next-Generation ATM. The same company is also working with Europe in other ATM programs such as the SESAR and operates in cities including Bremen (Germany), Malaga (Spain), Memphis (USA), Atlantic City (USA), Rio de Janeiro (Brazil), or Sidney (Australia). Northrop Grumman Park Air Systems has also developed and installed in several Norwegian airports a GBAS system for precision approach and landing. In Russia, NPPF Spectr have developed a GBAS CAT-I system called LCCS-A-2000 deployed in numerous Russian airports such as the ones of St Petersburg, Moscow, Samara, or Krasnoyarsk. Finally, the French company Thales has developed a CAT-I GBAS Facility, the DGRS 610/615, tested in Toulouse airport, and part of the SESAR Program. Other versions for higher precision performances such as CAT II/III are being developed by the same company.

Figure 4-7. Global GBAS facilities in 2019. (38)

Concerning the principle of GBAS corrections, for each satellite in view, the reference station broadcasts to users the following data:

- One scalar Pseudorange Correction (PRC) for every ranging measurement.
- A Range Rate Correction (RRC) corresponding to the evolution of corrections with time.
- The time of applicability, known as Z_{count}.

Their evolution is shown in Figure 4-8. The user receiver then computes the following linear extrapolation:

$$PRC(t) = PRC(Z_{count}) + RRC \cdot (t - Z_{count}) \tag{4.1}$$

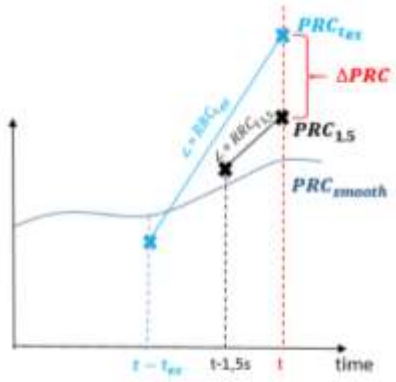


Figure 4-8. PRC and RRC evolution over time. (39)

In addition, a carrier smoothing filter is used in order to take advantage of the high accuracy of phase measurements. In Figure 4-9, is shown the processing architecture used which takes into account the pseudorange measurement, C1, the carrier phase measurement, L1, and the code-minus-carrier phase (CMC) measurement, which is not affected by the ambiguity present on phase measurements.

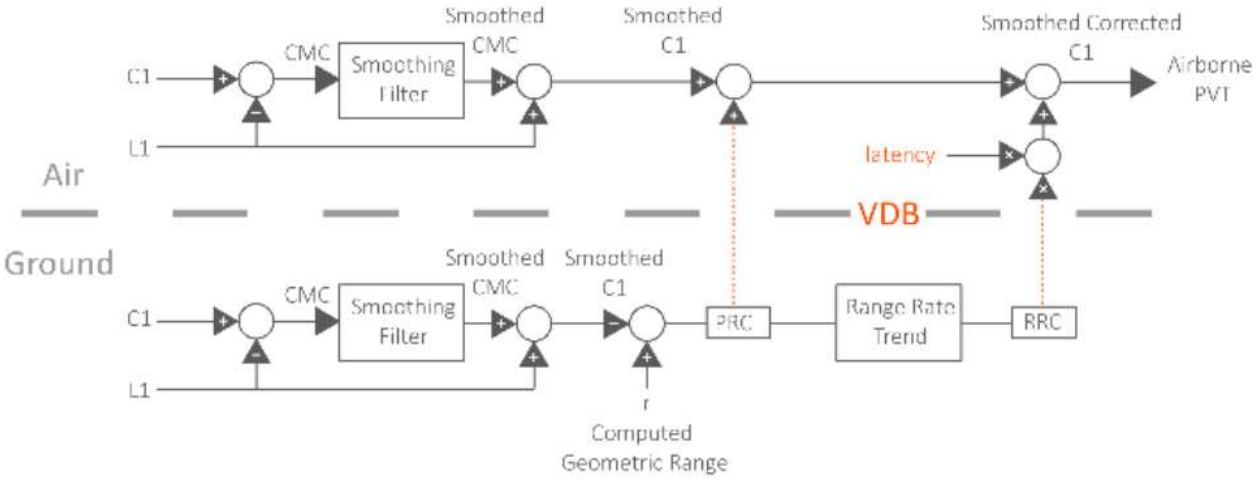


Figure 4-9. GBAS processing architecture. (39)

In Table 4-1 the GBAS Message Types are shown. GBAS message MT1 contains global data such as the reference time, Z_{count}, the message flag, the number of measurements, N, and the measurement type. It also contains a satellite measurements block with specific data for each satellite such as the IODE, the ranging source identification, the PRC, the RRC or integrity related data. GBAS message MT2 contains the location of the ground station reference point, the number of installed reference receivers, and other GBAS-related information important for ionospheric and tropospheric corrections, accuracy, continuity, and integrity estimation. All the information contained in Message Types 1, 2, 4 and 5 are shown in Annex H, I, J and K of this project respectively. (34)

Message type identifier	Message name
0	Spare
1	Pseudo-range corrections
2	GBAS-related data
3	Null message
4	Final approach segment (FAS) data
5	Predicted ranging source availability
6	Reserved
7	Reserved for national applications
8	Reserved for test applications
9 to 100	Spare
101	GRAS pseudo-range corrections

Note.— See 3.6.6 for message formats.

Table 4-1. GBAS VHF data broadcast messages. (34)

With respect to the GBAS accuracy performance assessment, the ground sub-system contributes to the GBAS Accuracy Designator (GAD), the number of installed reference receivers, and the description of the errors in the corrected pseudorange due to the ground facility. The airborne sub-system works with the Airborne Accuracy Designator and with the on-board receiver and airframe multipath contribution to the corrected pseudorange error. Finally, the GBAS total system accuracy, expressed through the NSE, works with the contributions from the ground and airborne sub-systems, GAD and Airborne Accuracy Designator, and with possible decorrelation errors, everything assessed in the position domain.

Moreover, the GBAS SIS integrity is monitored by the ground GBAS sub-system and a real-time positive indication that SIS integrity is ensured. The GBAS ground sub-system monitors the quality of all the system signals as well as the ground and space segments. Five types of GPS satellite failures have been identified so far: satellite signal deformation, low satellite signal power, excessive code-carrier divergence, broadcast of erroneous GPS ephemeris data and excessive range acceleration. In addition, two other types of failures are monitored, the ionospheric spatial-gradient anomaly and the tropospheric gradient anomaly. Finally, the PLs computed by the airborne GBAS receiver assumes a fault-free airborne receiver, pseudoranges corrected by GBAS data affected only by noise, as the other failures are detected by the ground sub-system, and that one of the reference receivers may be faulted. The constellation accounted is the common constellation used by both ground and airborne subsystems.

Regarding the AL, the Vertical Alert Limit (VAL) in GBAS is defined internationally as indicated in Table 4-2, where the Height, H, is defined using the Glide Path Angle (GPA) and the slant distance (SL) from the aircraft position to the Glide Path Intercept Point (GPIP), using the following formula (40)

$$H = sin(GPA) \cdot SL, \tag{4.2}$$

The Final Approach Segment Vertical Alert Limit (FASVAL) is set to be less than 10 meters. (41)

Vertical alert limit (m)	H (m)
FASVAL	$H \leq 60.96$
0.095965H + FASVAL-5.85	$60.96 < H \leq 408.432$
FASVAL + 33.35	$H > 408.432$

Table 4-2. VAL for GBAS. (40)

The Vertical Protection Level (VPL) in the Approach of GBAS SIS is the maximum of the VPL under the fault-free case hypothesis, and the VPL under the hypothesis of a fault in one of the reference receivers. (40) In case the VPL computed under those hypothesis or the VPL for an ephemeris error, computed for all GPS ranging sources used in the position solution, exceeds the VAL, the airborne GBAS system will raise a flag as being unavailable.

Finally, the GBAS service is defined to be available if all conditions that allow an approach to be initiated are met. These means:

- Accuracy: NSE (95%) < Requirement
- Integrity: PL < AL at any time
- Continuity during the whole approach

The different independent parameters that can affect the GBAS system availability are:

- Level of service
- Constellations and augmentations used
- Number and accuracy of reference and airborne receivers
- Mask angle
- Outages (hardware failures) from ground and airborne subsystems

4.2 Certification Process for a Ground Based Augmentation System

The TLS755 MMR is the system chosen to be certified in this project because, as shown in Figure 4-10, is the principal part of the Aircraft Subsystem of the GBAS, which has also a Ground Subsystem. As formerly mentioned, this second subsystem or facility will not be certified as it is out of the scope of this project, which only considers airborne embedded systems. In addition, Thales has been the chosen manufacturer as it is European, and therefore its products will be certified following the European procedure and regulation already explained.

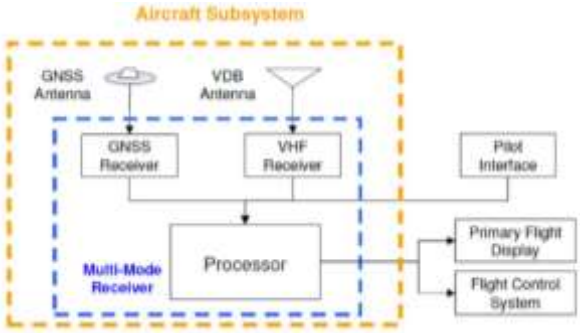


Figure 4-10. Architecture of the Aircraft Subsystem. (42)

The ETSOA Application needs to be done by an Applicant who has already received a POA and an ADOA. The DOA is not necessary in our case as the application is not for an APU. Therefore, firstly these two approvals are going to be studied, for then analysing the ETSOA Application with its corresponding deliverables, and the internal process of the EASA for its issuance. Even though all the documents and forms that have to be delivered to the Agency cannot be fully completed due to the lack of the system information and regulations, ideas and scenarios will be proposed and explained.

4.2.1 Application for Alternative Procedures to Design Organization Approval (ADOA)

The demonstration of design capabilities by the Applicant of an ETSOA which are required by EASA Part 21.A.602B (b) 2 is done by the application of an ADOA. This application must be done by submitting the application Form FO.DOA.00081 to EASA, shown in Annex L of this project. (43) In Annex M, the instructions for completing this EASA Form are indicated. In addition, together with the Form FO.DOA.00081, the Manual of ADOA for ETSOA has to be submitted in our case. As the required information must also appear in some other documents delivered for the Application of the ETSOA, this information can be shown entirely in this manual, or in external procedures appropriately identified and referred to.

This Manual of ADOA for ETSOA has to present the implementation of procedures which set out the specific design practices, resources and sequence of activities that are necessary to show compliance with Part 21. Additionally, the technical and administrative procedures regarding all aspects of work done under this approval have to be provided, showing how issues related with airworthiness are treated. Typical milestones of

the organization design process such as checkpoints or design reviews must be tackled, and the interfaces and coordination between technical departments and disciplines must be described, for example between design engineers, certification engineers or production engineers. The way the company deals with the registration and flowing of data between different departments including for example, the classification of changes or the on-going and approved projects has to be included. Finally, the person in charge for the preparation, recording, and update of the time-schedule, its format and location of its file must be present, as it is an essential part of the project organization. Finally, the techniques used in the project management have to be indicated. For instance, the Agile Scrum methodology for the software development. The use of flowcharts and diagrams is recommended for showing how procedures and relationships are tackled. In Figure 4-11 and 4-12 we can see some examples.

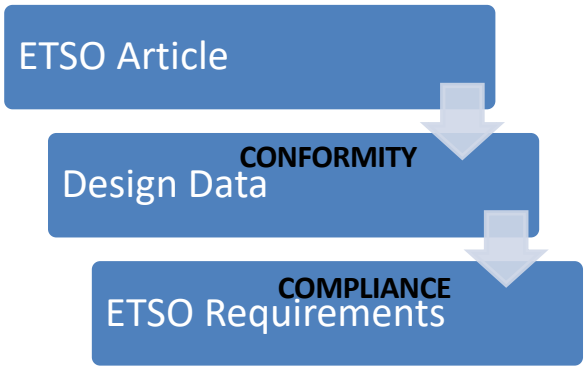


Figure 4- 11. Example of diagram for the Manual of ADOA for ETSOA (I).

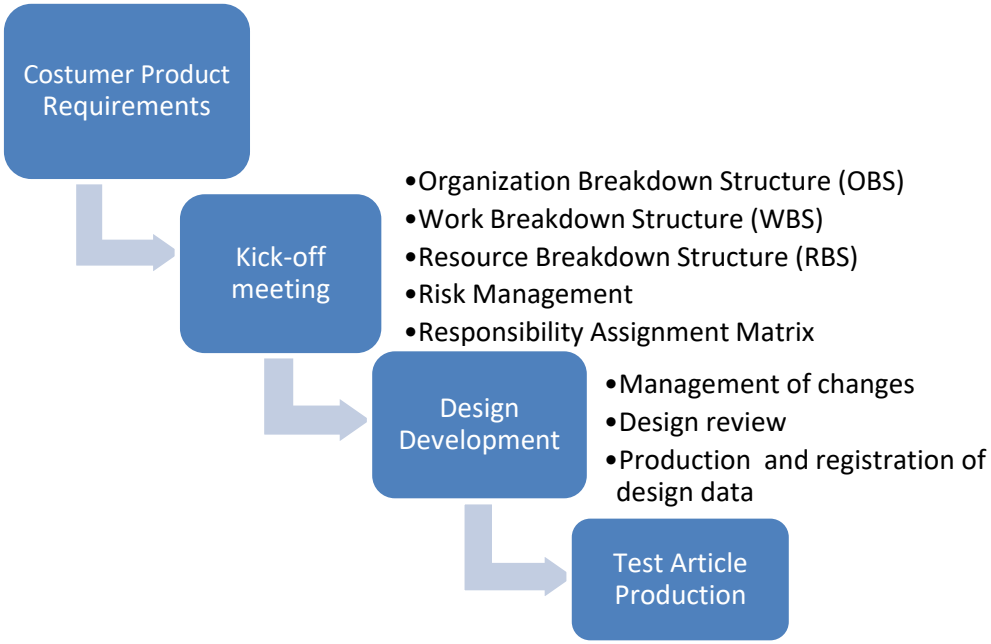
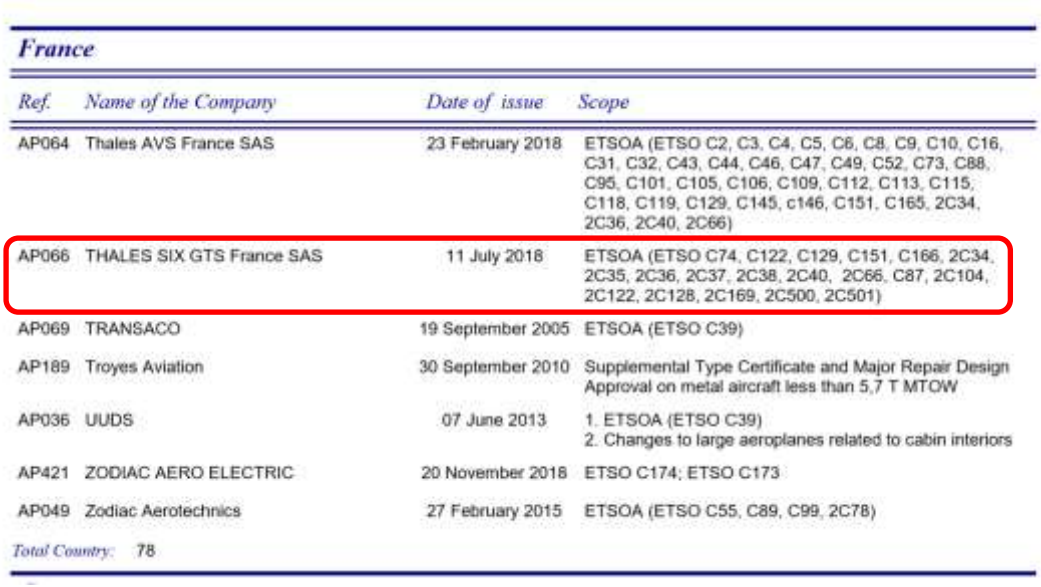


Figure 4-12. Example of diagram for the Manual of ADOA for ETSOA (II).

Once the application has been accepted by the EASA, a Project Manager to conduct the investigation will be assigned. The Fees & Charges of EASA are determined by Commission Regulation (EU) 319/2014. In the case of an ETSOA ADOA, in Part I, Table 7B of this regulation is established a fee of 6000 €. (44)

In our case, THALES SIX GTS France SAS, has already an ADOA under the scope of the ETSO-2C500a, *Combined ILS/MLS Airborne Receiving Equipment*, which is the ETSO corresponding to MMRs. In the list of EASA approved ADOAs, shown in Figure 4-13, it can be seen that the company received the certificate of approval in July 2018 under the reference of AP066. Therefore, there is no need of delivering any of the documents and EASA Forms mentioned in this section.



France

Ref.	Name of the Company	Date of issue	Scope
AP064	Thales AVS France SAS	23 February 2018	ETSOA (ETSO C2, C3, C4, C5, C6, C8, C9, C10, C16, C31, C32, C43, C44, C46, C47, C49, C52, C73, C88, C95, C101, C105, C106, C109, C112, C113, C115, C118, C119, C129, C145, c146, C151, C165, 2C34, 2C36, 2C40, 2C66)
AP066	THALES SIX GTS France SAS	11 July 2018	ETSOA (ETSO C74, C122, C129, C151, C166, 2C34, 2C35, 2C36, 2C37, 2C38, 2C40, 2C66, C87, 2C104, 2C122, 2C128, 2C169, 2C500, 2C501)
AP069	TRANSACO	19 September 2005	ETSOA (ETSO C39)
AP189	Troyes Aviation	30 September 2010	Supplemental Type Certificate and Major Repair Design Approval on metal aircraft less than 5,7 T MTOW
AP036	UUDS	07 June 2013	1. ETSOA (ETSO C39) 2. Changes to large aeroplanes related to cabin interiors
AP421	ZODIAC AERO ELECTRIC	20 November 2018	ETSO C174; ETSO C173
AP049	Zodiac Aerotechnics	27 February 2015	ETSOA (ETSO C55, C89, C99, 2C78)

Total Country: 78

Figure 4-13. Section of the list of EASA approved ADOAs in France. (45)

4.2.2 Application for Production Organization Approval (POA)

The EASA Quality Management System integrates the management of the POAs according to Subpart G of Regulation (EC) No 748/2012. All applications from EU and non EU countries are managed by the Agency. The application can be done by submitting EASA Form 50, shown in Annex N of this TFG, together with the following documents (46):

- FO.POA.00004-001: POA eligibility evaluation checklist (Annex O)
- FO.POA.00009-001: POA compliance checklist (Annex P)
- FO.POA.00015-002: Production Organization Exposition (POE) compliance checklist (Annex Q)
- EASA Form 4: Details of Management Personnel (Annex R). Document by which the POA Team Leader confirms the identity of the managers nominated for the project.
- EASA Form 51: used to apply for significant changes or variation of scope and terms by POA holders (Annex S)

The details and information on how to apply to a POA can be found in the EASA document UG.POA.00067, the User Guide for Production Organisations. In addition, according to Commission Regulation (EU) 319/2014, applicants must specify the annual turnover which is or will be generated by the production of all products, parts and appliances included in the scope of work, in order to determine the fees to pay to the Agency. In our case, ,the MMR market is expected to grow from USD 961.5 Million in 2017 to USD 1,213.1 Million by 2022. Therefore, as indicated in Figure 4-14, the company will need to pay 2784000 € as approval fee.

Finally, as happened for the ADOA, in our case the company THALES SIX GTS France SAS already has a POA certificate issued by the EASA. Its reference is FR.21G.0050 as shown in Figure 4-15. Therefore, there is no need of completing the aforementioned documents and EASA forms. However, the lack of information about the company's internal organization will have made it difficult to specify all the information required for both, ADOA and POA applications.

Production Organisation Approval

(referred to in subpart G in Section A of the Annex I to Regulation (EC) No 748/2012)

(EUR)

	Approval fee	Surveillance fee
Turnover (1) below 1 million euros	10 460	7 550
Between 1 000 000 and 4 999 999	58 000	36 790
Between 5 000 000 and 9 999 999	206 400	49 050
Between 10 000 000 and 49 999 999	309 600	73 600
Between 50 000 000 and 99 999 999	358 000	174 000
Between 100 000 000 and 499 999 999	417 600	232 000
Between 500 000 000 and 999 999 999	732 100	464 000
Over 999 999 999	2 784 000	2 207 000

(1) The turnover taken into account is the turnover related to activities under the scope of the agreement.

Figure 4-14. POA fees according to the Commission Regulation (EU) 319/2014. (47)

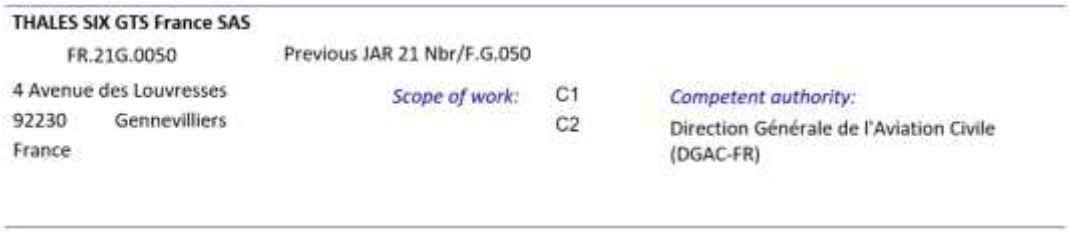


Figure 4-15. Fraction of the list of approved POA certificates by the EASA. (48)

4.2.3 Application for European Technical Standard Order Authorisation (ETSOA)

In this section, it is going to be explained how to apply currently to an ETSOA. For this project, we need to make some assumptions that will condition the certification procedure. We will assume the following in relation to our ETSOA Application:

- Application from an EU organization (French in our case)
- ETSOA Application is not for APU
- No ETSOA design change confirmed
- Activity identified as certification task
- New ETSOA defined
- Deviation CS-ETSO not applied for
- POA and ADOA confirmed

Applications are sent to the EASA Certification & Approval Support Department and must be made in accordance with Article 21A.603 of Commission Regulation (EU) No. 748/2012 and MB Decision 12/2007. As mentioned in previous sections, nowadays this type of application is made via the EASA Applicant Portal by creating a new application and selecting ETSOA - Initial Approval. (49) The previously used Form 34, shown in Annex T of this project, can still be used in exceptional circumstances only when the Applicant Portal is not available. In that case, applications must be submitted by email to *etsoa@easa.europa.eu*, slowing down the application process. (50) In our case, we are going to choose the Applicant Portal for simulating and explaining the application process.

Since the 1st June 2019, every technical document related with an ETSOA application should be submitted only via the SEPIAC tool, a Shared, Cloud-Based Electronic Platform for Initial Airworthiness Certification. Once the Applicant has become a member of SEPIAC, having at least one admin account, it can use the platform to communicate during the project and only after acceptance of the application submitted through the EASA Applicant portal. Some of the advantages of this platform are that specific software application is not needed and that the EASA, Applicants, NAAs and Third Country Authorities can have access to it. Therefore, as shown in Figure 4-16, different libraries with different access rights for the parties involved, EASA and Applicant, are created. (51)

Figure 4-16. SEPIAC libraries and other information given to Applicant. (51)

When uploading documents to the platform, the Applicant must only use the content type "ETSO deliverable", and only when necessary other ones such as "Meeting Agenda", "Minutes of meeting", "Presentation", "Video", "Email", "Archive/prefer discussion" or "Letter". Most of the content types are shown in Figure 4-17.

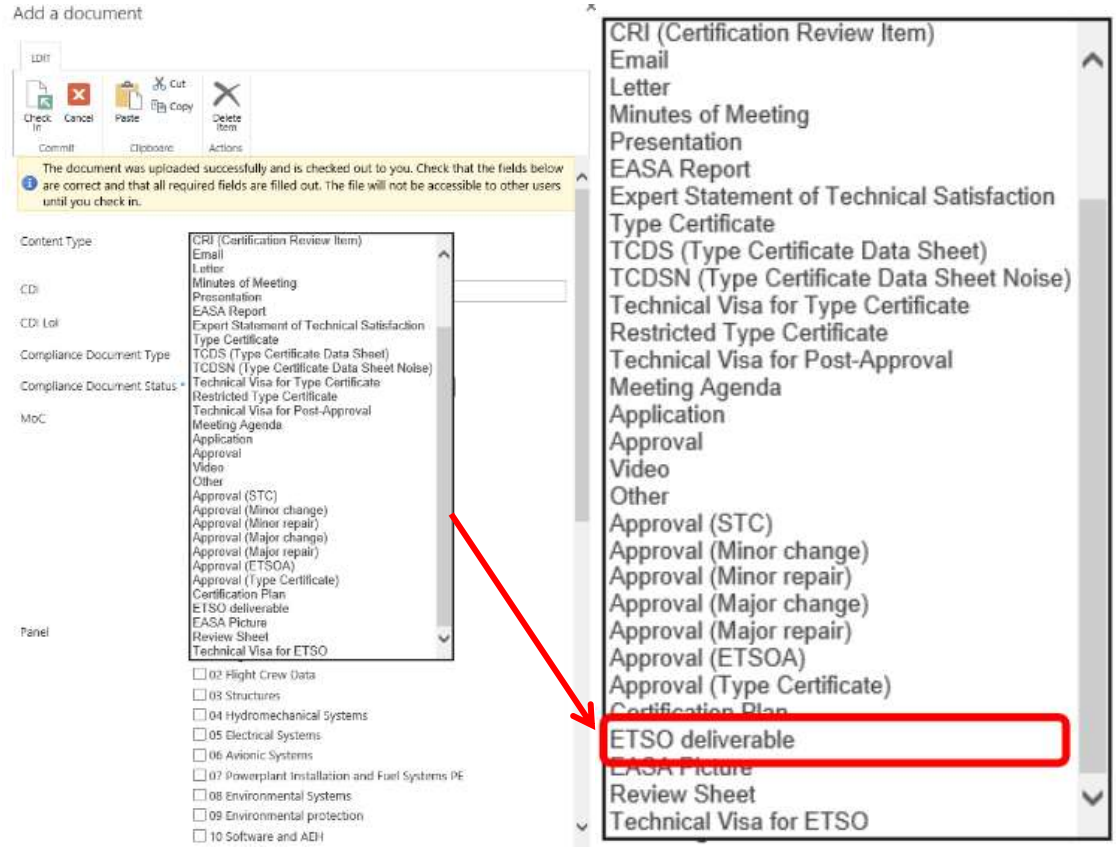


Figure 4-17. Documents upload to SEPIAC (I). (51)

After choosing the content type as "ETSO deliverable", the Applicant must select the ETSO document type. Some of these document types are shown in Figure 4-18. Even though there is not a generic list of technical documents that must be submitted, those necessary to show compliance with the specific ETSO standard must be uploaded. Normally those include the formerly mentioned documents that complete the ETSO data package.

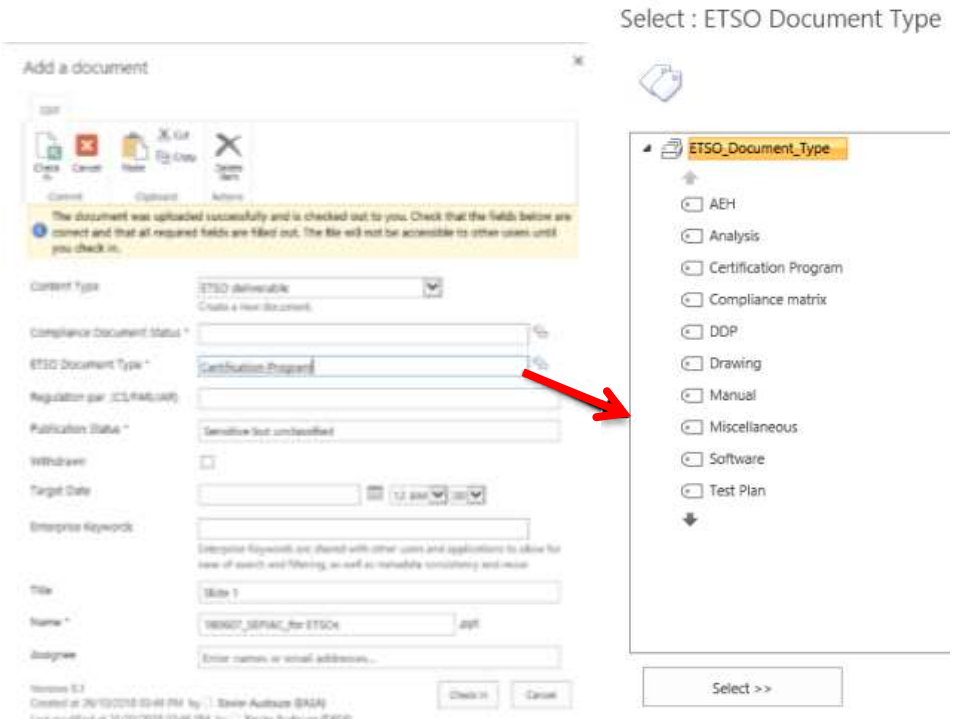


Figure 4-18. Documents upload to SEPIAC (II). (51)

Another advantage of the SEPIAC Platform is that discussions can be created in order to speed up the exchange of information that was formerly made via emails, as show in Figure 4-19. In addition, is it possible to see all the discussions which are linked to a specific document. Regarding notifications, although SEPIAC does not send e-mail notifications, this action can be activated.

Figure 4-19. Projects discussion via SEPIAC. (51)

In order to submit all the technical documentation related to the project into the SEPIAC platform, it is necessary to first create the application via the EASA Applicant Portal, for having the identifier associated to that application. For the registration, the Applicant must send an email to *Applicant.Portal@easa.europa.eu* (21). Once registered, the creation of the ETSO application can be done in 5 steps (21):

1. Applicant data
2. Product Identification
3. Certification basis
4. Application details
5. Attachments

In the first step, Applicant data, the address and contact data related to the application must be introduced. The following information is asked:

- Address section: applicant, billing address, approval delivery address, certificate address.
- Contact type section: contact person, financial contact person, delivery contact person.

For the second step, Product identification, the basic information of the application is introduced as shown in Figure 4-20. Firstly, the Applicant's Reference provides the unique internal identifier of the application, used in every step of the project. Secondly, the kind of equipment is chosen, conditioning the fees that the Applicant will need to pay. The Fees & Charges of EASA are determined by Commission Regulation (EU) 319/2014. Part I, table 1 includes the flat fee for new applications, which is in our case 8.780 €. This fee lasts for 12 months, meaning that another invoice covering the additional days until the date of approval will be issue by the EASA in case the product cannot be certified within that period. The current fees are:

- Product value > 20.000 € → flat fee 8.780 €
- Product value 2.000 – 20.000 € → flat fee 5.020 €
- Product value < 2.000 € → flat fee 2.910 €

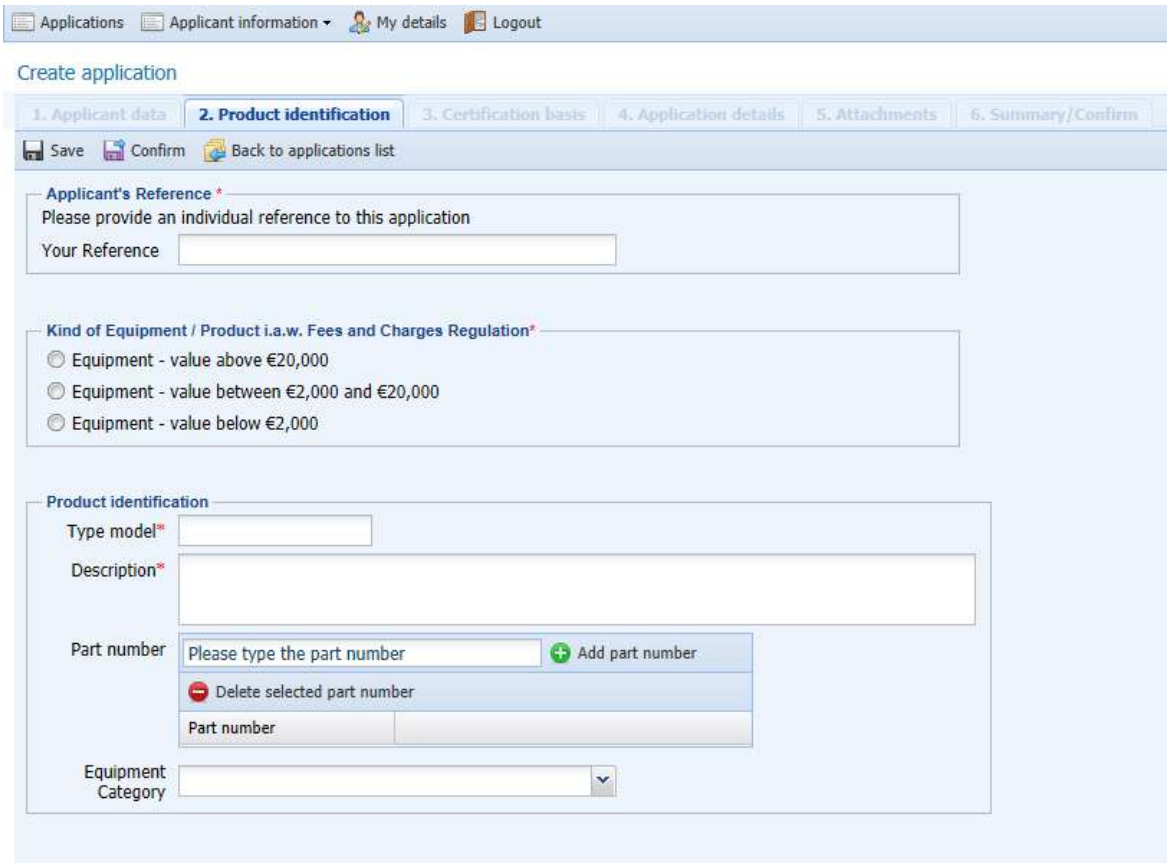


Figure 4-20. Product identification through the Applicant Portal. (21)

In addition, as the MMR will be installed or used in more than 50 aircraft (also applied for continued airworthiness), the Applicant will need to pay the annual fee, indicated in Part I, table 6 of the aforementioned regulation. Approval holders must once a year update the value of the product and the number of installations, as the fee can be reduced. Another fee that can be paid in a future for other activities such as the administrative re-issuance of minor change documents is the hourly rate, established to be 233 €. Depending on the annual inflation rate the charges may be annually adapted.

The last section of this second step is the Product Identification. The type/model name that will appear in the ETSOA certificate, a brief description, and the part number(s) will be introduced. Finally, the equipment category is selected. The full table of Equipment Categories is included in Annex U on this project. In the case of the MMR, it will be category 17.

For the third step, Certification basis, the applicable ETSO standard has to be chosen from the list as shown in Figure 4-21. In our case the standard is ETSO-C500a . The deviations, if any, have also to be entered together with the reference to the document that justifies the ELOS. In our case the bottom "None" has to be selected, according to the assumptions we have made.

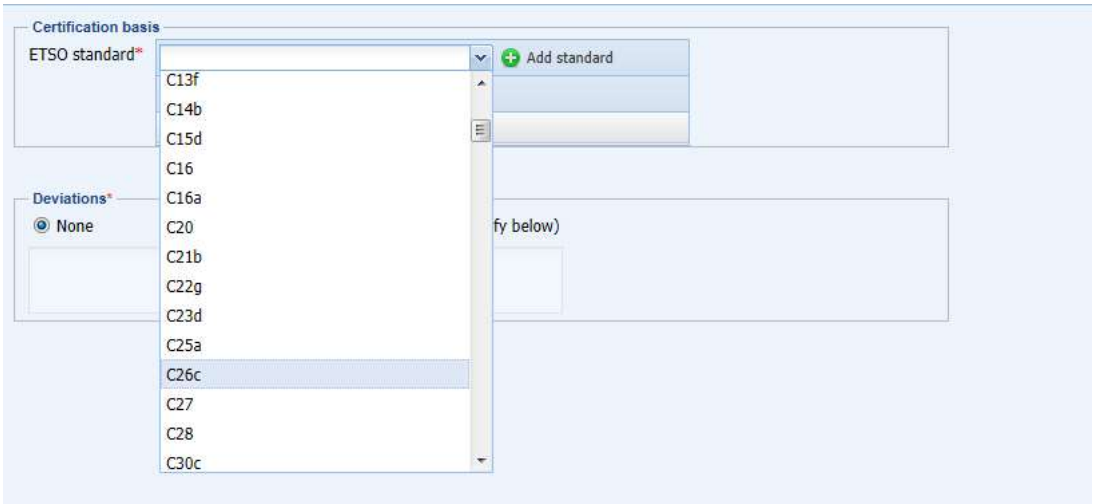


Figure 4-21. Certification basis selection through the Applicant Portal. (21)

For the fourth step, Application details, demonstration of capability of production and eligibility must be shown in accordance with Part 21. The applicable way of demonstrating eligibility has to be chosen as shown in Figure 4-22. Depending on the option, the application date or project number of any concurrent (A)DOA project have to be introduced, something not necessary for Applicants from countries not located in an EASA Member State territory. In our case, the first option has to be chosen with an ADOA reference of EASA.21J.066.

Figure 4-22. Demonstration of eligibility through the Applicant Portal. (21)

The fifth step, Attachments, allows the Applicant to enter remarks and upload documents. In our case, no important documents will be uploaded as everything will be done via SEPIC Platform. Finally, the sixth section, Summary/Confirm, provides a summary of the application information like the one shown in Figure 4-23.

After the Applicant accepts the EASA conditions and the fees to pay, the Applicant Portal entry page will reappear with the application EASA ID and its current status as shown in Figure 4-24. Once submitted, the Applicant receives a confirmation of receipt, and a later email indicating the acceptance of the application after eligibility check.

Applications | Applicant information | My details | Logout

Create application

6. Summary/Confirm

Save | Submit | Export to PDF | Back to applications list

European Aviation Safety Agency

Acknowledgement of Application for Approval of European Technical Standard Order Authorisation (ETSOA)

Request N°:

Your Reference		Submitted on	

Applicant	EASA AIR LTD. (306910)
Application Type	ETSOA - Initial Approval

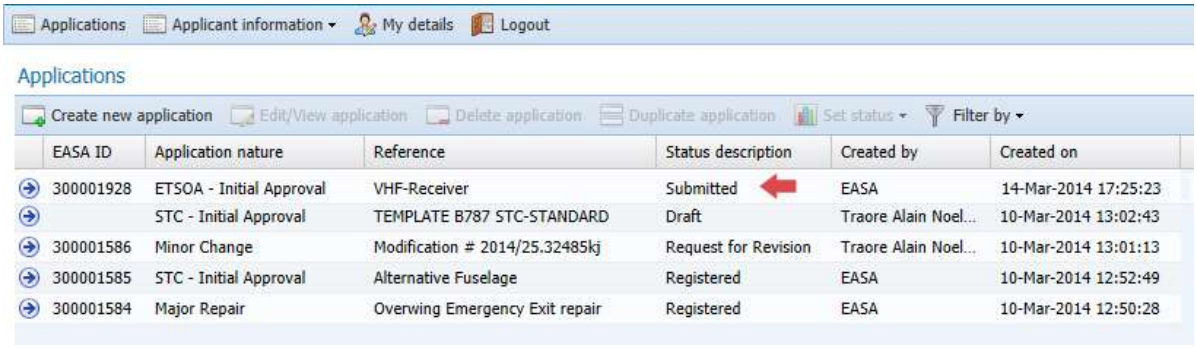
Product Identification	
Type/Model	VHF-Receiver
Description	EASA AIR VHF-Receiver
Part Number(s)	PN 123456789()()()
Part Number(s)	PN 987654321()()()
Part Number(s)	PN456789321()()()
Equipment Category	2 AVIONICS - COMMUNICATION
Fees & Charges Category	Equipment - value above €20,000

Certification Basis	
ETSO Standard(s)	C26c
Deviations	please enter the deviations

Data Requirements	
Demonstration for Capability for Production	EASA.21G.999
Remarks	additional information

Demonstration of Eligibility	
Within the current approved scope of work of (A)DOA	
(A)DOA Reference	EASA.21J.999

Figure 4-23. Summary of the ETSOA application provided by the Applicant Portal. (21)



Applications | Applicant information | My details | Logout

Applications

Create new application | Edit/View application | Delete application | Duplicate application | Set status | Filter by

EASA ID	Application nature	Reference	Status description	Created by	Created on
300001928	ETSOA - Initial Approval	VHF-Receiver	Submitted	EASA	14-Mar-2014 17:25:23
	STC - Initial Approval	TEMPLATE B787 STC-STANDARD	Draft	Traore Alain Noel...	10-Mar-2014 13:02:43
300001586	Minor Change	Modification # 2014/25.32485kj	Request for Revision	Traore Alain Noel...	10-Mar-2014 13:01:13
300001585	STC - Initial Approval	Alternative Fuselage	Registered	EASA	10-Mar-2014 12:52:49
300001584	Major Repair	Overwing Emergency Exit repair	Registered	EASA	10-Mar-2014 12:50:28

Figure 4-24. Application EASA ID and current status after submission through the Applicant Portal. (21)

4.2.4 European Technical Standard Order Authorisation (ETSOA) Deliverables

The ETSO deliverables have been seen in former chapters. However, as mentioned before, none of the documents are compulsory, the Agency just requires that all the compliance information is provided. In our case, the main ETSO deliverable is going to be the CP, which will include the rest of the documents of the ETSO data package. The other option would have been to create each document separately, and indicate their reference in the CP. The AMC 21.A.602B(b)(2), section 2 establishes that the CP should describe the process that will be followed to ensure that requirements of the relevant CS-ETSO are met. Therefore, Agency must accept all its revisions. For this project, the EASA CP Template is going to be used. In our case, all the indications given by the EASA on each section will appear in italics, and the new content added will appear on the format used along this TFG. As formerly mentioned, it is not possible under the scope of this project due to the lack of information about the product and the company's internal procedures, to complete entirely all the sections of the CP. However, examples will be shown and ideas will be proposed.

Certification Programme

Document Identifier(*)

Project Identifier

(**)

prepared	checked	Approved
[Position/Function]	[Position/Function]	[Position/Function]
Signature_____	Signature_____	Signature_____
date	Date	Date

(*) i.a.w. the numbering system defined in the ADOA manual.

(**) Authorised signatories shall be as defined in the ADOA manual.

TABLE OF CONTENTS

1. LOG OF REVISIONS

Rev. No	*Rev. date*	*Affected pages*	*Description*

2. INTRODUCTION

Provide a short description of the intent of the Certification Programme (CP). The CP should be used also to formalize involvement of EASA in the certification process.

The present Certification Programme (CP) is used to establish a protocol of communication between the Company THALES SIX GTS France SAS and the EASA in the framework of certification activities related to the Project XXX (numbering system defined in the ADOA manual) and to identify documents, certification basis, and time schedule required to accomplish abovementioned activities.

3. AMENDMENT POLICY

Provide a description of the policy for the amendment of the CP.
Identify the criteria triggering an update of the CP (i.e. change of requirements, significant change of the schedule, change of personnel, new subcontractor…). Reference can be provided to the relevant procedure in the ADOA manual.

See amendment policy procedure in the ADOA manual under the scope of Project number XXX (numbering system defined in the ADOA manual).

4. PROJECT DESCRIPTION

Provide a general project description with a special emphasis on novelties being part of the design (i.e. new technologies, new materials…) and peculiarities of the configuration. Provide visibility of those functions not covered by the ETSO standard (s). Description can be brief if more details are provided in an additional document (i.e. Product Specification) referenced in the Certification Programme under this paragraph.

Highly precision navigation and landing performances are achieved nowadays with the use of satellite-based systems such as the GNSS. Hence, Thales has designed a completely digital system, the TLS755 MMR, which integrates every reception function found on board, in order to undergo precision performances.

The TLS755 MMR, shown in Figure 4-25, presents numerous benefits as it permits different precision-landing possibilities depending if airports are equipped with ILS, MLS or GLS. The ILS is still the most used Cat. III precision landing system. However, it presents integrity problems due to FM interference and multipath reflection, which degrade the landing capacities under low-visibility conditions. In the case of MLS, it is an alternative option to ILS Cat. III B landing in specific geographical areas. Finally, the GLS is a new precision landing system which provides Prevision Approach capability. (52)

Thales approach for designing is based in full adaptability for the TLS755, undergoing a highly modular design, which allows this MMR to work within the scope of all applications, including the SBAS, GBAS and MLS. In addition, all functions including the ILS, GNSS, MLS and GLS are developed in-house according to production and design approvals, in order to guarantee compatibility. (52) Furthermore, currently the TLS755 is the only MMR with an MLS certified function. In Figure 4-26, the integration of the MMR and its relationships with the other embedded avionics systems in the aircraft is shown.

Figure 4-25. Thales TLS755 MMR. (53)

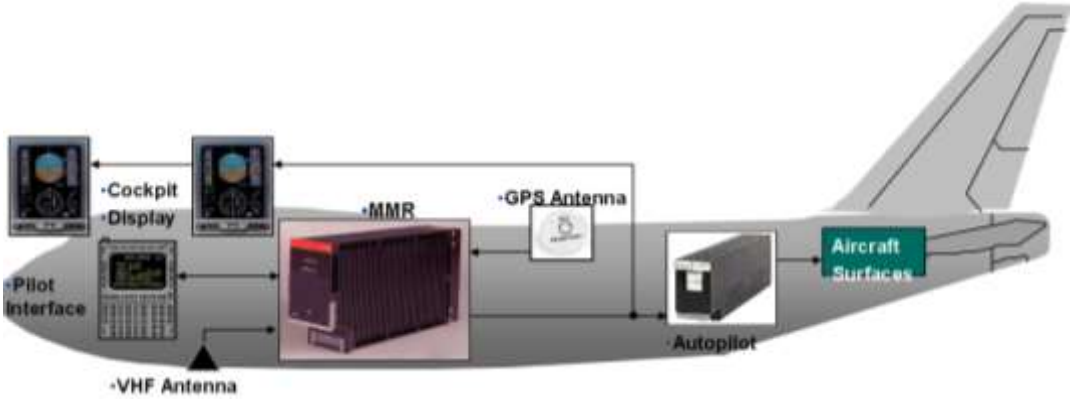


Figure 4-26. Distribution of avionics systems in an aircraft. (35)

This system meets ARINC 755 standards, and DO160D High-Intensity Radiated Field (HIRF) and lightning requirements. Regarding its basic characteristics, it integrates Digital Signal Processing (DSP), has 200 ms power interrupt transparency and a dual channel of processing with different hardware and software in order to separate analogue signal conditioning in hardware from digital signal processing in software. Therefore, it has full equipment monitoring. With respect to ILS performances, the standard ARINC 710 ILS has been replaced by the ICAO Annex 10 FM immunity. Additionally, is has Cat. I to Cat. III B high integrity design and dual or triplex autoland architecture. Concerning GNSS, the TLS755 includes permanent "en route" GNSS mode and 15 tracking channels, with the option of upgrading it up to 24 channels. It incorporates a highly integrated and sophisticated Application Specific Integrated Circuit (ASIC) already designed to support SBAS/GBAS and GLONASS, and it is Future Air Navigation System (FANS) compliant. It also has WAAS, EGNOS and MSAS capability regarding SBAS. (52)

When talking about MLS, this MMR has Cat. I to Cat. III B high integrity and reliability design, and ILS "look alike" interface, with autopilot and display systems. It also presents dual or triplex autoland architecture for MLS. Additionally, it has LAAS Cat. I to Cat. III B high integrity and reliability design concerning GBAS. The TLS755 includes GLS data link receiver and GLS Cat. I software upgrade only. Additionally, for GLS it also has ILS "look alike" interface with autopilot and display system and dual or triplex autoland architecture. (52)

For more information about mechanical structure, power supply and design characteristics, see Product Specification in Section 9.1 of this CP.

5. PRODUCT CONFIGURATION

Provide a table listing the product P/ Ns and provide, in a hierarchical structure, the documents identifying the configuration of the product in accordance with ADOA manual (see Template Manual ETSO chapter 2.1.6).
Explanation about open bracket system can be anticipated under this paragraph (see Template Manual ETSO chapter 2.1.5).

Table 4-3 lists all the Thales TLS755 MMR components' Part Numbers (P/Ns), together with their name and manufacturer. (54)

P/N	Item name	Manufacturer
TLS0809-S100K2R2	Semiconductor	Tdk Semiconductor Corporation
TLS046-18001GQ	Lav Mod	Jamco Corp
TLS 211 15355	N/A	Other Company Llc
TLS015-L	Fuse enclosed link	Littelfuse Inc
TLS070A	Fuse enclosed link	Littelfuse Inc
TLS-260-8N9	Wire electrical	Carlisle Interconnect Technologies
TLS010 L	Fuse enclosed link	Littelfuse Inc
TLS046-18011GQ	Lavatory	Jamco Corp
TLS-260-02N9	Wire electrical	Carlisle Interconnect Technologies
TLS-260-4N9	Wire electrical	Carlisle Interconnect Technologies
TLS-260-6N9	Wire electrical	Carlisle Interconnect Technologies
TLS025-L	Fuse enclosed link	Littelfuse Inc
TLS1	Light source	Honeywell International Inc
TLS060-L	Fuse enclosed link	Littelfuse Inc
TLS-107K-030-B1C	Capacitor fixed ele	Mallory Sonalert Products Inc
TLS050-L	Fuse enclosed link	Littelfuse Inc
TLS-32	Elbow pipe to hose	Dixon Valve And Coupling Company
TLS-3LS3277015KD3	Capacitor	Roederstein E Spezialfabrik
TLS-260-2N9	Wire electrical	Carlisle Interconnect Technologies
TLS0707471KR30	Semiconductor	Tdk Semiconductor Corporation
TLS006-L	Fuse enclosed link	Littelfuse Inc
TLS020-L	Fuse enclosed link	Littelfuse Inc
TLS-7302-S	Valve linear direct	Versa Products Co Inc
TLS05100	N/A	Tfk
TLS06K050C0A	Capacitor fixed ele	Mallory Sonalert Products Inc
TLS070V	NO INFO	Littelfuse Inc

TLS-275	Flashlight	Tactical Lighting Solutions Llc
TLS 367-TS 367	N/A	Toshbia
TLS 335-TS 335	N/A	Toshbia
TLS-64	Elbow pipe to hose	Dixon Valve And Coupling Company
TLS03300	Sensor	Temic Uk Ltd
TLS LB2-PC1	Clip flag	Kipper Tool Company

Table 4-3. Thales TLS755 MMR components' P/Ns, name and manufacturer.

6. TIME SCHEDULE

- Define the possible involvement of EASA in the certification process (e.g. witnessing tests).
- Include a time-schedule defining the main milestones and the decision process, especially the key points where an Agency decision/involvement is needed before further action. Such a schedule should be controlled and updated as necessary along the project.
- Define information to be forwarded to EASA along the project
Provide a Table/Diagram with main milestones identified in the certification process.

In Table 4-4, the main milestones identified in the certification process are included. The date the indicated activities are completed or finished must be updated throughout this certification process.

Activity	Date
Application to EASA (i.e. with Certification Programme + Compliance Matrix + Product specification + Nameplate drawing)	
First Certification Meeting (if required)	
…	
Prototyping	
Conformity Inspection	
…	
1st Delivery of Data package to EASA (i.e. test plans)	
First Test Campaign: start	
First Test Campaign: end	
…	
Second Test campaign: start	
Second Test campaign: end	
Second Certification Meeting (if required)	
…	
Final Delivery of Data Package	
DDP and Statement of Compliance for European Technical Standard Order Authorisation	
EASA approval (target)	

Table 4-4. Main milestones identified in the certification process.

7. RESOURCES

Identify personnel involved in the project with their specific roles according to the ADOA manual (see Template Manual ETSO chapter 1.5). Identify clearly the single point of contact with the Agency.

Name	Contact Details	Position

Identify laboratories locations and tests to be performed at each location.

8. COMPLIANCE DEMONSTRATION

Identify the ETSO standard (s) adopted for the project (number, amendment level).
List of adopted means of compliance against each of applicable requirements should be anticipated here for earlier agreement with the PCM.
Provide reference to the compliance matrix where more details about requirements, means of compliance and compliance data are provided.
More details about deviations (21.A.610) and equivalent level of safety (ELOS) proposed can be anticipated under this paragraph.

The ETSO standard adopted for this project is the ETSO-2C500a, which date of issuance was the 24/10/03. "*This ETSO gives the requirements which multi-mode receivers (ILS/MLS/GPS) that are manufactured on or after the date of this ETSO must meet in order to be identified with applicable ETSO marking*." (55). The technical conditions tackled for the compliance demonstration of the TLS755 MMR are going to be divided as follows:

- Environmental Standard
- Computer Software and Airborne Electronic Hardware (AEH)
- Minimum Performance Standard

Along this Section, the MOC are going to be studied against each applicable requirement, and tests are going to be proposed. The compliance matrix of Section 9.3 of this CP summarizes this compliance demonstration.

8.1. Environmental Standard

"*The applicable environmental standards are contained in EUROCAE/RTCA document ED-14D/DO-160D, "Environmental Conditions and Test Procedures for Airborne Equipment", change 3 dated December 2002*." (56)

The TLS755 MMR is tested for environmental conditions specified in DO-160 (need to include the corresponding revision used; in our case the standard is not available). Laboratory test method guidelines specified in MIL-STD-810G standard have been followed for testing. In the case of the MMR ambient conditions have to be closely controlled. Therefore, the following is maintained:

- Temperature: 23° ± 2°C (73 ± 3.6°F)
- Relative humidity: 50 percent + 5 percent
- Atmospheric pressure: 96.45 +6.6 / -10.0 kPa, 28.5 +2.0 / -3.0 in Hg

Electrical input power is needed in our case to function. Therefore, "*one should consider the normal operational input voltage range (steady state) specified from the power source (generator, transformer rectifier, and alternator/battery) that would be encountered in use*." (57) For commercial aircraft, ranges are stated in RTCA DO-160, section 16. Additionally, operation at the limit thresholds should be considered apart from nominal voltage. As a consequence of instrumentation or measurement inaccuracies, test condition tolerances are established for different parameters as follows:

- Test section air temperature: "*Keep these temperatures within ± 2°C (3.6°F) of the required test temperature. Ensure the air temperature gradient across the item does not exceed 1°C (2°F) per meter or a maximum of 2.2°C (4°F) total (test item non-operating). Wider temperature tolerances are acceptable in situations such as:*
  - *For large items with a volume greater than 5m3 (6.5 yd3), the temperature tolerance can be ± 3°C (± 5°F). Justify any larger tolerance and obtain approval for its use from the procuring activity.*
  - *For required temperatures greater than 100°C (212°F), the temperature tolerance can be ± 5°C (± 9°F).*" (57)
- Pressure: the maximum between ±5 % of the value or ±200 Pa (0.029 psi).
- Humidity: relative humidity at the chamber control sensor must be kept to ±5 % RH of the specified value.
- Vibration amplitude: Sinusoidal Peak at 10 % Random.
- Vibration frequency: measure to 25 Hz and above to an accuracy of ±2 %. Below 25 Hz, use ±½ Hz.
- Time: "*Control time (e.g., test durations and data gathering intervals) within +5 minutes for a total test duration greater than 8 hours, and within +1 percent of the specified value for durations or intervals of 8 hours or less, unless the nature of the test requires greater accuracy*." (57)
- Air velocity: within +10 % of specified value.
- Input Power: "*When input power is of major concern, use tolerances listed in the applicable power source standards (i.e., voltage, frequency, crest factor, ripple, phase displacement, distortion)*" (57)

For complying with environmental standard MIL-STD-461E, an Electromagnetic Compatibility (EMC) test is driven. (58) This type of test covers immunity and emissions testing. In the first case, the reaction to exposure to electromagnetic noise and other disturbances is analysed in order to prove that the system operates under expected operating environment. In the second case, the amount of electromagnetic noise generated by the device during normal operation is measured, in order to ensure it operates under standard limits, not causing harmful interference to other devices. Compliance with DO-160 and other standards for avionics equipment can be shown using EMC test. Simulations include (59):

- Magnetic fields from electrical wires
- Voltage drops caused by brownout or other power interruption
- Electromagnetic surges from lightning strike
- Conducted and radiated electromagnetic noise
- Electrostatic discharges related with static electricity
- Fast transients caused by electrical switches, motors and relays, fluorescent lamp ballasts, etc.

Electromagnetic interference (EMI) and EMC can be interchangeable regarding regulatory testing of electronic components. The test includes a setup station and wiring going to a standard EMI Bulkhead and from the EMI Bulkhead to the test equipment. Surge generators, power amplifiers, and spectrum analysers are used. Figures 4-27 and 4-28 show some detail of the test setup.

Figure 4-27. Flight Test Pallet outside the EMI Chamber and cable layout. (60)

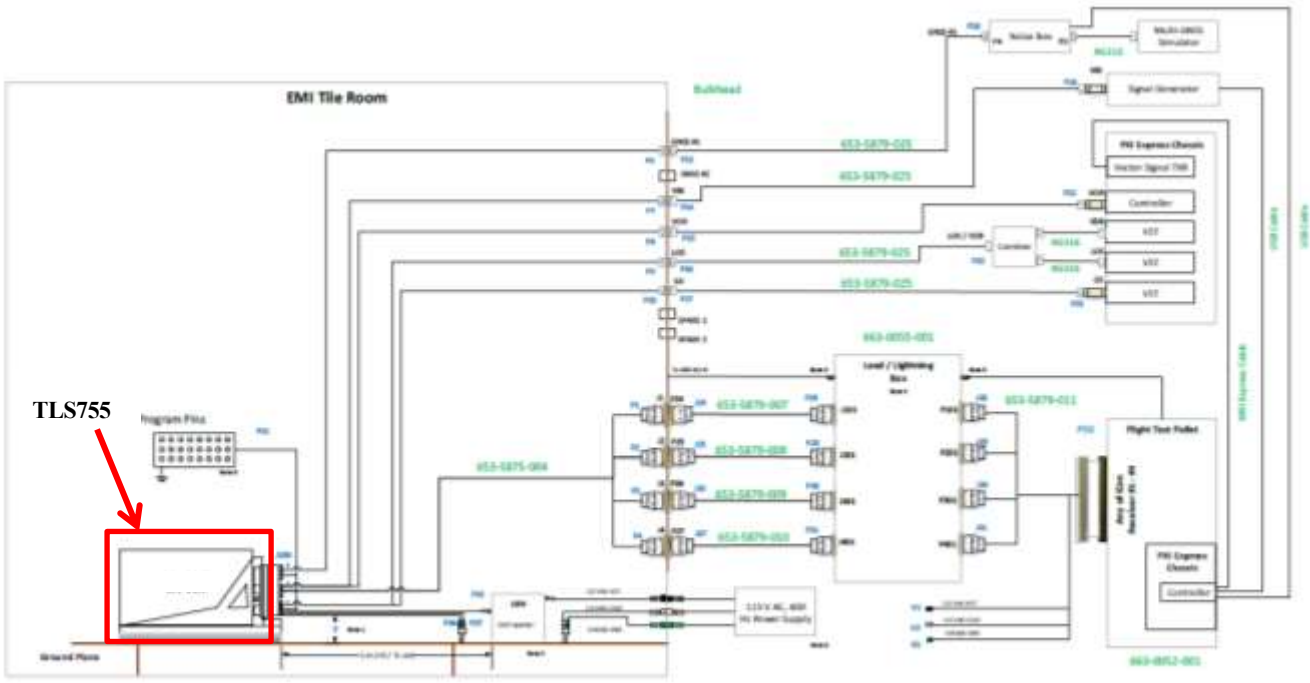


Figure 4-28. Test Setup diagram based on (60).

An Environmental Qualification Form according to DO-160 categories can be provided at the end of the certification procedure where the following elements have been tested :

- Temperature and altitude
- Temperature variation
- Humidity
- Shock/crash safety
- Vibration
- Explosion proof
- Waterproof
- Fluid susceptibility
- Sand and dust
- Salt spray
- Fungus
- Magnetic effects
- Power input
- Voltage spike
- Induced signal susceptibility
- RF susceptibility
- Emission of radio frequency energy
- Lightning induced susceptibility
- Lightning direct effects
- Icing
- Fire, Flammability

8.2. Computer Software and Airborne Electronic Hardware (AEH)

"*If the equipment design implementation includes a digital computer, the computer software must be verified and validated in an acceptable manner. Unless stated otherwise in paragraph 3.1.3 of the specific ETSO, one acceptable means of compliance for the verification and validation of the computer software is outlined in EUROCAE/RTCA document ED-12B/DO-178B, "Software considerations in Airborne Systems and Equipment Certification", dated December 1992. For those applicants who elect to use EUROCAE/RTCA document ED-12B/DO-178B to demonstrate compliance for the verification and validation of the computer software, the following requirements must be met:*

(i) This document defines five levels of software: Level A, Level B, Level C, Level D, and Level E. The applicant must declare the level (or levels) to which the computer software has been verified and validated.
(ii) If the equipment incorporates more than one software level, appropriate partitioning of different software level is required." (56)

The TLS 755 MMR software is verified and validated according to DO-178B. For its verification process the inputs are the following (61):

- System requirements
- Software requirements and architecture
- Traceability data
- Source Code
- Executable Object Code
- Software Verification Plan

The requirements-based coverage analysis is used for studying the traceability between the software requirements and the test cases. While the structural coverage analysis studies the traceability between the code structure and the test cases. Therefore, our software testing process aims to demonstrate that the software satisfies its requirements and that errors which could lead to unacceptable failure conditions, which are obtained from System Safety Assessment (SSA) process, have been removed. Figure 4-29 shows a diagram of the software testing process, which includes the following milestones:

- Test cases based on the software requirements or normal range test cases
- Test cases which verify correct functionality and establish potential errors conditions or robustness (abnormal range) test cases.
- Software requirements coverage analysis
- Structural coverage analysis

The test cases are divided into three categories: Low-Level, Software Integration and Software/Hardware Integration Tests. In Figure 4-30 the possible errors that can be revealed at each type of test case are shown. In addition, Figure 4-31 shows another type of classification of tests cases, which covers our aim for testing methods.

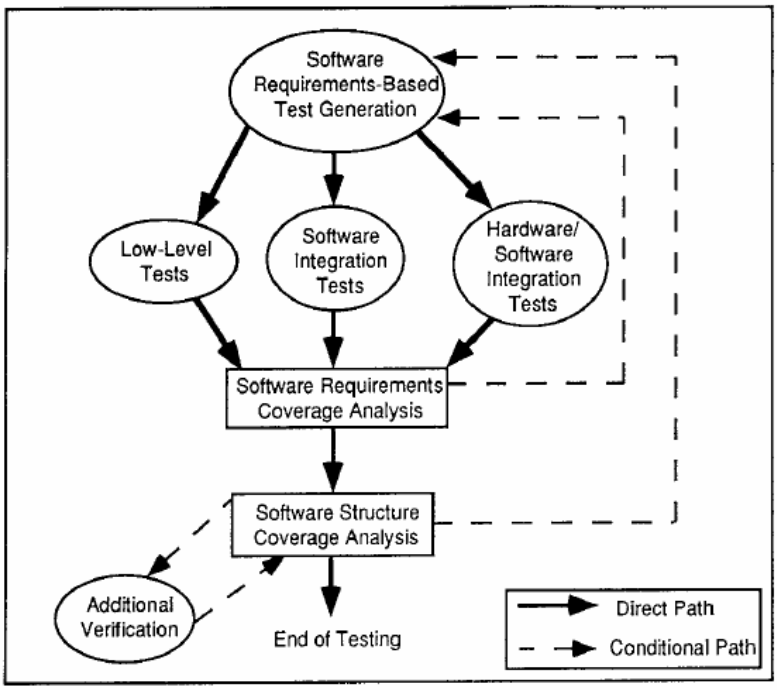


Figure 4-29. Software Testing Process. (61)

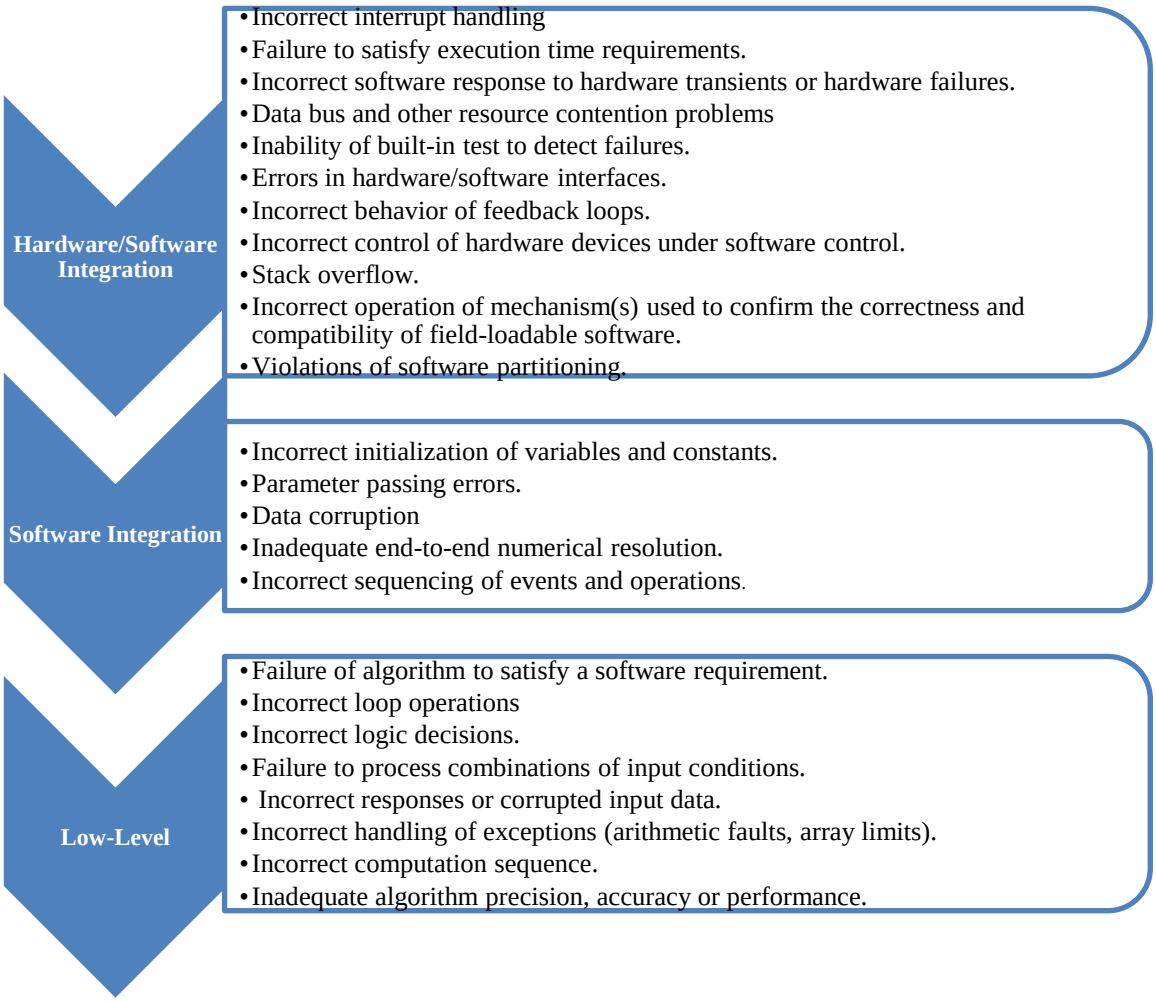


Figure 4-30. Possible errors that can be revealed at each type of test case.

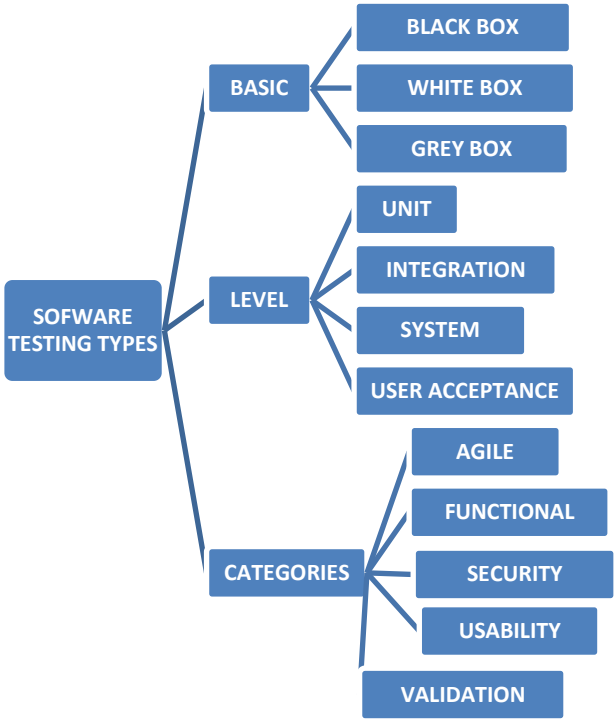


Figure 4-31. Alternative classification of tests cases.

Annex A Tables A-3 to A-7 of DO-178B "*contain a summary of the objectives and outputs of the software verification process, by software level*." These are useful as a check list for tasks fulfilment in the validation and verification process for our software. Once these processes are finished, we are able to confirm that the TLS755 MMR software is developed as per DO-178B Level C. Therefore, in our case the MMR has a "*software whose anomalous behavior, as shown by the system safety assessment process, would cause or contribute to a failure of system function resulting in a major failure condition for the aircraft*." (61)

The testing of the AEH has been done following the RTCA DO-254 (revision not available). The guidance given by this document is applicable, but not limited, to the following hardware items (62):

- Line Replaceable Units (LRU),
- Circuit board assemblies,
- Custom micro-coded components such as ASIC and Programmable Logic Devices (PLD) including any associated macro functions,
- Integrated technology components such as hybrids and multi-chip modules,
- Commercial Off The Shelf (COTS) hardware.

Additionally, the DO-254 provides guidance for undergoing tests on hardware as follows:

- "*Each requirement to be validated or verified by test should be identified. Environmental qualification test requirements are part of these requirements.*
- *The testing stimulus, sequence and test conditions, such as item ambient temperature and applied voltage, should be defined for each test.*
- *Pass/fail criteria and a method for recording the results should be defined prior to test execution.*
- *The complete identification of the test equipment and calibration date for each should be recorded.*
- *The configuration identity of the hardware item being tested should be recorded.*
- *Test results should be recorded and retained.*
- *Test failures should be fed back to the appropriate process for resolution*." (63)

Apart from testing, verification and validation processes use or combine other methods such as design and requirements reviews and analyses. Studies on the functionality, performance, traceability and safety implications of a hardware item function and its influence in functions within the airborne system or equipment are done by using analysis. This processes use data provided by the design process, service experience or other available databases as inputs. The analyses used for studying the TLS755 MMR have been the following (63):

- Thermal Analysis: for verifying that the design implementation complies with requirements when operating in thermal environment.
- Stress Analysis: for verification that components meet de-rating criteria over the required operating range.
- Reliability Analysis: studies design implementation according to reliability requirements of the product.
- Design Margin Analysis: studies design implementation according to functional requirement due to the variability of components.
- Similarity Analysis: for comparing the characteristics and usage of our system and systems previously certified.
- Simulation Analysis: for comparing simulation results and expected results and visualizing the circuit and higher levels of functional operation. Simulation has also been used to reduce the design errors affecting safety due to production variations in hardware parameters.

The main analysis developed, which took more time to complete during the validation and verification process was the Functional Failure Path Analysis (FFPA). This analysis is a structured, top-down, iterative analysis that detects the parts of the design which implement the function (assemblies, components and elements related to each path) and the associated failure modes. Additionally, relevant effects which determine the AEH's architecture and safety implementation are studied.

The first step of the FFPA has been the PSSA, used for identifying system level Functional Failure Paths (FFPs), which might later on be decomposed into and allocated to hardware FFPs. Therefore, the objective of the FFPA is to identify individual FFPs. For this partitioning, conventional top-down safety assessment techniques have been used such as FTA and FMEA for successively level decomposition. FFPA is applied normally for Level A and B functions. However, it can also be used for hardware implementing level C or lower level functions, which can be assured by using only the former analyses.

The TLS755 MMR hardware, is developed as per DO-254 Level C. Therefore, the "*Hardware functions whose failure or anomalous behavior, as shown by the hardware safety assessment, would cause a failure of system function resulting in a major failure condition for the aircraft*." (63) It can then be considered a very good option as a receiver, as it will hardly create hazardous or catastrophic failure situations as, at a given time, the navigation solution computed comes from combined, weighted inputs from various independent sensor platforms. In Table 2-1 of DO-254 standard, the Hardware DAL Definitions and their Relationships to Systems DAL is shown. Hence, it contains essential information for hardware verification and validation processes.

8.3. Minimum Performance Standard

Regarding the Minimum Performance Standards for MMRs, they are "*set forth in EUROCAE document ED-88 dated August 1997*." (55) As the former ED-88 is not available for the project, we are going to focus the minimum performance compliance activities in the ED-114A, which establishes the minimum operational performance for GBAS supporting CAT I operations. This document mainly specifies tests for the GBAS Ground Subsystem. (62) However, flight tests have been carried out in order to verify the performance of the MMR with respect to the functional implementation. This process can be organised as follows if we suppose, for example, that Thales collaborates with Airbus aircraft:

- Prototype specification
- Incremental Function Implementation on Thales and Airbus side
- Prototype flight test readiness
- Airbus flight test with ground station prototype in Toulouse/Blagnac (flight test installation for MMR can be seen in Figure 4-32)
- Analysis of preliminary flight test results, prototype and test set up adaptations
- Flight test with design and product validation

Figure 4-32. Flight test installation for MMR certification. (64)

As it can be seen in Figure 4-33, HMI is not changed specifically for GBAS CAT I/II/III. It has an "ILS-look alike" concept applied in order to ease the precision approach procedure to the crew.

Figure 4-33. HMI function implementation on test aircraft. (64)

The test must include several approaches to Toulouse-Blagnac from inside and outside of approach areas, all the different combinations of runway and landing directions, the touchdown and roll out manoeuvers, and other GBAS operational aspects such as the guided take-off and taxiing. The flight test conduction can be seen in Figure 4-34. With these flight tests it is possible to verify:

- Functioning of the GBAS CAT I/II/III function implementation at aircraft architecture and MMR level
- Touchdown performance of automatic flight and NSE
- MMR prototype based on LRU in operational GLS conditions
- Interoperability between aircraft implementation and GAST-D ground system
- Capability to ensure CAT III positioning source Integrity
- SIS Continuity requirements

Figure 4-34. Flight test conduction. (64)

Prototypes for the GLS are also done only for flight tests, as the one shown in Figure 4-35.

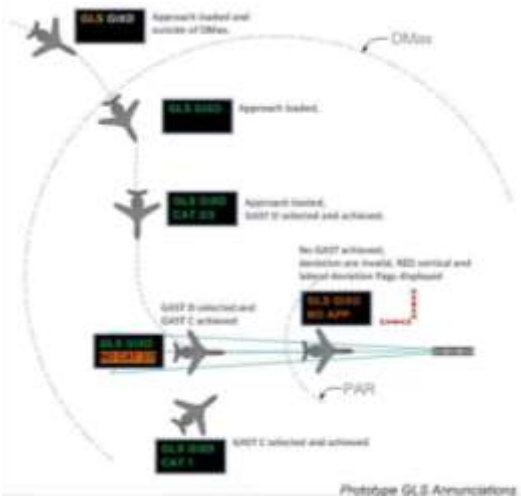


Figure 4-35. Prototypes for the GLS for flight tests. (64)

In addition, the benefits of augmented vision and GNSS augmented navigation activities can be tested. These solution can reduced environmental impact, shorten the path, improve accuracy of flight, decrease noise, lower fuel consumption, lower CO_2 emissions and can be accessible for all types of airport and all types of Airspace users. In Figure 4-36, the simulation of Required Navigation Performance (RNP) to GBAS approaches can be seen represented in red.

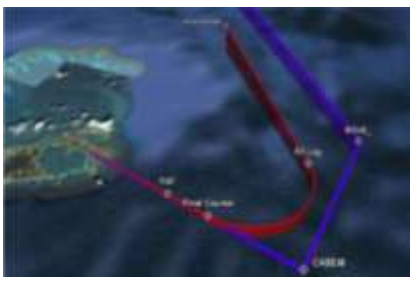


Figure 4-36. Simulation of RNP to GLS. (64)

9. PROJECT DATA PACKAGE

Following documents as minimum need to be listed under this paragraph:

- *All compliance documents quoted within the compliance matrix, including test plans and test reports*
- *Product specification, if any*
- *Master drawing list*
- *Component Maintenance Manual*
- *Installation Manual*
- *DDP*
- *Nameplate dwg*

Nevertheless a complete overview of the list of documents that PCM is expected to receive composing the ETSO package should be provided. If a Master Document List is established, reference could be made only to this document, to be provided to the PCM along the process.

9.1. Product Specification

The TLS755 is mounted in an ARINC 600 size 3 MCU case (common type of cover used as an example). Its chassis, as shown in Figure 4-25, has a top and bottom plates, front panel, left and right covers, and a rear connector as the one shown in Figure 4-37. This connector is mounted in an assembly that protects the MMR against HIRFs and has inserts for the GNSS antenna connections, VOR/MB localizer antenna connections, and Glide-Slope antenna connections.

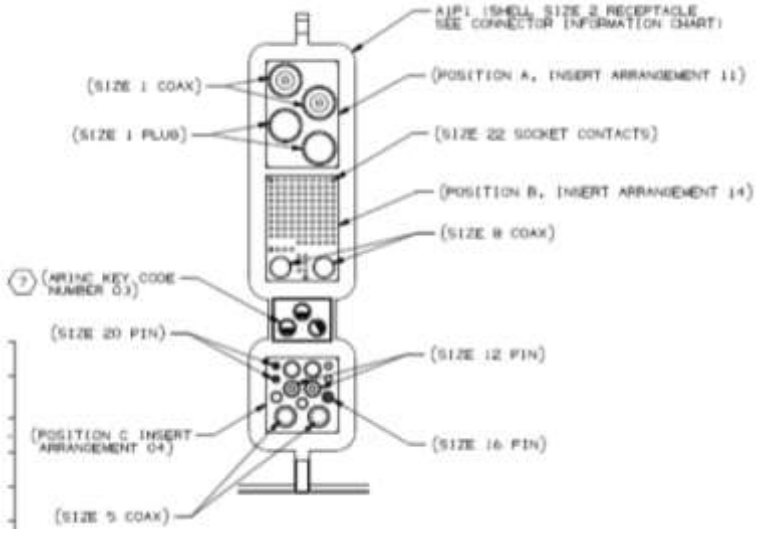


Figure 4-37. MMR case rear connector. (65)

In order to access the interior, removal of the left or right side covers is necessary. The MMR is cooled with a system of forced-air supply, inlet holes on the bottom of the unit and outlet holes on the top of the unit. Regarding the power supply, the unit operates on 115 V of alternating current, 400 Hz single phase power supplied by the aircraft. This input power moves from the rear interconnect to the forward power supply. In Figure 4-38 a scheme of the unit's elements and interconnections is shown. Table 4-5 includes details on these elements weights, dimensions, and power usage.

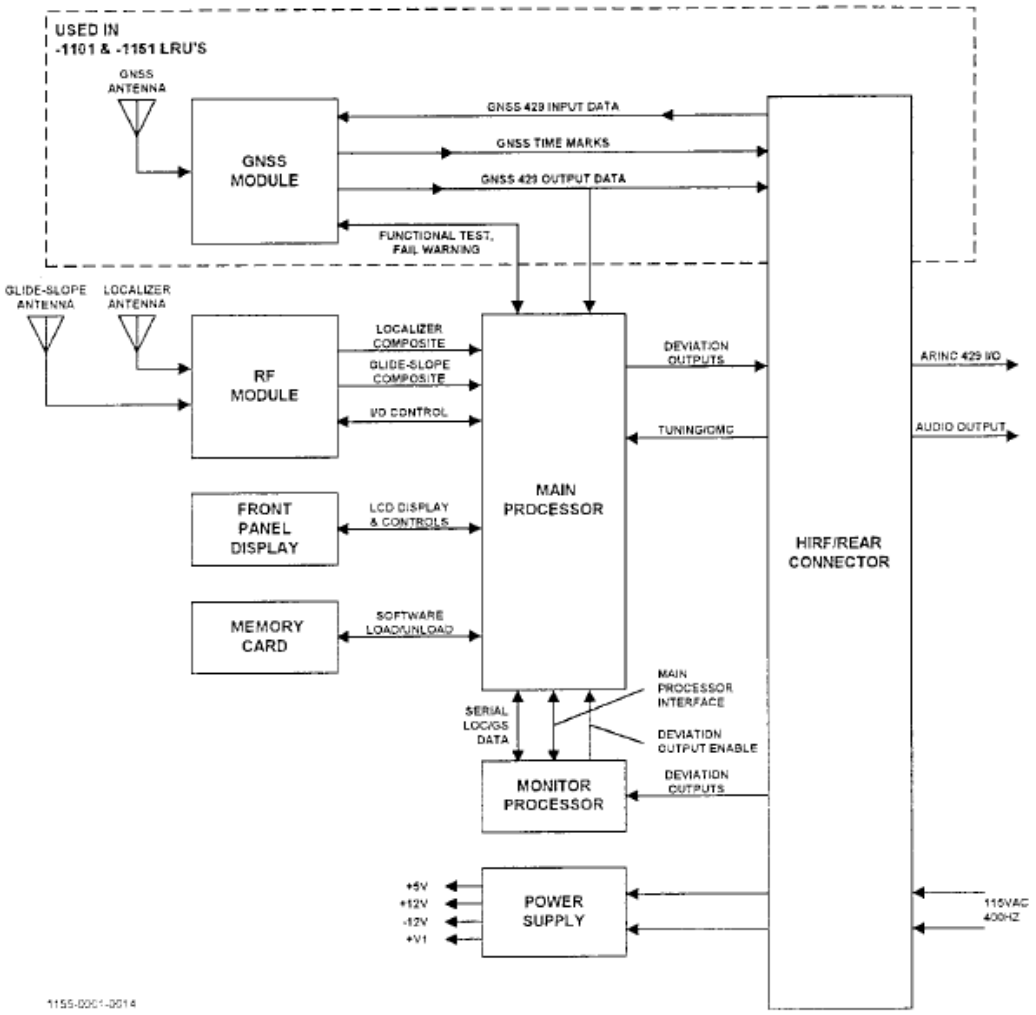


Figure 4-38. MMR System Block Diagram. (65)

Characteristic	Specification
CONNECTOR	
Rear connector	- Rear connector RCPN 859-2777-630 - ARINC 600 size 2 shell with three inserts and an - index pin code of 03 - Top plug insert arrangement 11 - Middle plug insert arrangement 14 - Bottom plug insert arrangement 04
LOCALIZER RECEIVER	
Frequency range	108.00 - 111.95 MHz
Channel spacing	50 kHz (40 channels), 108.10 MHz to 111.95 MHz
Antennas	50 Ohms Nominal
Receiver sensitivity	- Aural sensitivity 6 dB (S+N)/N minimum, over the range –99 to –33 dBm - Valid data threshold −110 dBm minimum (+/- 2.0 dBm) - Identification tone threshold −93 dBm at percent modulation, 1020 Hz
GLIDE-SLOPE RECEIVER	
Frequency range	328.6 to 335.4 MHz
Channel spacing	150 kHz (40 channels), from 329.15 to 335.0 MHz

Antenna input	50 Ohms (nominal)
Receiver sensitivity	Valid data threshold −87 dBm minimum
INSTRUMENTATION	
LOCALIZER DEVIATION ACCURACY	
Centering	± 0.004 DDM, 95% probability ± 0.004 DDM, bench
GLIDE-SLOPE DEVIATION ACCURACY	
Centering	± 0.0093 DDM, 95% probability ± 0.0093 DDM, bench
Localizer audio output level	Adjustable 5 to 40 mW, -87 dBm to -33 dBm, for standard localizer signal, modulated 30% at 1000 Hz into 600-ohm load
VDB RECEIVER	
Frequency range	108.000 - 117.975 MHz
Channel spacing	25 KHz
Receiver sensitivity	Message failure rate ≤ 0.15%, with an input power level of −87 dBm
VOR RECEIVER	
Frequency range	108.00 - 117.95 MHz
Channel spacing	50 kHz
Antenna input	50 Ohms (nominal)
Receiver sensitivity	- Aural sensitivity 6 dB (S+N)/N minimum, over the range –109.5 to –27 dBm - Valid data threshold −110 dBm minimum (+0.5 / -2.0 dBm) - Identification tone threshold −109.5 dBm at percent modulation, 1020 Hz
VOR audio output level	Adjustable 5 to 40 mW, -98 dBm to -33 dBm, for standard VOR signal, modulated 30 percent at 1000 Hz into 600-ohm load
MB RECEIVER	
Frequency range	75 MHz
Antenna input	50 Ohms (nominal)
Receiver sensitivity	- Aural sensitivity 6 dB (S+N)/N minimum, 15 dBm range of threshold (-67 dBm for high, -53 dBm for low) to -13 dBm - Valid data threshold –67 dBm (High), –53 dBm (Low)
GNSS RECEIVER	
Frequency	1575.42 MHz
Channels	14 GPS channels, 4 SBAS channels (Primary/Monitor)
Time to first fix	Worst Case 300 seconds (5 minutes) with or without initialization (95%)
Accuracy (Non SBAS/GBAS)	- Horizontal 15 meters 95% (HDOP 1.5) SA OFF - Vertical 21 meters 95% (VDOP 3) SA OFF
Receiver sensitivity	GPS MOPS Testing performed to a signal level of -120.5 dBm at the input to the receiver

Table 4-5. MMR elements weights, dimensions, and power usage based on (60).

9.2.Installation Manual

The system installation will imply the following procedures and elements:

1. Case: the selected mounting case should be wired according to the system wiring diagram (example shown in Figure 4-39), and installed according to the manufacturer's instructions. The outer cases and plates are designed to be removed without rewiring and connectors. To wire the plates into the system, first remove the rear connector cover and connector plate assembly. Then crimp or solder (as applicable) the interconnecting wiring to the appropriate connector pins. Finally, situate the connector plate assembly and cover back to their former position. Follow the equipment manufacturer's installation instructions to install the case into the airframe.

NOTE: For inspection or repair of the connector, or the wiring to the connector, sufficient lead length must be left for pulling forward rear connector assembly several inches. Bend must be created in the harness near the connector for allowance of water droplets which might form from condensation, to be collected at the bend and not affect the connector.

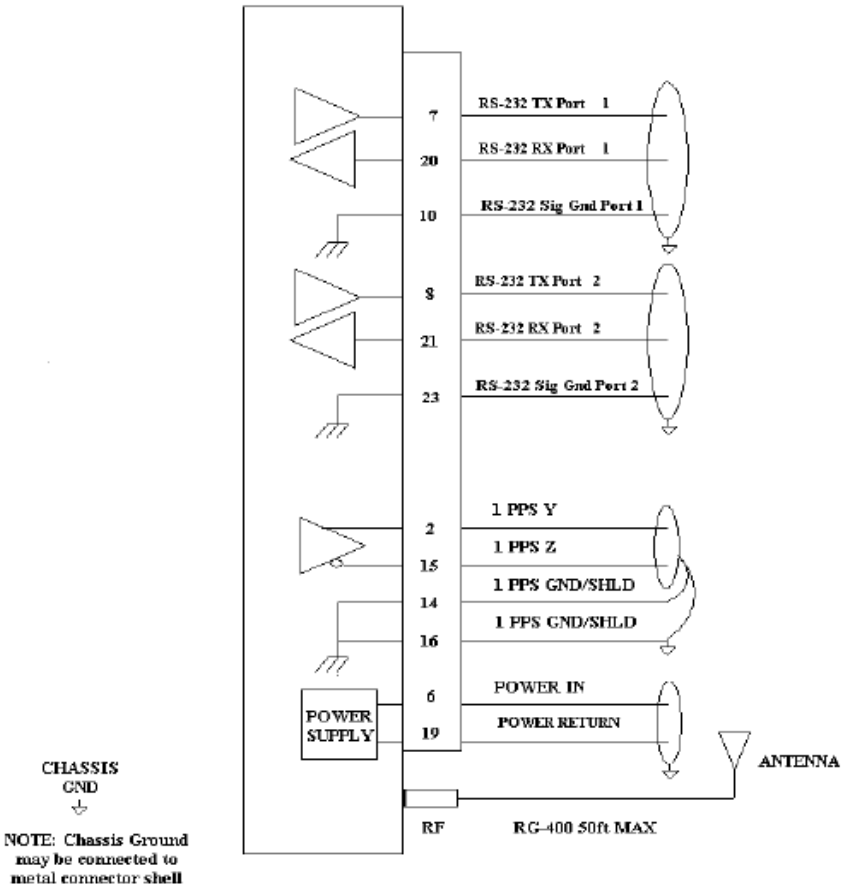


Figure 4-39. Wiring diagram. (65)

2. MMR: installed in the base as follows:
   a. Pull the MMR unit into the base until the guide pins are aligned and the electrical connectors are firmly anchored.
   b. Secure the front of the MMR to the case by tightening the two knurled screw clamps. Ensure they are firmly situated over hold-down hooks located on the front of the unit.
   c. Safety wire the two screw clamps.

3. MMR control Panel: must be wired according to the system wiring diagram, and the manufacturer's instructions.

4. Electronic Horizontal Situation Indicator (EHSI): located in the aircraft instrument panel providing easy visibility. Install according to manufacturer's instructions and wire in accordance with system wiring diagram.

5. Localizer antenna: install in accordance with manufacturer's instructions.

NOTE 1: Localizer operation can be affected by output from VHF transmitter antenna. Therefore, at least 35 dB (preferably 45 dB) of space attenuation must be provided between both antennas.

NOTE 2: Coaxial cable necessary between case and localizer antenna. This cable should be as short and direct as possible to limit attenuation. Required bends should be gradual. Guarantee minimum signal loss which will be detrimental to localizer reception. Coaxial cable must have an impedance of 50 ohms. The antenna system should present less than 5:1 VSWR under every environmental condition, including precipitation and icing.

6. Glide-slope antenna: install according to manufacturer's instructions.

NOTE: Coaxial cable necessary between case and localizer antenna. This cable should be as short and direct as possible to limit attenuation. Required bends should be gradual. Guarantee minimum signal loss which will be detrimental to glide-slope operation. Coaxial cable must have an impedance of 50 ohms. The antenna system should present less than 5:1 VSWR under every environmental condition, including precipitation and icing.

7. GNSS Antenna: install according to manufacturer's instructions.

NOTE: Coaxial cable necessary between case and localizer antenna. This cable should be as short and direct as possible to limit attenuation. Required bends should be gradual. Guarantee minimum signal loss which will be detrimental to GNSS receiver operation. Coaxial cable must have an impedance of 50 ohms. The antenna system should present less than a 2.0:1 VSWR under every environmental condition, including precipitation and icing.

The inspection procedure includes all units interfering with the MMR and which can affect its performance. (66) This inspection should be done after the system installation and as a periodic check. The following must be checked:

- ARINC 600 size 3 MCU case: as defined by manufacturer's instructions.
- MMR:
  - Ensure full insertion of the unit in the case.
  - Check knurled screw clamps are tight and safety wired.
  - Inspect the case for deformation, dents, corrosion, and damage.
  - Guarantee that ventilation holes in the case are not choked.
  - Check correct placement of cooling source.
- Control panel: as defined by manufacturer's instructions.
- EHSI: as defined by manufacturer's instructions.
- Localizer antenna: as defined by manufacturer's instructions.
- Glide-Slope antenna: as defined by manufacturer's instructions.
- GNSS antenna: as defined by manufacturer's instructions.

9.3. Compliance Matrix

Compliance Matrix related to TLS755 MMR is shown in Table 4-6.

ETSO requirement reference (2)	Requirement title	Means of Compliance/ procedure ref.	Evidence Report	Compliance statement (1)	Comments
CS-ETSO 2C500a §3.1.1 Minimum Performance Standard →*detail here the MOPS requirements for example :*					
ED-72A §3.1.5.1	*Tracking through Normal Manoeuvres*	*HVP § 2.1.3*	*HVR §4.3.2*	*C*	
AS 8034A §4.2.1	*Viewing angle*	*QTP §3.2.5*	*QTR §4.2.3*	*C*	
ED-114 §5.16	Flight Testing	Information not available	Information not available	Flights at appropriate heights and distance are required to ensure the coverage requirements are satisfied.	Only flight testing activities related to GBAS Ground Subsystem site acceptance are within the scope of this MOPS (not under the scope of this project but used as an example for GBAS testing).
CS-ETSO 2C500a §3.1.2 Environmental standard CS-ETSO Subpart A §2.1 →detail here the applicable DO-160 requirements for example (3)					
DO-160F §4.5.2	*Operating Low temperature*	*QTP §3.5.3.1*	*QTR §5.6.3.3*	*C*	DO-160F not available for this project
MIL-STD-461E §4.3.9	Operation of Equipment Under Test (EUT)	Information not available	Information not available	For EUTs with several available modes a, sufficient number of modes shall be tested for emissions susceptibility such that all circuitry is evaluated	
MIL-STD-810G §5.1	Test Conditions	Information not available	Information not available	Unless otherwise specified in the individual test methods, adhere to	

				the test condition tolerances shown below for the following parameters.	
CS-ETSO Cxxx §4 Marking					
4.1	*General Marking requirement*	*P/N xxx Labelling procedure*	*P/N xxx Nameplate drawing issue 01*	*C*	
4.2	*Specific*	*…*			
CS-ETSO 2C500a §3.1.3 Computer Software CS-ETSO Subpart A §2.2					
DO-160F §4.5.2	*Operating Low temperature*	*QTP §3.5.3.1*	*QTR §5.6.3.3*	*C*	DO-160F not available for this project
DO-178B §6.2	Software Verification Process Activities	Information not available	Information not available	Software verification process objectives are satisfied through a combination of reviews, analyses, The development of test cases and procedures, and the subsequent execution of those test procedures.	
DO-178B §6.4	Software Testing Process	Information not available	Information not available	Testing of airborne software has two complementary objectives. One objective is to demonstrate that the software satisfies its requirements. The second objective is to demonstrate with a high degree of confidence that errors which could lead to unacceptable failure conditions, as determined by the system safety assessment process, have been removed.	

DO-254 §6.3.1	Tests	Information not available	Information not available	Test is a method that confirms that the hardware item correctly responds to a stimulus or series of stimuli.	
DO-254 §6.3.2	Analysis	Information not available	Information not available	Analysis is a detailed, repeatable, analytical method for evaluation of specific hardware item characteristics to demonstrate that a specific requirement is met.	

Table 4-6. Compliance Matrix for TLS755 MMR.

9.4. Maintenance Procedures

For maintenance of the Thales TLS755 MMR, the following areas have to be checked (65):

1. Adjustments and alignments: there are no adjustments or alignments required for the MMR. All alignment and adjustment procedures are done during bench maintenance. The technician should remove the unit from the aircraft when its performance indicates an adjustment or alignment is necessary.

2. System protection: the system should be protected by a two-ampere circuit breaker located at the circuit breaker panel of the aircraft.

3. Lubrication: any MMR component requires periodic lubrication.

4. Cleaning: when necessary, depending on exposure environment and intensity of use. Periodic cleaning should be performed. Any dust on the MMR system LRU should be eliminated with a lint-free cloth. Any cleaning of equipment interior is limited to that driven during overhaul (bench-type) work.

9.5. Declaration of Design and Performance (DDP)

The DDP can be considered as the summary of the article certification process and design, as it states that the article is designed, tested and manufactured according to the applicable sections of Part 21 and CS-ETSO already mentioned. A template of the DDP is included in Annex V of this project, taken from the AMC 21A.608 of Part 21. (11) Relevant information regarding compliance demonstration and description of the article will be specified.

As explained in former sections of this project and CP, the information included in the different documents is numerous times repeated. Therefore, for this simulation of CP, the DDP is not going to be completed as it summarizes all the information already shown along this CP and adds some other information that is out of the scope of knowledge of this project. Additionally, the DDP is a document that is normally delivered at the end of the certification process, once all the ETSO data is completed by the Applicant after compliance demonstration through tests among other means.

4.2.5 European Union Aviation Safety Agency (EASA) Internal Procedure for European Technical Standard Order Authorisation (ETSOA) Certificate Issuance

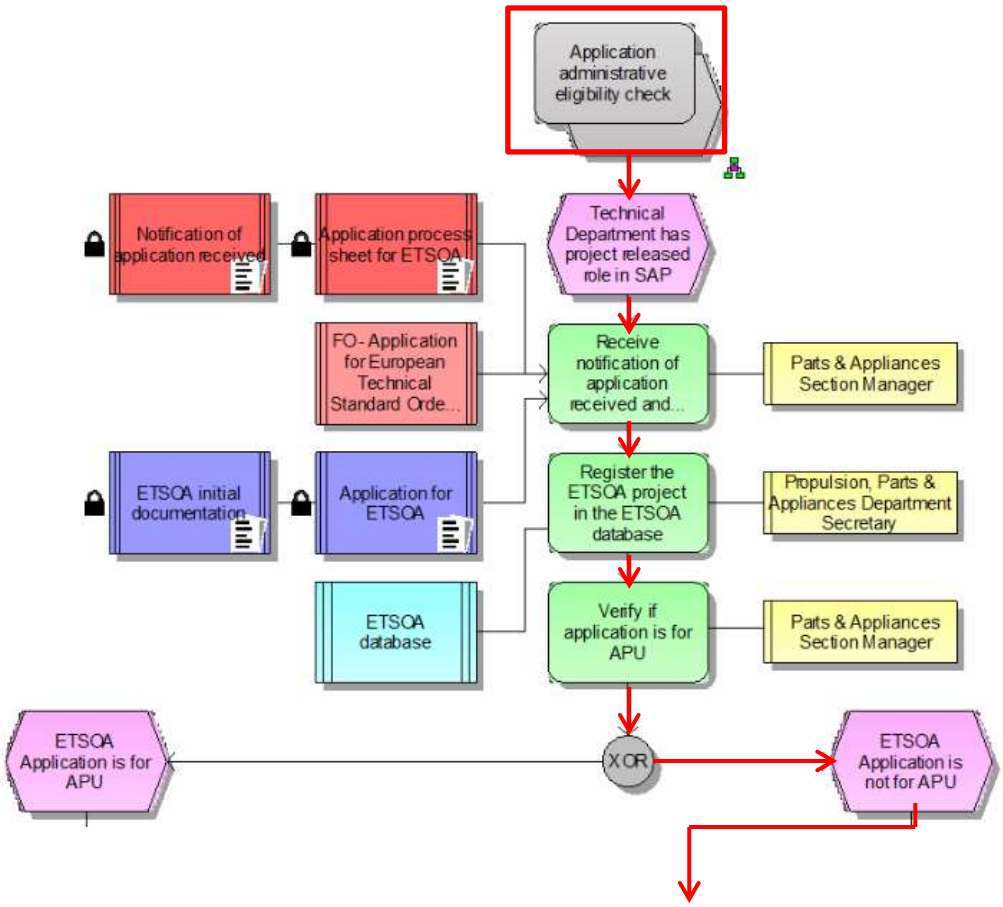
4.2.5.1 Classification of the European Technical Standard Order Authorisation (ETSOA) Application

After the application has been sent, it is important to verify its classification. For it, two classification and

technical eligibility checks are done. The flow chart of the first process is shown in Figure 4-40 and 4-41. Once the notification of application has been received and process sheet issued, the Parts & Appliances Section Manager, together with the Propulsion Section Manager in case of an application for an APU, which is not our case, performs a first check on eligibility according to Commission Regulation (EU) No. 748/2012, Annex I and determines the way they will proceed with the application. They will let the Applicant know their opinion, together with the applicable requirements needed within the month after reception of the correct application. Finally, in the case of new projects the responsible Secretary of the Propulsion, Parts & Appliances Department is the responsible for the registration of the project and all relevant information in the ETSOA database under the EASA/SAP project number given in the Applicant Portal once applied.

In Figure 4-41 is shown the 2nd classification and technical eligibility check. When assessing if it is a validation or a certification activity, equipment from applicants whose headquarters is located outside the territory of the Member States must be analysed. Depending on the bilateral agreements or working arrangements with the State of Design, alternative procedures not encompassed in these flow charts might be used according to the associated Technical Implementation Procedure (TIP) which may supplement, change or complement the European legislation and corresponding procedures, calling it validation instead of certification activity. It is not the case of the Thales TLS755 MMR.

In our case, no DOA is needed as the application is not for an APU, but in other cases, the PCM- Parts & Appliances will check the eligibility and demonstration of capability for design required in Articles 21.A.602A and 21.A.602B(b) of Annex I to Commission Regulation (EU) No. 748/2012. However, a POA or LoA are needed. Therefore, the aforementioned manager must check the eligibility and the demonstration of capability for production, proving the existence of a production approval under Subpart F or G of the same Annex. If it is not the case, the Applications Management Section will be notified by the manager, and they will be in charge of sending a Holding Letter to the Applicant, with a request of application for POA or LoA to the corresponding NAA. The rest of the procedure is put on hold until the reception of the application.



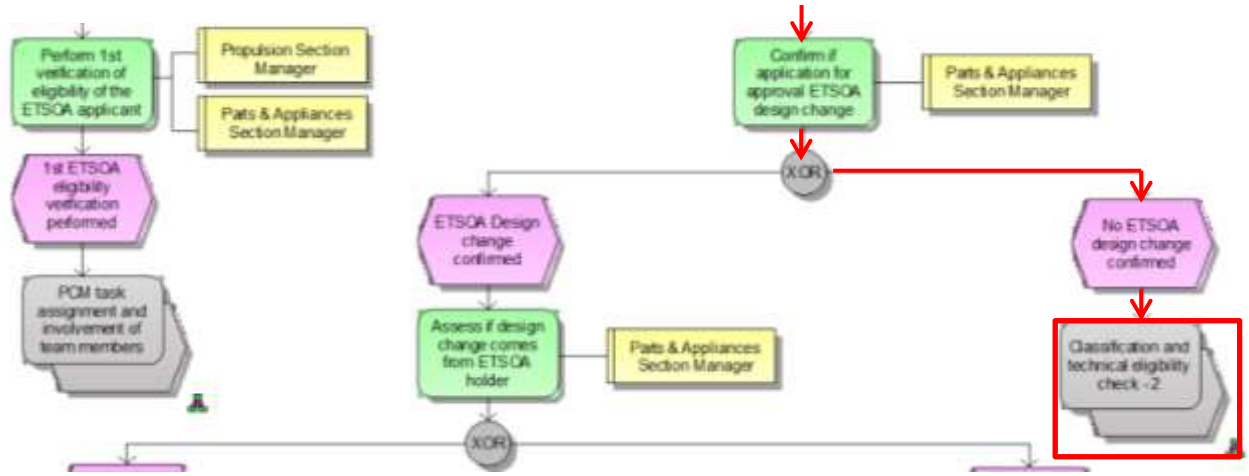
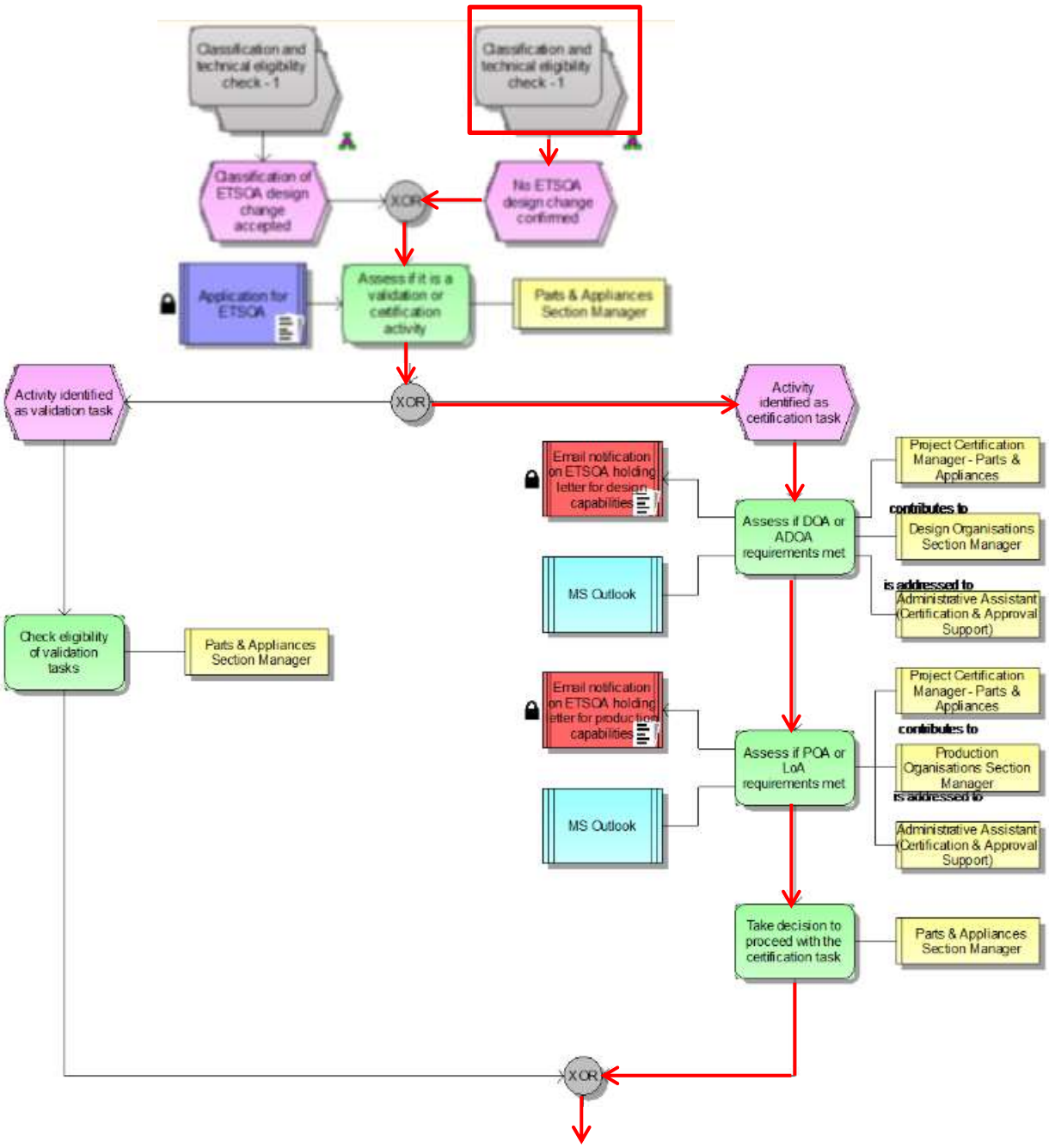


Figure 4-40. 1st Classification and technical eligibility check based on (23).



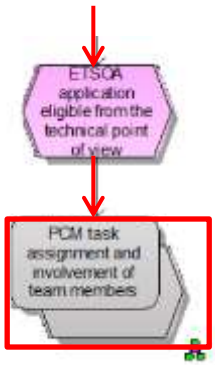
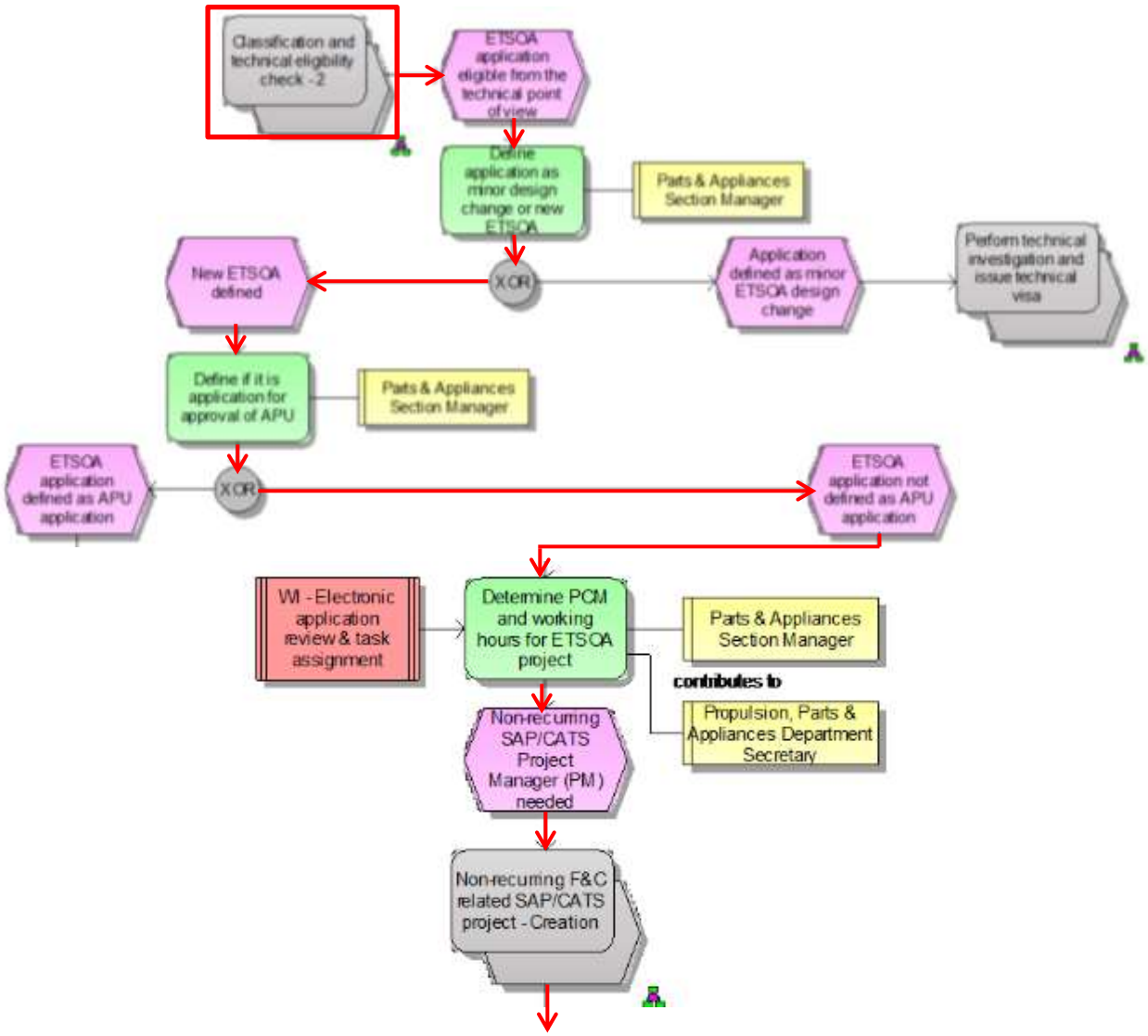


Figure 4-41. 2nd Classification and technical eligibility check based on (23).

4.2.5.2 Project Certification Manager (PCM) task assignment and involvement of team members

Once eligibility has been assessed and therefore the application has been accepted by the Agency, the Parts & Appliances Section Manager nominates the PCM, informing about the total/individual workload estimated and registering it in SAP. This PCM is the person in charge of letting the responsible Secretary of the Propulsion, Parts & Appliances Department know about the team composition and planned working hours, which will be also registered in SAP. All this process is described in the flow diagram of Figure 4-42.



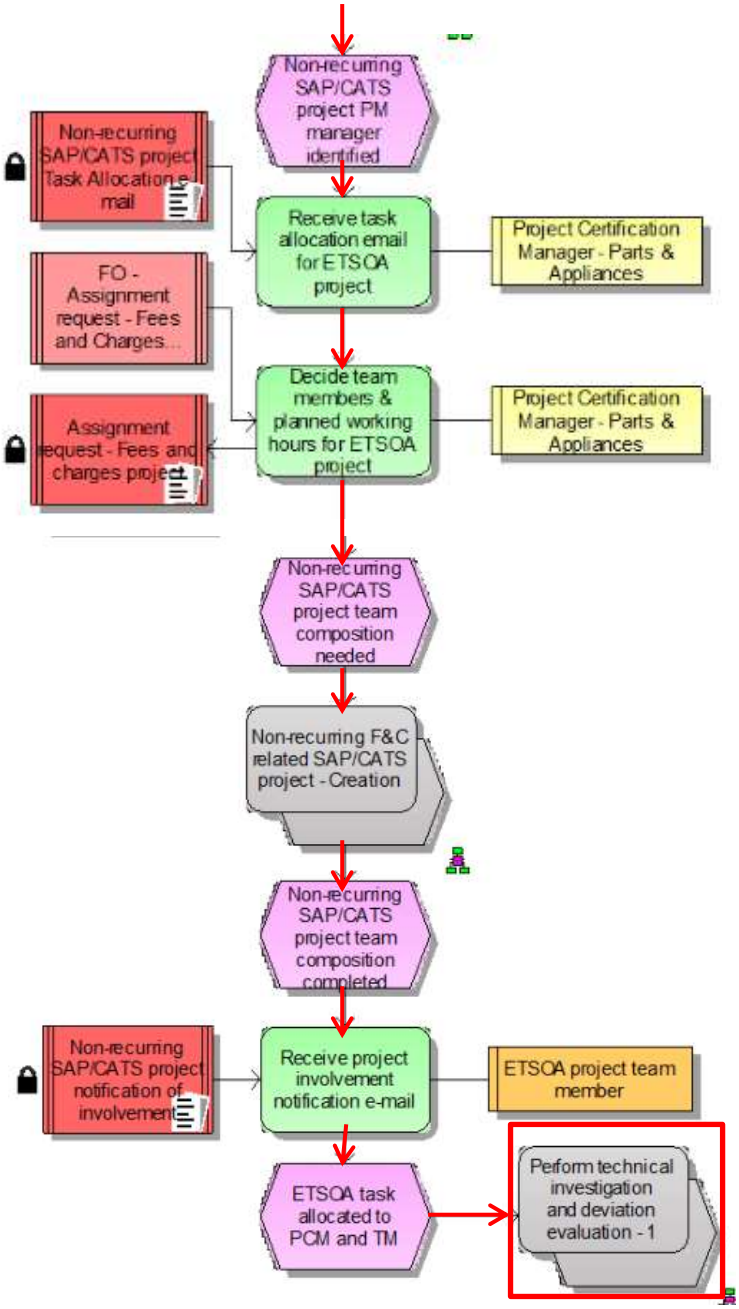


Figure 4-42. PCM task assignment and involvement of team members based on (23).

4.2.5.3 Technical Investigation

When performing the first technical investigation for ETSOA, the PCM Parts&Appliances will:

- "*participate in a familiarisation meeting (optional),*
- *accept Certification Basis applied for after its verification,*
- *verify that all data required by 21.A.605 have been submitted,*
- *manage the compliance finding process including,*
  - *evaluate the documents provided by the Applicant for compliance with ETSO,*
  - *involve software expert / expert for software/hardware quality assurance:*
    - *perform audits for software / hardware qualification,*
    - *review design process report (software /complex hardware),*

- *review test plan / compliance demonstration plan, i.e. verify whether the Applicant has a correct understanding of the testing requirements,*
- *review test (test witnessing, test reports),*
- *review compliance report and matrix (crosscheck compliance finding against each requirement),*
- *request and review nameplate,*
- *review DDP,*
- *review manuals (installations / operations),*
- *request missing information,*
- *participate in technical discussions,*

➢ *close the project in database,*

➢ *verification whether POA or LoA (production according to Annex 1 Part 21 Subpart F) exists and capability list covers application."* (23)

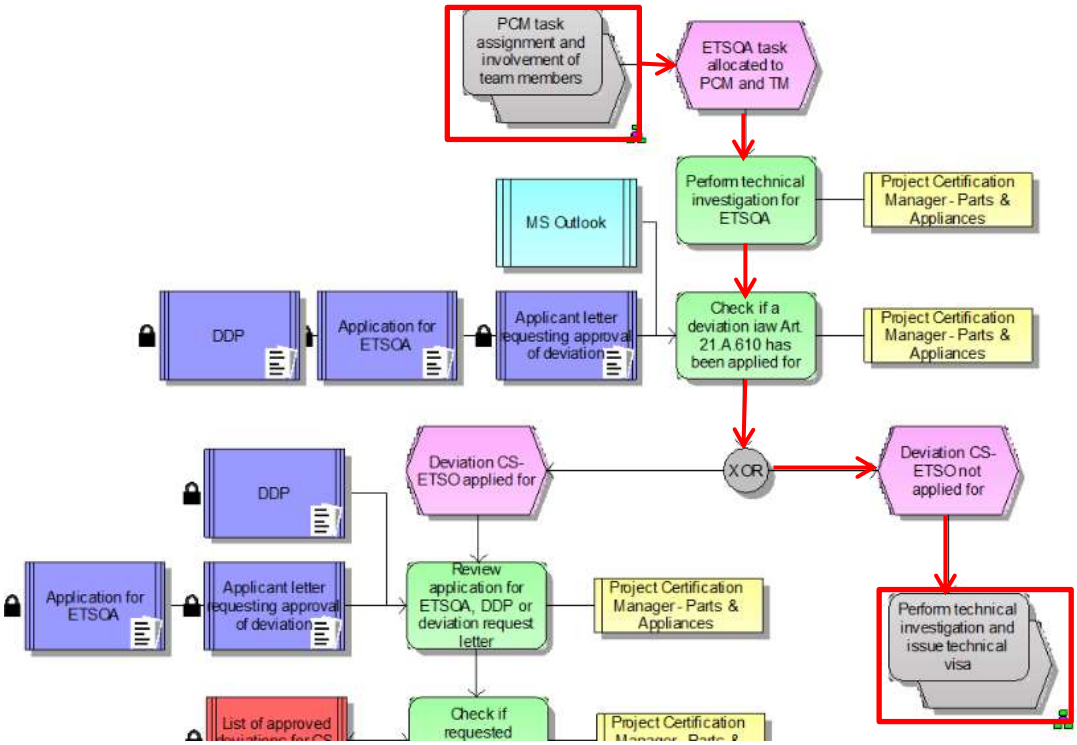


Figure 4-43. 1st Technical investigation and deviation evaluation based on (23).

No second technical investigation and deviation evaluation is needed to be performed as, according to our assumptions, there are no deviations. As shown in Figure 4-43 and Figure 4-44, for the technical evaluation and issuance of technical visa, the PCM Parts &Appliances will check whether the DOA Manager and the POA Manager have confirmed that ADOA and POA exist and capability list covers application.

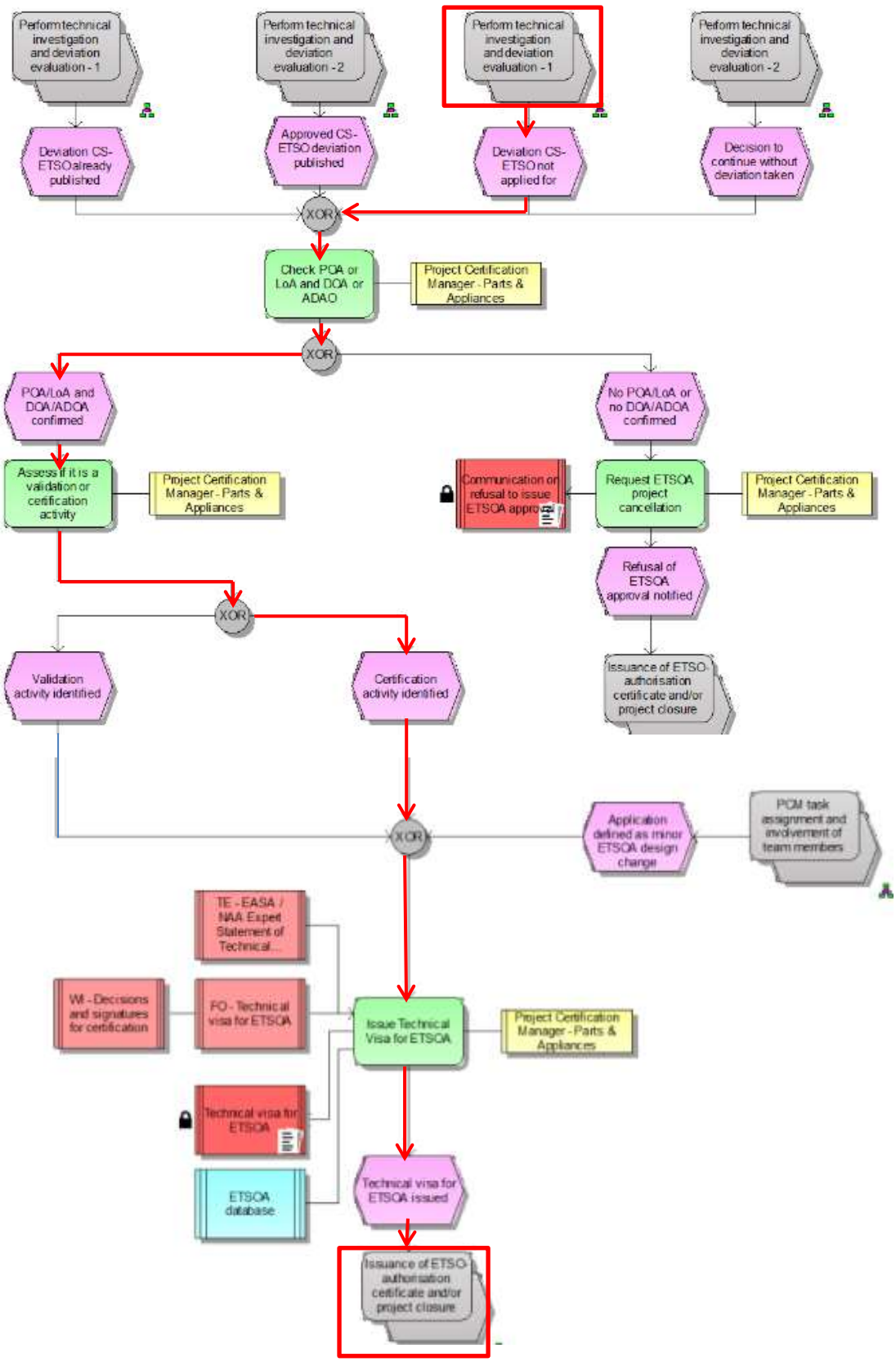


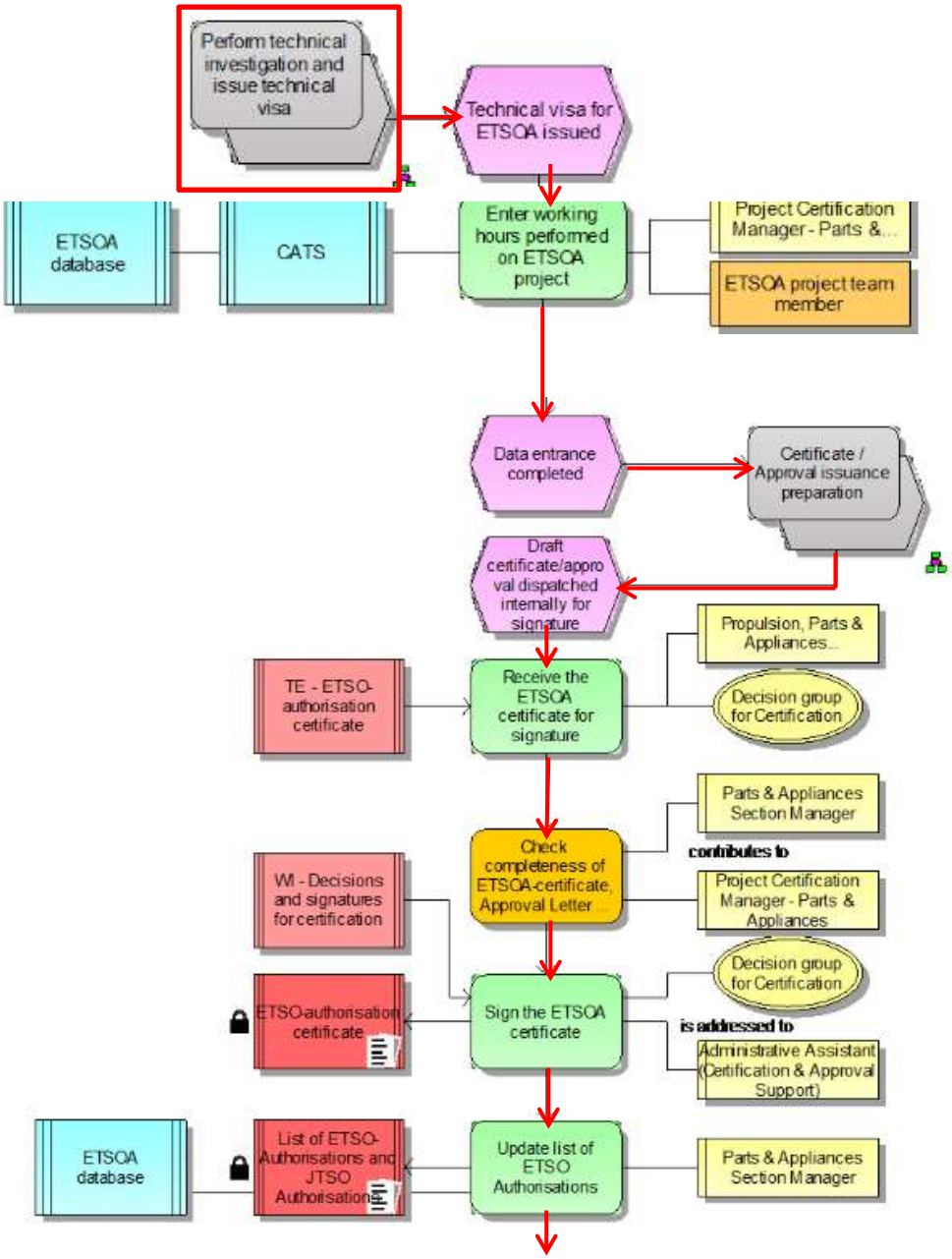
Figure 4-44. Technical evaluation and issuance of technical visa based on (23).

4.2.5.4 Issuance of European Technical Standard Order Authorisation (ETSOA) Certificate and project closure

Once the technical investigation and acceptance of proposed deviations has been finished, the PCM Parts & Appliances submits the technical visa to the Applications Management Section to generate the ETSOA certificate. The Parts & Appliances Section Manager will be in charge of signing. In case of experts involvement, the PCM Parts & Appliances has to be given the Statement of Satisfaction from the corresponding expert(s). This expert will be part of the Panel of Experts established by EASA and who provides advice on technical certification principles and technical interpretation of the IRs of the Basic Regulation, technical standardisation and technical training. In case they act as team members, their roles must not conflict. In addition the certification data package must be checked for completeness:

- technical visa,
- compliance checklist,
- deviations (not our case),

The record keeping and archiving is also very important as defined in EASA Work Instruction on Records Management. Additionally, The PCM shall organise continuing airworthiness actions. The flowchart of this step is shown in Figure 4-45.



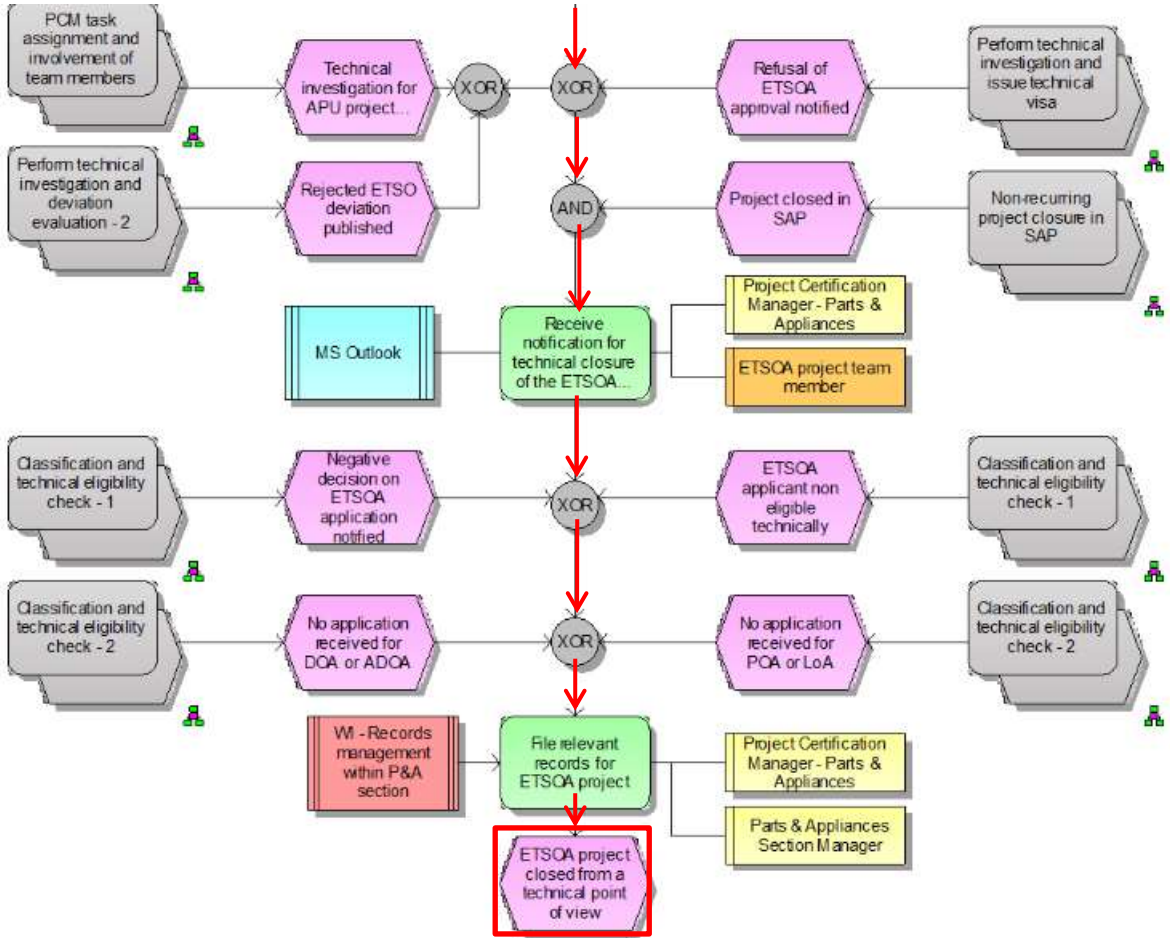


Figure 4-45. Issuance of ETSOA Certificate based on (23).

5 Conclusion and Future work

After having studied the entire aviation certification framework, some conclusions can be drawn. As formerly mentioned, certification is a domain that is still unknown for many aerospace engineers. Indeed, avionics equipment which really needs a particular, extended and thorough certification procedure to be follow during its development and integration, is even more unfamiliar for numerous manufacturers and engineers.

GBAS was the equipment chosen to be certified due to its numerous advantages, already stated and studied throughout this TFG. Nowadays is one of the avionics navigation systems that offer more precision in critical flight phases such as the approach. However, for its certification stakeholders have to be involved since the beginning of the project. Due to its applicability scope, and due to the fact that its performance relies on satellites constellations, during its certification process many international authorities, organizations, companies and governments must be involved. Probably, that is the reason why this project cannot go into detail in many aspects of the process.

Even though we can consider the objective of the project covered, it can still be more developed and improved if more information about the actual GBAS system was available. In addition, certification procedures are very changing and volatile, as they depend on many situations. Furthermore, many regulations that are needed for this project were not available for students, fact that made more difficult the process of compliance demonstration. Also many of the regulations are not still updated for GBAS certification, especially for GBAS CAT II/III approaches. Therefore, sometimes was hard to find how to comply with regulations as, even though these types of approaches are defined, they are still under development and trying to be improved by authorities and governments.

Moreover, for the avionics system chosen to be certified, additional approvals are needed. As it is not possible to perform the GBAS system without a ground reference station, this area has to be also validated. This then involves not only the aforementioned stakeholders, but also all the personnel related to airports. From the airport employees up to the airport authorities must be involved, and must receive training on this issue. This fact even makes more difficult to encompass under the scope of this project the whole certification process of GBAS in detail.

As a consequence, I chose to focus only on the aircraft embedded subsystem of the GBAS. Especially, I decided to certificate the MMR, as it is one of the most important items of this subsystem. This decision not only reduced the scope of the certification process, but also enabled me to focus on avionics regulations such as the DO-178 for software and the DO-254 for hardware verification and validation processes. Apart from explaining how to apply to an ETSOA certificate for a MMR, and the Agency's internal process for evaluating the application, a simulation of a CP was done. It was very difficult to develop a whole CP including forms and manuals to be delivered, due to the lack of information about the item. However, tests and methods were proposed as example in order to orientate the reader on how to create a CP for this type of equipment.

From my point of view, the way the project is structured really helps to understand the current legal structure of aeronautical certification. It covers international, European and Spanish authorities, regulations and ways of working, for then explaining the steps of a certification process. All these sections are done with the aim of being able to understand how the avionics equipment certification is done. Finally, the process is specified for

GBAS equipment, describing general characteristics of this system and analysing them from a certification and validation point of view. The EASA internal process that undergoes the certification application is also described so that the reader can understand the scope of its activity.

For further studies and projects on avionics equipment certification, I will recommend breaking down the different steps of the application. Even though, a student cannot have access to confidential information about hardware, software and performance of some avionics equipment, certification regulations can be analysed in more detail if the scope of the project would not be that large. For instance, an interesting project could be the elaboration of a compliance matrix for specific avionics equipment. This will imply the creation of a detail compliance demonstration of the equipment, maybe not undergoing such a large analysis of the rest of certification steps. If it is the case of a student project, I will recommend choosing a system that for its certification does not involve as many stakeholders as GBAS, as this will help to simplify and really show a step by step compliance demonstration, which is not really shown in this paper due to the scope of the system chosen.

Moreover, as it has happened with the SEPIAC platform, which has been launched the 1st June 2019 (during the project's development), and has changed the way the Applicant musts issue documents to and communicate with the EASA, many projects are currently being developed in relation with GBAS. Indeed, most of them involve the development of CAT II/III approaches using GBAS. For instance, the FAA works on the Next Generation Air Transportation System (NextGen), showing the evolution of major FAA investments and programs to meet the future demand. In fact, GBAS Precision Approaches is one of the investment programs that provide solution to improve terminal environment in the NextGen Implementation Plan. In addition, the Eurocontrol's SESAR Programme and Eurocontrol GBAS Project are focused on improving the air traffic capacity and developing GAST D approaches.

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Annexes

[A] List of EASA Member States:

- Austria
- Belgium
- Bulgaria
- Croatia
- Cyprus
- Czech Republic
- Denmark
- Estonia
- Finland
- France
- Germany
- Greece
- Hungary
- Iceland
- Ireland
- Italy
- Latvia
- Liechtenstein
- Lithuania
- Luxembourg
- Malta
- Netherlands
- Norway
- Poland
- Portugal
- Romania
- Slovakia
- Slovenia
- Spain
- Sweden
- Switzerland
- United Kingdom

[B] List of AESA competences:

- Certification
- Maintenance
- Licenses
- Operations
- Aircraft Registration
- Aerial Work
- Sport Aviation
- Training
- Aeronautical Medicine
- Air Navigation
- Operational Safety
- Air Cargo
- Legal Advice
- Human Resources
- Aeronautical Teachings
- Global Navigation Satellite System (GNSS) Programs
- Interoperability
- Single Sky
- Aeronautical Easements
- Air Space
- Facilitation
- Computing
- Aerodromes
- Fuel Hiring
- Security against acts of illicit interference
- Economic Financial Management
- Territorial Integration
- Environmental Planning.

[C] List of AESA tasks:

Regarding the aircraft:

- Approves and monitors the organizations that manufacture and maintain aeronautical products in Spain.
- Issues individual airworthiness certificates for each aircraft.
- Approves maintenance programs, supervises their execution and inspects maintenance centres.
- Approves maintenance procedures.
- Approves operational procedures.
- Manages the Registration of Aircraft.
- Manages the construction of aircraft by amateurs.
- Issues Type Certificates (TCs) of motorized ultralight aircraft.
- Approves airline safety programs.

Regarding the infrastructures (airports and air navigation):

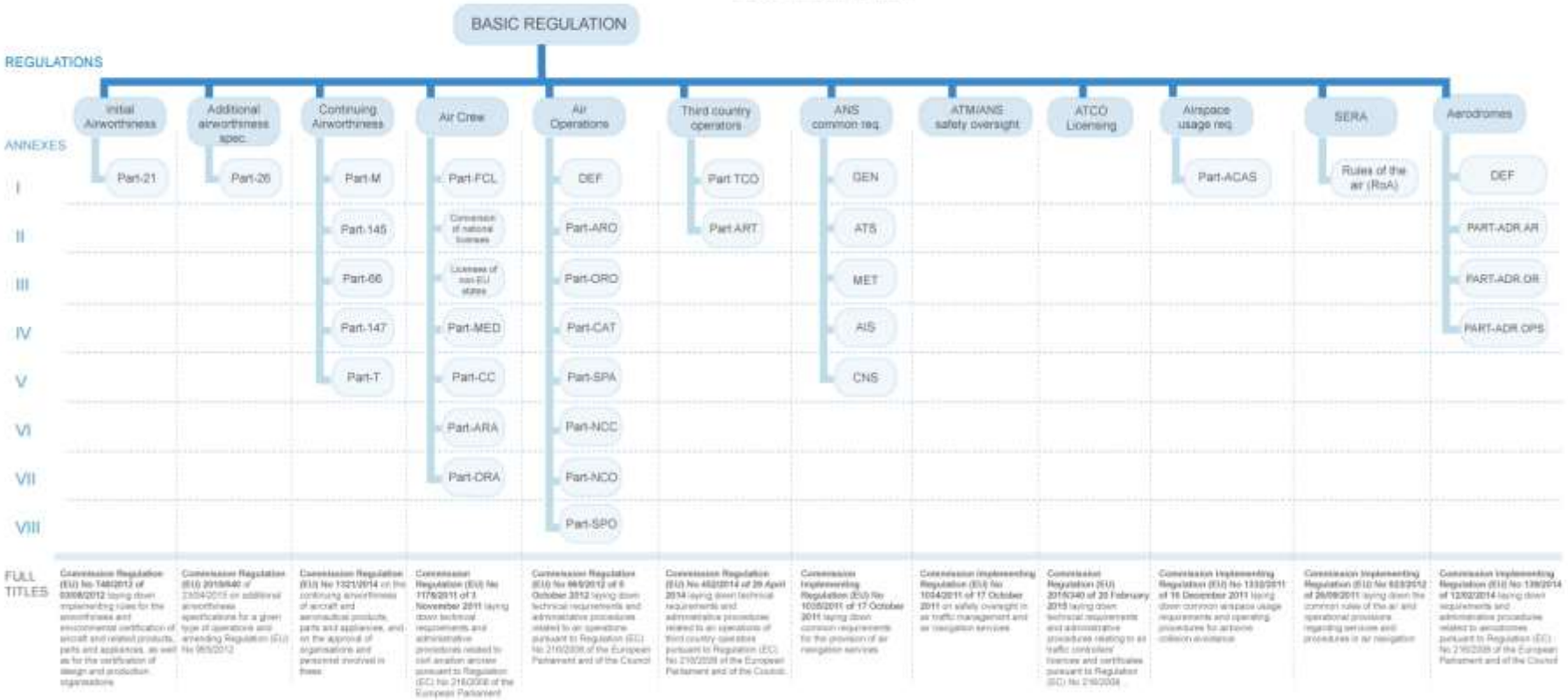
- Certifies airports.
- Authorizes private aerodromes and heliports.
- Approves the operation of the Air Navigation Systems (ANS).
- Carry out Air Navigation programs.
- Supervises Air Traffic Management (ATM).
- Supervises airport and air navigation systems.
- Establishes airport security mechanisms.
- Solves constructions and facilities affected by aeronautical easements.
- Authorizes ground handling companies and cargo agents.
- Approves airport security programs.
- Issues the Certificate to:
    - Known freight forwarders and shippers.
    - Suppliers of supplies on board.
    - Air Traffic Control (ATC) Services Providers.
    - Aerodrome Flight Information (AFIS) Service Providers.
    - Communication, Navigation and Surveillance (CNS) Service Providers.
    - ATC Training Providers.

[D] EASA Regulations Structure:

Regulations Structure

Each Part to each implementing regulation has its own **Acceptable Means of Compliance and Guidance Material (AMC/GM)**. These AMC and GM are amended along with the amendments of the regulations. These AMC/GM are so-called 'soft law' (non-binding rules), and put down in form of EASA Decisions. A comprehensive explanation on AMC in form of questions and answers can be found on the FAQ section of the EASA website.

Furthermore, **Certification Specifications** are also related to the implementing regulations, respectively their parts. Like AMC/GM they are put down as Decisions and are non-binding.



[E] List of EASA CS on Initial Airworthiness:

- CS-31HB Hot Air Balloons
- CS-31GB Gas Balloons
- CS-25 Large Aeroplanes
- CS-E Engines
- CS-23 Normal, Utility, Aerobatic and Commuter Aeroplanes
- CS-36 Aircraft Noise
- CS-22 Sailplanes and Powered Sailplanes
- CS-29 Large Rotorcraft
- CS-27 Small Rotorcraft
- CS-AWO All Weather Operations
- CS-APU Auxiliary Power Units
- CS-34 Aircraft Engine Emissions and Fuel Venting
- CS-LSA Light Sport Aeroplanes
- CS-Definitions on Definitions and Abbreviations
- CS-ETSO European Technical Standard Orders
- CS-VLA Very Light Aeroplanes
- CS-VLR Very Light Rotorcraft
- CS-P Propellers
- CS-31TGB Tethered Gas Balloons

[F] List of current European Technical Standard Orders (ETSOs):

EASA ETSO	Issue	Subject Title	Published at	Main Industry Standard
Subpart A	Update	CS-ETSO Subpart A	27/08/2018	
ETSO-C1e	Update	Cargo Compartment Fire Detection Instruments	23/02/2018	SAE AS 8036 sup
ETSO-C2d	New	Airspeed Instruments	24/10/2003	SAE AS 8019
ETSO-C3e	Update	Turn and Slip Instruments	05/08/2016	SAE AS 8004
ETSO-C4c	New	Bank and Pitch Instruments	24/10/2003	SAE AS 396B sup
ETSO-C5f	Update	Direction Instrument, Non-Magnetic (Gyroscopically Stabilized)	05/08/2016	SAE AS 8021
ETSO-C6e	Update	Direction Instrument, Magnetic (Gyroscopically Stabilized)	21/12/2010	SAE AS 8013[a] sup
ETSO-C7d	New	Direction Instrument, Magnetic Non-stabilized Type (Magnetic Compass)	24/10/2003	SAE AS 398[a] sup
ETSO-C8e	Update	Vertical Velocity Instrument (Rate-of-Climb)	21/12/2010	SAE AS 8016[a]
ETSO-C10b	New	Aircraft Altimeter, Pressure Actuated, Sensitive Type	24/10/2003	SAE AS 392C sup
ETSO-2C11e	New	Powerplant Fire Detection Instruments (Thermal and Flame Contact Types)	24/10/2003	SAE AS 8028
ETSO-C13f	New	Life preservers	18/07/2006	all in ETSO
ETSO-C14b	New	Aircraft Fabric, Intermediate Grade; External Covering Material	24/10/2003	SAE AMS 3804c sup
ETSO-C15d	New	Aircraft Fabric, Grade A; External Covering Material	24/10/2003	SAE AMS 3806d sup
ETSO-C16b	Update	Electrically Heated Pitot and Pitot-Static Tubes	23/02/2018	SAE AS 8006A sup, EuroCAE ED-225 sup
ETSO-2C19c	Update	Portable Water-Solution Type Hand Fire Extinguishers	16/12/2016	SAE AS 245B
ETSO-C20	New	Combustion Heaters	24/10/2003	SAE AS 143B
ETSO-C21b	New	Aircraft Turnbuckle Assemblies	24/10/2003	MIL-T-5685[a] sup

		and/or Turnbuckle Safetying Devices		
ETSO-C22g	New	Safety Belts	24/10/2003	SAE AS 8043 sup
ETSO-C23f	Update	Personal Parachute Assemblies and Components	23/02/2018	PIA TS-135 Revision 1.4 sup
ETSO-C25a	New	Aircraft Seats and Berths (Type I Transport 6g Forward Load)	24/10/2003	AIA NAS 809 sup
ETSO-C26d	Update	Aircraft Wheels and Wheel-Brake Assemblies (CS-23, -27 and -29 aircraft)	16/12/2016	SAE ARP5381
ETSO-C27	New	Twin Seaplane Floats	24/10/2003	AIA NAS 807 sup
ETSO-C28	New	Aircraft Skis	24/10/2003	AIA NAS 808
ETSO-C30d	Update	Aircraft Position Lights	23/02/2018	SAE AS 8037C
ETSO-2C34f	New	ILS Glide Glope Receiving Equipment Operating within the Radio Frequency Range of 328·6-335·4 Megahertz (MHz)	24/10/2003	EuroCAE ED-47B w amt1
ETSO-2C35d	New	Radio Marker Receiving Equipment	24/10/2003	EuroCAE 1/WG7/70
ETSO-2C36f	New	Airborne ILS Localizer Receiving Equipment Operating within the Radio Frequency Range 108-112 Megahertz	24/10/2003	EuroCAE ED-46B w amt1
ETSO-C39c	Update	Aircraft Seats and Berths Certified by Static Testing only	21/12/2010	SAE AS 8049[a]
ETSO-2C40c	New	VOR Receiving Equipment Operating Within the Radio Frequency Range 108-117.95 Megahertz	24/10/2003	EuroCAE ED-22B sup
ETSO-2C41d	New	Airborne Automatic Direction Finding (ADF) Equipment	24/10/2003	EuroCAE ED-51 w amt1 or RTCA DO-179 sup
ETSO-C42	New	Propeller Feathering Hose Assemblies	24/10/2003	MIL-H-8795D sup
ETSO-C43c	New	Temperature Instruments	24/10/2003	SAE AS 8005
ETSO-C44c A1	Editorial	Fuel Flowmeters	28/11/2008	SAE AS407C sup
ETSO-C45b A1	Editorial	Manifold Pressure Instruments	12/07/2013	SAE AS405C sup

ETSO-C46a	New	Maximum Allowable Airspeed Indicator Systems	24/10/2003	all in ETSO
ETSO-C47a A1	Editorial	Pressure Instruments - Fuel, Oil and Hydraulic (Reciprocating Engine Powered Aircraft)	12/07/2013	SAE AS 408C sup
ETSO-2C48a	New	Carbon Monoxide Detector Instruments	21/12/2010	all in ETSO
ETSO-C49b	New	Electric Tachometer:Magnetic Drag (Indicator and Generator)	24/10/2003	SAE AS 404B sup
ETSO-C53a	New	Fuel and Engine Oil System Hose Assemblies	24/10/2003	all in ETSO
ETSO-C54	New	Stall Warning Instruments	24/10/2003	SAE AS403A sup
ETSO-C55a	Update	Fuel and Oil Quantity Instruments	05/07/2012	SAE AS 405C sup
ETSO-C56b A1	Editorial	Engine-driven Direct Current Generators/Starter-generators	12/07/2013	SAE AS8020
ETSO-C59b	Update	Airborne Selective Calling Equipment	23/02/2018	RTCA DO-93[a]
ETSO-C62e	Update	Aircraft Tyres	05/07/2012	all in ETSO
ETSO-C63e	New	Airborne Weather Radar Equipment	23/02/2018	RTCA DO-220[a]
ETSO-C64b	Update	Oxygen Mask Assembly, Continuous Flow, Passenger	16/12/2016	SAE AS 8025[a] sup
ETSO-2C66b	New	Distance Measuring Equipment (DME)Operating Within the Radio Frequency Range of 960-1215 Megahertz	24/10/2003	EuroCAE ED-54
ETSO-C69c	New	Emergency Evacuation Slides, Ramps and Slide/Raft Combinations	24/10/2003	all in ETSO
ETSO-C70b	New	Life Rafts	05/08/2016	SAE AS1356 sup
ETSO-C71	New	Airborne Static (‘DC to DC’) Electrical Power Converter (for Air Carrier Aircraft)	24/10/2003	all in ETSO
ETSO-C72c	New	Individual Flotation Devices	24/10/2003	all in ETSO
ETSO-C73	New	Static Electrical Power Inverter	24/10/2003	all in ETSO
ETSO-2C75	New	Hydraulic Hoses Assembly	24/10/2003	all in ETSO

ETSO-C76b	Update	Fuel Drain Valves	05/08/2016	all in ETSO
ETSO-C78a	New	Crewmember Demand Oxygen Masks	23/02/2018	SAE AS 8026[a]
ETSO-C79	New	Fire Detectors (Radiation Sensing Type)	24/10/2003	all in ETSO
ETSO-C80	New	Flexible Fuel and Oil Cell Material	24/10/2003	all in ETSO
ETSO-C87a	Update	Low Range Radio Altimeters	12/07/2013	EuroCAE ED-30 sup
ETSO-C88b	Update	Automatic Pressure Altitude Reporting Code Generating Equipment	05/08/2016	SAE AS8003
ETSO-C89a	Update	Crew Member Oxygen Regulators, Demand	05/08/2016	SAE AS8027 sup
ETSO-C90d A1	Update	Cargo Pallets, Nets and Containers	05/08/2016	AIA NAS 3610, SAE AS36100, SAE AS36102
ETSO-C92c	New	Ground Proximity Warning, Glide Slope Deviation Alerting Equipment	24/10/2003	RTCA SO161A sup
ETSO-2C93b	New	Airborne Interim Standard Microwave Landing System Converter Equipment	24/10/2003	EuroCAE ED-35[a]
ETSO-C95a	Update	Mach Meters	05/07/2012	SAE AS 8018[a]
ETSO-C96b	Update	Anticollision Light Systems	23/02/2018	SAE AS 8017C
ETSO-C99a	Update	Flight Deck (Sedentary) Crew Member Protective Breathing Equipment	05/08/2016	SAE AS8031A sup
ETSO-C100c	Update	Aviation Child Safety Device (ACDS)	05/08/2016	SAE AS5276/1 sup
ETSO-C101	New	Overspeed Warning Instruments	24/10/2003	SAE AS 8007
ETSO-C102	New	Airborne Radar Approach and Beacon Systems for Helicopters	24/10/2003	RTCA DO-172 change 1
ETSO-C103	New	Continuous Flow Oxygen Mask Assembly (for Non-transport Category Aircraft)	24/10/2003	SAE AS 1224[a]
ETSO-2C104a	New	Microwave Landing System (MLS)Airborne Receiving	24/10/2003	EuroCAE ED-36A

		Equipment		amd 1 and amd 2
ETSO-C105	New	Optional Display Equipment for Weather and Ground Mapping Radar Indicators	24/10/2003	RTCA DO174
ETSO-C106 A1	Editorial	Air Data Computer	12/07/2013	SAE AS 8002 sup
ETSO-C109	New	Airborne Navigation Data Storage System	24/10/2003	Global Systems
ETSO-C110a	New	Airborne Passive Thunderstorm Detection Systems	24/10/2003	RTCA DO-191
ETSO-C112e	Update	Secondary Surveillance Radar Mode S Transponder	05/08/2016	EuroCAE ED-73E sup
ETSO-C113a	Update	Airborne Multi-purpose Electronic Displays	05/08/2016	SAE AS 8034B sup
ETSO-C114 A1	Editorial	Torso Restraint Systems	12/07/2013	SAE AS 8043 sup
ETSO-C115d	Update	Required Navigation Performance (RNP) Equipment using Multi-Sensor Inputs	23/02/2018	RTCA DO-283B sup
ETSO-C116a	Update	Crew Member Portable Protective Breathing Equipment	05/08/2016	SAE AS 8047 sup
ETSO-C117a	New	Airborne Windshear Warning and Escape Guidance Systems (Reactive Type) for Transport Aeroplanes	24/10/2003	all in ET
ETSO-C118a	Update	Traffic Alert and Collision Avoidance System I (TCAS I) C	23/02/2018	RTCA DO-197[a] sup
ETSO-C119d	Update	Airborne Collision Avoidance System II (ACAS II) Version 7.1 with Hybrid Surveillance	05/08/2016	EuroCAE ED-143 change 1 and 2 sup and EuroCAE ED-221 sup
ETSO-C121b	Update	Underwater Locating Devices	12/07/2013	SAE AS 8045[a] sup
ETSO-2C122	New	Devices That Prevent Blocked Channels Used in Two-Way Radio Communications Due to Simultaneous Transmissions	24/10/2003	EuroCAE ED-68
ETSO-C123c	Update	Cockpit Voice Recorders Systems	23/02/2018	EuroCAE ED-112[a]
ETSO-C124C	Update	Flight Data Recorder Systems	23/02/2018	EuroCAE ED-112[a]
ETSO-C126b	Update	406 and 121.5 MHz Emergency	05/08/2016	EuroCAE ED-62[a]

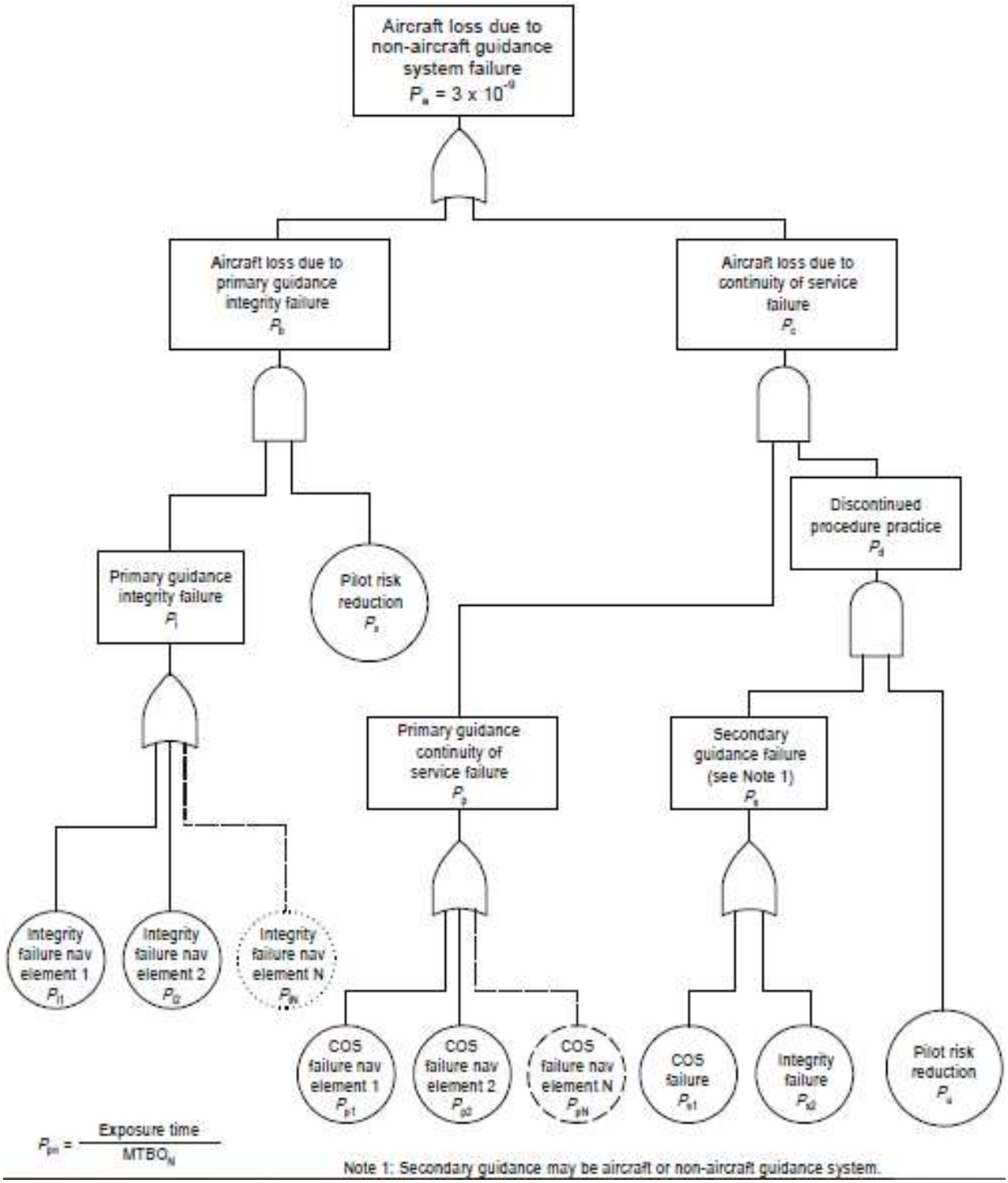
		Locator Transmitter		sup
ETSO-C127b	Update	Rotorcraft, Transport Aeroplane, and Small Aeroplane Seating Systems	05/08/2016	SAE AS 8049B sup, SAE ARP 5526C sup
ETSO-2C128	New	Devices That Prevent Blocked Channels Used in Two-Way Radio Communications Due to Unintentional Transmissions	24/10/2003	EuroCAE ED-67
ETSO-C132a	Update	Geosynchronous Orbit Aeronautical Mobile Satellite Services Aircraft Earth Station Equipment	16/12/2016	RTCA DO 210D change 1-4
ETSO-C135a	Update	Large Aeroplane Wheels and Wheel and Brake Assemblies	21/12/2010	all in ETSO
ETSO-C139a	Update	Aircraft Audio Systems and Equipment	05/08/2016	RTCA DO-214[a]
ETSO-C141	New	Aircraft Fluorescent Lighting Ballast/Fixture Equipment	24/10/2003	SAE AS 4914[a]
ETSO-C142a	New	Non-Rechargeable Lithium Cells and Batteries	28/11/2008	RTCA DO-227 sup
ETSO-C144a	Update	Passive Airborne Global Positioning System (GNSS) Antenna	21/12/2010	RTCA DO-228
ETSO-C145e	Update	Airborne Navigation Sensors Using the Global Positioning System Augmented by the Satellite Based Augmentation System	23/02/2018	RTCA DO-229E sup
ETSO-C146e	Update	Stand-Alone Airborne Navigation Equipment Using the Global Positioning System Augmented by the Satellite Based Augmentation System	23/02/2018	RTCA DO-229E sup
ETSO-C147a	Update	Traffic Advisory System (TAS) Airborne Equipment	16/12/2016	RTCA DO-197[a] sup
ETSO-C151c	Update	Terrain Awareness and Warning System (TAWS)	05/08/2016	all in ETSO
ETSO-2C153	New	Integrated Modular Avionics (IMA) Platform And Modules	02/05/2016	all in ETSO
ETSO-C154c	New	Universal Access Transceiver (UAT) Automatic Dependent	05/07/2012	RTCA DO-282B

		Surveillance - Broadcast (ADS-B) Equipment Operating on the Frequency of 978 MHz		
ETSO-C155b	Update	Recorder Independent Power Supply	23/02/2018	EuroCAE ED-112[a] sup
ETSO-C157b	Update	Flight Information Services-Broadcast (FIS-B) Equipment	16/12/2016	RTCA DO-358 respectively DO-267A
ETSO-C158	New	Aeronautical Mobile High Frequency Data Link (HFDL) Equipment	05/07/2012	RTCA DO-265
ETSO-C159c	Update	Next Generation Satellite Systems (NGSS) Equipment	23/02/2018	RTCA DO-262B
ETSO-C160a	New	VDL Mode 2 Communications equipment	12/07/2013	EuroCAE ED-92B
ETSO-C161a	Update	Ground Based Augmentation System Positioning and Navigation Equipment	05/07/2012	RTCA DO-253C sup
ETSO-C162a	New	Ground Based Augmentation System Very High Frequency Data Broadcast Equipment	05/07/2012	RTCA DO-253C
ETSO-C164	New	Night Vision Goggles	12/07/2013	RTCA DO-275
ETSO-C165a	Update	Electronic Map Systems for Graphical Depiction of Aircraft Position	01/05/2014	RTCA DO-257[a] sup
ETSO-C166b A3	Update	Extended Squitter Automatic Dependent Surveillance-Broadcast (ADS-B) and Traffic Information Service-Broadcast (TIS-B) Equipment Operating on the Radio Frequency of 1090 Megahertz (MHz)	23/02/2018	EuroCAE ED-102[a]
ETSO-2C169a	New	VHF Radio Communications Transceiver Equipment Operating Within The Radio Frequency Range 117.975 To 137.000 Megahertz	21/12/2010	EuroCAE ED-23C
ETSO-C170	New	High Frequency (HF) Radio Communications Transceiver Equipment Operating Within the Radio Frequency 1.5 to 30 Megahertz	05/07/2012	RTCA DO-163
ETSO-C172a	Update	Cargo Restraint Strap	16/12/2016	SAE AS 5385C sup

		Assemblies		
ETSO-C173a	Update	Nickel-Cadmium, Nickel Metal-Hydride, and Lead-Acid Batteries	05/08/2016	RTCA DO-293[a] sup
ETSO-C174 A1	Editorial	Battery Based Emergency Power Unit (BEPU)	12/07/2013	all in ETSO
ETSO-C175	New	Galley Cart, Containers and Associated Components	28/11/2008	SAE AS 8056 sup
ETSO-C176a	Update	Aircraft Cockpit Image Recorder Systems	23/02/2018	EuroCAE ED-112[a]
ETSO-C177a	Update	Data Link Recorder Equipment	16/12/2016	EuroCAE ED-112[a]
ETSO-C178	New	Single Phase 115 VAC, 400 Hz Arc Fault Circuit Breakers	12/07/2013	SAE AS 5692
ETSO-C179a	New	Rechargeable Lithium Cells and Lithium Batteries	05/07/2012	RTCA DO-311
ETSO-C184	New	Galley Equipment	05/07/2012	SAE AS 8057 sup
ETSO-C190	New	Active Airborne Global Navigation Satellite System (GNSS) Antenna	21/12/2010	RTCA DO-301
ETSO-C194	New	Helicopter Terrain Awareness and Warning System (HTAWS)	05/07/2012	RTCA DO-309
ETSO-C196a	New	Airborne Supplemental Navigation Sensors for Global Positioning System Equipment Using Aircraft-Based Augmentation	05/07/2012	RTCA DO-316
ETSO-2C197	New	Information Collection and Monitoring Systems	05/07/2012	EuroCAE ED-155
ETSO-C198	New	Automatic Flight Guidance and Control System (AFGCS) Equipment	12/07/2013	RTCA DO-325
ETSO-C199	New	Traffic Awareness Beacon System (TABS)	23/02/2018	all in ETSO
ETSO-C200a	Update	Low-frequency Underwater Locating Device (ULD)	16/12/2016	SAE AS 6254[a]
ETSO-C201	New	Attitude and Heading Reference Systems (AHRS)	05/08/2016	RTCA DO-334
ETSO-C202	New	Cargo Stopper Devices	05/08/2016	SAE AS 6554 sup

ETSO-C203 A1	Update	Fire containment covers (FCC)	23/02/2018	SAE AS 6453 sup
ETSO-C207	New	Aeronautical Mobile Airport Communication System (AeroMACS)	16/12/2016	EuroCAE ED-223
ETSO-C209	New	Electronic Flight Instrument System (EFIS) Display	23/02/2018	SAE AS6296 & SAE AS8034B
ETSO-C210	New	Airborne Head Up Display	23/02/2018	SAE AS8055A
ETSO-C214	New	Functional ETSO Equipment Using An ETSO-2C153-Authorised IMA Platform Or Module	27/08/2018	all in ETSO
ETSO-2C500a	New	Combined ILS/MLS Airborne Receiving Equipment	24/10/2003	EuroCAE ED-88
ETSO-2C501	New	Mode S Aircraft Data Link Processor	24/10/2003	EuroCAE ED-82[a]
ETSO-2C502	New	Helicopter Crew and Passenger Integrated Immersion Suits	18/07/2006	all in ETSO
ETSO-2C503	New	Helicopter Crew and Passenger Immersion Suits for Operations to or from Helidecks Located in a Hostile Sea Area	18/07/2006	all in ETSO
ETSO-2C504	New	Helicopter Constant-Wear Lifejackets for Operations to or from Helidecks Located in a Hostile Sea Area	18/07/2006	all in ETSO
ETSO-2C505	New	Helicopter Liferafts for Operations to or from Helidecks Located in a Hostile Sea Area	18/07/2006	all in ETSO
ETSO-2C509	New	Light Aviation Secondary Surveillance Transponders (LAST)	18/12/2007	EuroCAE ED-115
ETSO-2C512	New	Portable Gaseous Oxygen Supply (PGOS)	28/11/2008	SAE AS 1046
ETSO-2C513	New	Tow Release	28/11/2008	all in ETSO
ETSO-2C514a	New	Airborne Systems for Non Required Telecommunication Services (in Non Aeronautical Frequency Bands) (ASNRT)	23/02/2018	all in ETSO
ETSO-2C515	New	Aircraft Halocarbon Clean Agent — Hand Held Fire Extinguishers	05/08/2016	SAE AS 6271

[G] ICAO generic Integrity Risk Allocation Tree:



[H] GBAS Message Type 1 (pseudo-range corrections message):

Data content	Bits used	Range of values	Resolution
Modified Z-count	14	0 to 1 199.9 s	0.1 s
Additional message flag	2	0 to 3	1
Number of measurements (N)	5	0 to 18	1
Measurement type	3	0 to 7	1
Ephemeris decorrelation parameter (P)	8	0 to 1.275×10^{-3} m/m	5×10^{-6} m/m
Ephemeris CRC	16	—	—
Source availability duration	8	0 to 2 540 s	10 s
For N measurement blocks			
Ranging source ID	8	1 to 255	1
Issue of data (IOD)	8	0 to 255	1
Pseudo-range correction (PRC)	16	±327.67 m	0.01 m
Range rate correction (RRC)	16	±32.767 m/s	0.001 m/s
$\sigma_{pr\ gnd}$	8	0 to 5.08 m	0.02 m
B_1	8	±6.35 m	0.05 m
B_2	8	±6.35 m	0.05 m
B_3	8	±6.35 m	0.05 m
B_4	8	±6.35 m	0.05 m

[I] GBAS Message Type 2 (GBAS-related data message):

Data content	Bits used	Range of values	Resolution
GBAS reference receivers	2	2 to 4	—
Ground accuracy designator letter	2	—	—
Spare	1	—	—
GBAS continuity/integrity designator	3	0 to 7	1
Local magnetic variation	11	±180°	0.25°
Spare	5	—	—
$\sigma_{vert\_iono\_gradient}$	8	0 to 25.5 × 10^{-6} m/m	0.1 × 10^{-6} m/m
Refractivity index	8	16 to 781	3
Scale height	8	0 to 25 500 m	100 m
Refractivity uncertainty	8	0 to 255	1
Latitude	32	±90.0°	0.0005 arcsec
Longitude	32	±180.0°	0.0005 arcsec
GBAS reference point height	24	±83 886.07 m	0.01 m
Additional data block 1 (if provided)			
Reference station data selector	8	0 to 48	1
Maximum use distance (D_{max})	8	2 to 510 km	2 km
$K_{md\_e\_POS,GPS}$	8	0 to 12.75	0.05
$K_{md\_e,GPS}$	8	0 to 12.75	0.05
$K_{md\_e\_POS,GLONASS}$	8	0 to 12.75	0.05
$K_{md\_e,GLONASS}$	8	0 to 12.75	0.05
Additional data block 2 (if provided)			
Additional data block length	8	2 to 255	1
Additional data block number	8	2 to 255	1
Additional data parameters	Variable	—	—

[J] GBAS Message Final Approach Segment (FAS) data block:

Data content	Bits used	Range of values	Resolution
Operation type	4	0 to 15	1
SBAS provider ID	4	0 to 15	1
Airport ID	32	—	—
Runway number	6	1 to 36	1
Runway letter	2	—	—
Approach performance designator	3	0 to 7	1
Route indicator	5	—	—
Reference path data selector	8	0 to 48	1
Reference path identifier	32	—	—
LTP/FTP latitude	32	±90.0°	0.0005 arcsec
LTP/FTP longitude	32	±180.0°	0.0005 arcsec
LTP/FTP height	16	–512.0 to 6 041.5 m	0.1 m
ΔFPAP latitude	24	±1.0°	0.0005 arcsec
ΔFPAP longitude	24	±1.0°	0.0005 arcsec
Approach TCH (Note)	15	0 to 1 638.35 m or 0 to 3 276.7 ft	0.05 m or 0.1 ft
Approach TCH units selector	1	—	—
GPA	16	0 to 90.0°	0.01°
Course width	8	80 to 143.75 m	0.25 m
ΔLength offset	8	0 to 2 032 m	8 m
Final approach segment CRC	32	—	—

Note.— Information can be provided in either feet or metres as indicated by the approach TCH unit selector.

[K] GBAS Message Type 5 (predicted ranging source availability message):

Data content	Bits used	Range of values	Resolution
Modified Z-count	14	0 to 1 199.9 s	0.1 s
Spare	2	—	—
Number of impacted sources (N)	8	0 to 31	1
For N impacted sources			
Ranging source ID	8	1 to 255	1
Source availability sense	1	—	—
Source availability duration	7	0 to 1 270 s	10 s
Number of obstructed approaches (A)	8	0 to 255	1
For A obstructed approaches			
Reference path data selector	8	0 to 48	—
Number of impacted sources for this approach (N_A)	8	1 to 31	1
For N_A impacted ranging sources for this approach			
Ranging source ID	8	1 to 255	1
Source availability sense	1	—	—
Source availability duration	7	0 to 1 270 s	10 s

[L] EASA Form FO.DOA.00081 for an Alternative Procedures to DOA Application:

Data protection: Personal data included in this application is processed by EASA pursuant to Regulation (EC) No 45/2001 on the protection of individuals with regard to the processing of personal data by the Community institutions and bodies and on the free movement of such data. It will be processed solely for the purposes of the performance, management and follow-up of the Application by the Agency, without prejudice to possible transmission to internal audit services, to the Court of Auditors, to the European Anti-Fraud Office (OLAF) for the purposes of safeguarding the financial interests of the European Union. The Applicant shall have the right of access to his personal data and the right to rectify any such data that is inaccurate or incomplete. Should the Applicant have any queries concerning the processing of his personal data, he shall address them to the Agency at the following address: dpo [at] easa.europa.eu. The Applicant shall have right of recourse at any time to the European Data Protection Supervisor.

1. APPLICANT'S REFERENCE

1.1 Your Reference	**PLEASE PROVIDE A SHORT AND UNIQUE REFERENCE TO EACH APPLICATION** This reference will be used as an identifier of your application in all communication, e.g. invoice/s, acceptance letter, by EASA.

2. Applicant Address and Contact Data

2.1 Applicant Data

2.1.1 Name and Address (registered (business) name and address/legal seat of the company)	Applicant Number	**3XXXXX**
	(Company) Name	
	Street / Nr	
	Post Code	
	City	
	Country	
2.1.2 Contact Person (responsible for this application)	Title	☐ Mr ☐ Ms
	Name	
	First name	
	Job title	
	Phone/Fax	
	Email	

Important Note: First time applicants need to submit a copy of the company's **Business Registration** or similar legal document stating name and seat of the company together with the application. In case the applicant is not a company but a natural person, a copy of the person's **ID or passport** needs to be provided with the first application.

2.2 Billing Data (may be left blank, if same as Applicant Data under 2.1)

2.2.1 Billing Address (for the receipt of EASA F&C	(Company) Name	Same as in section 2.1.1 (other name only in exceptional cases)

	Street / Nr	
	PO Box	
	Post Code	
	City	
	Country	
2.2.2 Contact Person (Financial)	Title	☐ Mr ☐ Ms
	Name	
	First name	
	Job title	
	Phone/Fax	
	Email	

2.3 Shipping Data (may be left blank, if same as Applicant Data under 2.1)

4.3 2.3.1 Shipping Address (for the shipping of original EASA documents)	(Company) Name	
	Street / Nr	
	PO Box	
	Post Code	
	City	
	Country	
2.3.2 Contact Person (Shipping)	Title	☐ Mr ☐ Ms
	Name	
	First name	
	Job title	
	Phone/Fax	
	Email	

3. SCOPE OF APPLICATION

3.1 ☐ **Initial Application for the acceptance of Alternative Procedures to DOA** → please continue with chapter 4

3.2 ☐ **Application subsequent to an update of the procedures as per one or more of the following reasons:**

3.2.1 ☐ Changes to the scope of work of the AP

3.2.2 ☐ Changes impacting the showing of compliance with Part 21

3.2.3 Changes, other than above, affecting the content of the previous EASA finding of compliance

☐ Change of ownership

☐ Change to the company name and/or address

☐ Other: → please specify

→ please indicate your existing ADOA reference below.

3.2.4 ADOA REFERENCE:	ADOA Reference

4. SCOPE OF DESIGN

Design in accordance with applicable type-certification basis and environmental protection requirements:

4.1 Eligibility		**4.2 Description of case**
☐ TYPE CERTIFICATE	*as per 21A.14(b)*	name of product
☐ STC	*as per 21A.112B(b) and GM 21A.112B(b)*	description and products on which it applies
☐ Major Repair	*as per 21ª.432B(b)*	description and products on which it applies
☐ ETSOA	*as per 21ª.602B(b)(2)*	provide ETSOA titles

5. REFERENCE PROCEDURES

Reference	**Title**	**Issue Date**

Please add rows to this table as applicable

6. OTHER INFORMATION

7. OUTLINE OF ADDITIONAL DATA REQUIREMENTS

Data to be submitted together with this application form:

- A copy of the Business Registration or similar legal document stating name and seat of the company

Additional information about your design organisation will be requested in a second stage.

8. APPLICANT'S DECLARATION AND ACCEPTANCE OF THE GENERAL CONDITIONS AND TERMS OF PAYMENT

I declare that I have the legal capacity to submit this application to EASA and that all information provided in this application form is correct and complete.

I have understood that I am submitting an application for which fees or charges will be levied by EASA in accordance with Commission Regulation (EC) on the fees and charges levied by the European Aviation Safety Agency, available from http://easa.europa.eu/> Legislation > Fees & Charges

I acknowledge that I have read and understood the Agency's General Conditions and Terms of Payment (see http://easa.europa.eu/> Legislation > Fees & Charges>General Conditions and Terms of Payment) and agree to abide by them. I declare to be aware that fees or charges, as well as all relevant travel costs must be paid whether or not the application is successful and that they might not be refundable. Moreover, I declare that I am aware of the consequences of non-payment.

Date/Location	Name/Title	Signature

Important Note: EASA cannot accept applications without signature. Please make sure that you sign the application.

This application and a copy of the business registration of your company should be sent either by fax, email or regular mail to the:

European Aviation Safety Agency
Certification and Approval Support Department
Postfach 10 12 53
D-50452 Köln
Germany

Fax: +49 – (0)221 - 89990 ext. ext. 9514

E-mail: DOA@easa.europa.eu

Completion Instructions

Completion Instructions_Form 81

please double-click on the icon to access the completion instructions

[M] Instructions for completing the EASA Form FO.DOA.00081:

This Application Completion Instruction Sheet will provide you with any additional instructions and requirements necessary to complete the Application for Alternative Procedures to Design Organisation Approval (ADOA). It is strongly recommended to use the English language in completing the application. Please complete the form in a **clearly legible** way.

# - Field Name	Completion Instructions
1.1 Your Reference	Please provide a **unique** internal reference to this application. This reference will be used as an identifier of your application in all communication, e.g. invoice/s, acceptance letter, by EASA.
2.1.1 Name and Address	**Applicant Number:** If known, please enter your EASA Applicant Number. This number follows the pattern 3XXXXX and can be found on any application acceptance letter received for previous applications. It is called either "Customer Number " or "Applicant Number" on the application acceptance letter. Please enter the full **name of the company** as it appears on the Business Registration or similar legal document stating name and seat of the company. If applicable also enter the Trade Name, Doing-business-as and the Company registration number. In case the applicant is not a company but a **natural person**, please enter the full name as it appears in your ID Card/Passport. Please enter the address of the registered office as it appears on the Business Registration or similar legal document. In case the applicant is not a company but natural person, please enter the address at which you are registered. First time applicants need to submit a copy of the company's **Business Registration** or similar legal document stating name and seat of the company together with the application. In case the applicant is not a company but a natural person, a copy of the person's **ID or passport** needs to be provided with the first application.
2.1.2 Contact Person	The name and contact details specified in this section are those of the person responsible for the application.
2.2.1 Billing Address	The (company) name and address specified in this section will be printed on the invoice/s EASA will issue. A (company) name deviating from the one entered in section 2.1.1 can only be accepted by EASA upon justified request.
2.2.2 Contact Person	The name and contact details specified in this section are those of the person that will be contacted for all issue connected with the EASA invoice/s. (e.g. accounts payable clerk). Please contact EASA if you would like to receive electronic versions of EASA invoices to a specific/generic email address.
2.3.1 Shipping Address	The (company) name and address specified in this section is where EASA will send the original certificate/approval.
2.3.2 Contact Person	The contact person of this section is the person the original certificate/approval will be sent to.
3.1 Initial Application for the acceptance of Alternative Procedures to DOA	Tick this box in case this is a first time application for the acceptance of the Alternative Procedures to DOA..
3.2 Application subsequent to an update of the procedures as per one or more of the following reasons	Tick this box in case of changes to an existing approval, subsequent to an update of the procedures. Please specify one or several reasons by ticking the relevant tick boxes 3.2.1 – 3.2.3.
3.2.1 Changes to the scope of work of the AP	**Changes to the scope of work of the AP:** e.g. new ETSO, additional technical fields, etc.
3.2.2 Changes impacting the showing of compliance with Part 21	**Changes impacting the showing of compliance with Part 21**: e.g. change to the design practices, resources, sequence of activities, organisation, etc.
3.2.3 Changes, other than above, affecting the content of the previous EASA finding	Please tick the relevant box in case of change of ownership or change of the company name and/or address. In these cases please submit a copy of your company's business registration together with the application.

of compliance	Please tick Other in case of changes to e.g. handbook/ procedures references, title or issue/date
3.2.4 ADOA Reference	Please indicate your ADOA reference in case of an application subsequent to an update (3.2)
4.1 Eligibility	Identify eligibility by ticking the related checkbox. One or several boxes may be ticked.
4.2 Description of case	Add description of case indicated under 4.1. Categories to be used are the categories described in **21A.14(b).**
5. Reference Procedures	If available, provide the procedures; add rows if necessary.
6. Other Information	Add information on schedule and application reference for Type Certificate, STC, ETSOA or other design approval. Add information on existing Type Certificate, STC, ETSOA or other design approvals.
7. Outline of additional data	**Please do not send any technical data package together with application.** Business Registration or similar legal documents stating name and seat of the company should be translated into English.

Estimation

You may request an estimation for a certification task, that is calculated on an hourly basis. This estimate will be amended if it appears that the task is simpler or can be carried out faster than initially foreseen or, on the contrary, if it is more complex and takes longer to carry out than the Agency could reasonably have foreseen.

Please be aware that EASA is to continue the processing of the application only after the estimation has been accepted and, consequently, the provision of an estimation will lead to a delayed project start.

The estimation is for information purposes and has no binding effect on the Agency or applicant.

[N] EASA Form 50 for Application for Production Organisation Approval:

Data protection: Personal data included in this application is processed by EASA pursuant to Regulation (EU) 2018/1725 on the protection of natural persons with regard to the processing of personal data by the Union institutions, bodies, offices and agencies and on the free movement of such data, and repealing Regulation (EC) No 45/2001 and Decision No 1247/2002/EC. It will be processed solely for the purposes of the performance, management and follow-up of the Application by the Agency, without prejudice to possible transmission to internal audit services, to the Court of Auditors, to the European Anti-Fraud Office (OLAF) for the purposes of safeguarding the financial interests of the European Union. The Applicant shall have the right of access to his personal data and the right to rectify any such data that is inaccurate or incomplete. Should the Applicant have any queries concerning the processing of his personal data, he shall address them to the Agency at the following address: dpo[at]easa.europa.eu. The Applicant shall have right of recourse at any time to the European Data Protection Supervisor.

1. APPLICANT'S REFERENCE

1.1 Your Reference	PLEASE PROVIDE A BRIEF, UNIQUE IDENTIFIER THAT WE WILL USE TO REFER TO YOUR APPLICATION

2. Applicant Address and Contact Data

2.1 Applicant Data

2.1.1 Name and Address (registered (business) name and address/legal seat of the company)	Applicant Number	**3XXXXX** (if known)
	Company Name	
	Trade Name	if different from legal name
	Street / Nr	
	Post Code	
	City	
	Country	
2.1.2 Contact Person (responsible for this application)	Title	☐ Mr ☐ Ms
	Name	
	First name	
	Job title	
	Phone/Fax	
	Email	

2.2 Billing Data (may be left blank, if same as 2.1 Applicant Data)

2.2.1 Billing Address	Company Name	Same as in section 2.1.1 (other name only in exceptional cases)

	Street / Nr	
	PO Box	
	Post Code	
	City	
	Country	
2.2.2 Contact Person (Responsible for ensuring the EASA terms of payment are honoured. An electronic invoice will be issued to the email address indicated here.)	Title	☐ Mr ☐ Ms
	Name	
	First name	
	Job title	
	Phone/Fax	
	Email	

3. Locations for which the approval is applied for:		
3.1 Location Address	Street / Nr	
	Post Code	
	City	
	Country	

[please copy the above table to add further locations]

4. Activity	☐ Initial ☐ Renewal	
5. Brief summary of proposed activities at the addresses indicated under item 3	5.1 General:	
	5.2 Scope of approval:	
	5.3 Nature of privileges:	
6. DESCRIPTION OF ORGANISATION:		
7. LINKS/ARRANGEMENTS WITH DESIGN APPROVAL HOLDER(S)/ DESIGN ORGANISATION(S) WHERE DIFFERENT FROM 1. :		
8. APPROXIMATE NUMBER OF STAFF ENGAGED OR INTENDED TO BE ENGAGED IN THE ACTIVITIES:		

9. ACCOUNTABLE MANAGER	NAME	
	POSITION	

10. APPLICANT'S DECLARATION AND ACCEPTANCE OF THE GENERAL CONDITIONS AND TERMS OF PAYMENT

I declare that I have the legal capacity to submit this application to EASA and that all information provided in this application form is correct and complete.

I have understood that I am submitting an application for which fees or charges will be levied by EASA in accordance with Commission Regulation (EU) on the fees and charges levied by the European Union Aviation Safety Agency, as last amended and available from http://easa.europa.eu/ > Regulations > Fees & Charges.

I acknowledge that I have read and understood the Agency's Terms of Payment (see http://easa.europa.eu/> the Agency > FAQs > Fees & Charges > Terms of Payment) and agree to abide by them. I declare to be aware that fees or charges, as well as all relevant travel costs must be paid whether or not the application is successful and that they might not be refundable. Moreover, I declare that I am aware of the consequences of non-payment.

Date/Location	Signature of the Accountable Manager

Important Note: EASA cannot accept applications without signature. Please make sure that you sign the application.

11. INFORMATION REQUIRED FOR CALCULATION OF FEE CATEGORY

Applicants are required to supply a signed certificate from an authorised representative of the organisation concerned in order for the Agency to determine the corresponding fee category.

This fixed fee for organisations is based on the annual turnover (currency in Euro) of the organisation directly related to the activities for which Production Organisation Approval is applied for.

Registered name of the organisation	

Declares that its annual turnover directly related to the activities for which Production Organisation Approval is applied for is or is estimated to be as average for the first two year period following the granting of the EASA POA:

Yearly amount	currency in Euro

Signed by authorised representative of the organisation

Date/Location	Name and Function	Signature

Important Note: It should be noted that applications not providing this information will not be taken into account.

This Application should be sent by e-mail or regular mail to:

European Union Aviation Safety Agency
Applicant Services Department
Postfach 10 12 53
D-50452 Köln
Germany

Completion Instructions

E-mail: applicant.services@easa.europa.eu	Completion Instructions

[O] EASA FO.POA.00004-001 for Production Organization Approval eligibility evaluation checklist:

Name of Organisation:	
Location(s) of Organisation:	
Date:	

Note:

- *In completing of this form, the following paragraphs of Part 21 articles need to be taken into account Part 21.A.4; Part 21.A.133; Part 21.A.151; Part 21.A.163*
- *Accurate completion of the list is essential being the input for POA eligibility determination.*

List and location of major customers which require EASA Form 1		**Direct Delivery Authorisation to be granted by Holder of approved design (Y/N)**	**Means of compliance with 21.A.133 and 21.A.4 (consult AMC 21.A.4; AMC N0. 1 & 2 to 21.A.133(b) and (c)** Make reference to and provide copy of arrangements	**Aviation Authority approving the Design**	**Identify the Holder of the approved design**	**Detailed description of Terms of Approval to be applied for: (part / appliance for aircraft**
	State which eligibility criteria in GM 21.A.133(a) are applicable Indicate how eligibility criteria in this GM are satisfied		4.6	4.5		
			4.8	4.7		
			4.10	4.9		
			4.12	4.11		
			4.14	4.13		
			4.16	4.15		

[P] EASA FO.POA.00009-001for Production Organization Approval Compliance Checklist:

PART 21 SUBPART G PRODUCTION ORGANISATION APPROVAL COMPLIANCE CHECK LIST

Survey Ref:	

Applicant Name:	**Approval Ref:**
Address	
Sites Assessed:	
Contact Names:	**Tel No:**
POATL Name:	
POAT Names:	
Exposition Title:	**Exposition Ref:**

Compiled By: **Signed:** **Date:**

Additional Information:

Note:

Once completed to be passed to the POATL and will be included as part of the applicants Compliance record.

This checklist can be initially prefilled by applicant.

Activity Areas Audited	Part 21A	AMC21A	POE / Proc.	Comments	Result

Activity Areas Audited	Part 21A	AMC21A	POE / Proc.	Comments	Result
Design Links					
Does the applicant have suitably documented arrangements (see AMC No 2 to 21.A.133b&c) with a DOA to ensure satisfactory co-ordination including:-	133b/c	No 2 to 133b/c			
• the timely transfer of all airworthiness and design data	133b/c	No 1 to 133b/c			
• the responsibilities & procedures of the applicant for developing and validating manufacturing data against design & airworthiness data supplied.	133b/c	No 1 to 133b/c			
• the arrangements to assist the DOA with airworthiness matters (i.e. traceability of parts & processes, retrofitting, technical information, deviations etc.)	133b/c 139b1	No 1 to 133b/c			
• Part 21 requirements such as 21.A.145b, 21.A165(c),(f)&(g)	133b/c	No 1 to 133b/c			
• the arrangements to assist the DOA in showing compliance prior to type certification	133b/c	No 1 to 133b/c			
• the procedures to deal adequately with non-conforming parts	133b/c 139b1	No 1 to 133b/c			
• the procedures to ensure config. control of parts to enable determination & identification for conformity or airworthiness release	133b/c	No 1 to 133b/c			
• the transfer of design data eligibility and approval status in accordance with Part 21.A.4	133b/c4	No 1 to 133b/c4			
• any agreement relating to Direct Delivery Authorisation, see also Part 21.A.4	133b/c4	No 1 to 133b/c4			

Activity Areas Audited	Part 21A	AMC21A	POE / Proc.	Comments	Result
• Identification of conformity or airworthiness release by virtue of certification authority approval of design data	133b/c	No 1 to 133b/c			
• Which persons or offices are responsible for controlling the above arrangements and associated data	133b/c	No 1 to 133b/c			
Is all necessary airworthiness, noise, fuel venting and exhaust data received from EASA and design organisation	145b1				
Is airworthiness, noise, fuel venting and exhaust data correctly incorporated into production data.	145b2	145b2			
• Does the applicant have an adequate and effective procedure covering verification of production data with applicable airworthiness and design data.	145b2	145b2			
• Is there an adequate and effective procedure to define traceability of such data to each product, part or appliance for the purpose of certifying safe operation and conformity	145b2	145b2			
Is the above data kept up-to-date and made available to staff who need access to perform their duties	145b3				
Are test specimens and prototype models made under controlled conditions	165c	No 1 to 165c			
Is there an adequately proceduralised internal 'occurrence reporting system'	165e				

Activity Areas Audited	Part 21A	AMC21A	POE / Proc.	Comments	Result
Are there adequate procedures to ensure that released parts with deviations from applicable design data are reported to the TC or design approval holder in a timely manner and :-	165f1				
• are any of the above deviations which could lead to an unsafe condition reported to the Agency in an acceptable and timely manner (within 72 hours)	165f2 3b				
• when acting as a supplier to another POA, are the above reported to that POA in an acceptable and timely manner	165f3				
Are there adequate & effective procedures for providing assistance to the holder of the TC or design approval in continuing airworthiness problems	165g				
Are the part marking requirements of Subpart Q incorporated into the applicable design data, including EPA marking if applicable	804				
Production Organisation Exposition					
Has a POE been furnished to the EASA and verified for compliance. Does it reflect the organizations' activities applicable to the scope of approval applied for	143a				
Is the POE amended as necessary to remain an up-to-date description of the organisation	143b				
Are copies of amendments supplied to the EASA	143b				

Activity Areas Audited	Part 21A	AMC21A	POE / Proc.	Comments	Result
Changes to the organisation must be notified to the EASA as soon as practicable, including change to: the organisation structure; accountable manager; EASA Form 4 nominated manager; quality system or significant change to production capacity, methods or systems.	147a	147a			
Changes in location of the manufacturing facilities must be notified to the EASA prior to the change and as soon as practicable.	148	148			
Is the POE used as a basic working document	165a	165a			
• Has the applicant made the POE available to those staff who require it to perform their work.	165a	165a			
• Is there a distribution list for the POE	165a	165a			
• Are sub-tier procedures referred to in the POE circulated to the level required for use.	165a	165a			
• Are staff familiar with the POE & associated documents applicable to their tasks.	165a	165a			
Is the production organisation maintained in accordance with the approved data and procedures	165b				
Quality System					
Has the applicant established a quality system which includes the products, parts or appliances detailed in the scope of the organisation	139a				
• Is the quality system documented in a form which makes it easily available to personnel who need it to perform their duties	139a	No1 to 139a			

Activity Areas Audited	Part 21A	AMC21A	POE / Proc.	Comments	Result
• Is the manager responsible for ensuring that the quality system is implemented identified	139a	No1 to 139a			
Are there adequate procedures for document issue, approval & change	139b1				
Are there adequate procedures for work performed at any location other than the approved facilities	139b1				
Are there adequate control procedures for any critical parts	139b1				
Is there an adequately proceduralised independent quality assurance function to monitor compliance with, and adequacy of, the procedures of the quality system	139b1 139b2	No1 to 139b2			
• Is quality assurance independent of the functions which it monitors	139b2	No1 to 139b2			
• Are staff able to work without technical reliance on the monitored function	139b2	No1 to 139b2			
• Does the quality assurance function perform planned continuing and systematic evaluations or audits of factors which affect conformity, airworthiness and safety of the product	139b2	No2 to 139b2			
• Does this evaluation include all elements of the quality system in order to show compliance with subpart G	139b2	No2 to 139b2			
Are quality assurance results fed back to the manager responsible for the function to ensure adequate corrective action	139b2				
Are quality assurance results fed back to the accountable manager to ensure adequate corrective action	139b2				
Are there sufficient competent personnel	145a	145a			

Activity Areas Audited	Part 21A	AMC21A	POE / Proc.	Comments	Result
Are there adequate procedures for the completion and retention of records	139b1				
Are records kept of all work in a form acceptable to the authority	165d	165d/h			
Are there adequate & effective procedures for instituting an archiving system, including suppliers/partners/sub-contractors data, used for the purposes of conformity release and continued airworthiness	165h	165d/h			
Personnel					
What is the name of the accountable manager	145c1	145c1			
Are they aware of their responsibility to maintain the applicants organisation in accordance with the data and procedures identified in the POE	145c1				
Has the authority been delegated in writing to another person	145c1	145c1			
Do they have the necessary responsibility and authority to ensure production is performed to the required standard.	145c1	145c1			
• Do they ensure that all necessary resources are available and properly used in order to produce in accordance with subpart G	145c1	145c1			
Do they have the necessary knowledge and authority to respond to the EASA on production matters	145c1	145c1			
Have a group of managers been identified as responsible to the accountable manager to ensure the organisation is, and remains, in compliance with the approval requirements	145c2	145c2			

Activity Areas Audited	Part 21A	AMC21A	POE / Proc.	Comments	Result
• do they report to, or have formally established direct access to, the accountable manager	145c2	145c2			
• have their responsibilities and authority been clearly identified and detailed in procedures to other staff within the organisation	145c2	145c2			
• have details been made available on EASA Form 4's	145c2	145c2			
• Is their knowledge, background and experience appropriate to their responsibilities	145c2	145c2			
• Does the manager responsible for monitoring the organisations compliance with subpart G (quality manager) have direct access to the accountable manager	145c2	145c2			
Do the procedures clearly identify the appropriate authority of staff at all levels	145c3				
Is there full and effective co-ordination between staff relating to airworthiness, noise, fuel venting and exhaust emission matters	145c3				
Are there adequate resources and procedures with regard to personnel competence and qualification (part of the quality system)	139b1 145a	145a			
Certifying Staff					
Have certifying staff been clearly identified (EASA Form 1 signatories)	145d1				
• Is their background & experience appropriate to discharge their responsibilities	145d1				

Activity Areas Audited	Part 21A	AMC21A	POE / Proc.	Comments	Result
• Is their number sufficient with regard to the complexity of the part and the production rate	145d1	145d1			
• Is their knowledge and experience of the production processes adequate	145d1	145d1			
• Is their knowledge of the approval requirements adequate to make releases	145d1	145d1			
Has adequate training been included for certifying staff	145d1	145d1			
Is the training updated with changes in the organisation and its technology and staff re trained as necessary	145d1	145d1			
Does training include a feedback system to maintain currency of both staff and training	145d1	145d1			
Are records available of all certifying staff detailing the following:-	145d2				
a) Name	145d2	145d2			
b) Date of birth	145d2	145d2			
c) Basic training and standard attained	145d2	145d2			
d) Specific training and standard attained	145d2	145d2			
e) Continued training (as appropriate)	145d2	145d2			
f) Experience	145d2	145d2			
g) Scope of authorisation.	145d2	145d2			
h) Date of first issue	145d2	145d2			
i) Expiry date, if appropriate	145d2	145d2			
j) Identification number of authorisation.	145d2	145d2			
• Are the records for certifying staff detailed as a procedure in the quality system	145d2	145d2			

Activity Areas Audited	Part 21A	AMC21A	POE / Proc.	Comments	Result
• Are certifying staff records restricted to prevent unauthorised alteration	145d2	145d2			
• Can certifying staff access their own records upon request	145d2	145d2			
• Are records maintained for at least two years following cessation of the authorisation.	145d2	145d2			
Are certifying staff provided with evidence of the scope of their authorisation	145d3				
• Does the document style make clear the scope of the authorisation	145d3	145d3			
• Is the authorisation document made available in a reasonable time	145d3	145d3			
Are there adequate procedures for the issue of airworthiness certifications (EASA Form 1)	139b1 163c				
• Are EASA Form 1s completed in accordance with Part 21 Appendix I	App I				
• Are they only signed by certifying staff	163c	163c			
• Are copies of the EASA Form 1s held on file	163c	163c			
Is it ensured that each product, part or appliance is complete, conforms to the approved design data and is in a condition for safe operation before issuing a EASA Form 1 for airworthiness	165c2	No 2, 4 to 165c2			
Is it ensured that each product, part or appliance is complete and conforms to the applicable design data before issuing a EASA Form 1 for conformity and is the reason for not releasing for airworthiness indicated	165c3	No 1, 4 to 165c3			

Activity Areas Audited	Part 21A	AMC21A	POE / Proc.	Comments	Result
In the case of engines is it determined that emissions requirements current at the date of manufacture are complied with when raising an EASA Form 1	165c2	No 2, 4 to 165c2			
Supplier Control					
Are there adequate procedures for vendor & subcontractor assessment, audit & control.	139b1				
• Are external suppliers identified by the quality system		No2 to 139a			
• Are external suppliers controlled by using the following techniques as appropriate to ensure conformity	139a	No2 to 139a			
◊ Qualification and auditing of the suppliers system.	139a	No2 to 139a			
◊ Evaluation of capability to establish conformity to applicable design data	139a	No2 to 139a			
◊ First article inspection to verify conformity to applicable data	139a	No2 to 139a			
◊ Incoming inspection and test where appropriate	139a	No2 to 139a			
◊ A vendor rating system which gives confidence in performance and reliability	139a	No2 to 139a			
◊ Additional work, including inspection and checks needed to enable parts to be delivered as spares, which are not included in the normal production cycle.	139a	No2 to 139a			
◊ Supplier personnel satisfy the competency standards of the applicants quality system as appropriate	139a	No2 to 139a			

Activity Areas Audited	Part 21A	AMC21A	POE / Proc.	Comments	Result
◊ Quality measurements are clearly identified by the supplier	139a	No2 to 139a			
◊ Supplier records and reports showing conformity are available for review and audit	139a	No2 to 139a			
◊ Does the applicant rely on suitable documentation (EASA Form 1) from suppliers with a POA and are they identified	139a	No2 to 139a			
◊ Is the control of buyer furnished equipment included in the Quality system	139a	No2 to 139a			
Are there adequate procedures for the verification of incoming materiel against applicable design data	139b1				
Are there adequate procedures for handling, storage & packaging (by suppliers & internally)	139b1				
Production					
Are there adequate procedures for identification and traceability	139b1				
Are there adequate procedures for manufacturing processes	139b1				
Are there adequate procedures for inspection and test (including production flight test if applicable)	139b1				
Are there adequate procedures for calibration of tools, jigs and test equipment (traceable to national standards) and are they implemented	139b1 145a	145a			
Are adequate resources available to carrying out production under the scope of approval, with regard to:-	145a				
• Accommodation and working environment	145a	145a			

Activity Areas Audited	Part 21A	AMC21A	POE / Proc.	Comments	Result
• Equipment and tools	145a	145a			
• Special processes and associated materials	145a	145a			
• NDT, welding equipment and facilities	145a	145a			
• Inspection and test equipment and facilities	145a	145a			
• Competent personnel	145a	145a			
Is there access and evidence of effective co-ordination between and within departments	145a	145a			
Aircraft Production					
If the applicant produces a complete aircraft, does the organisation have adequate & effective procedures for the production of a Statement of Conformity (EASA Form 52) to obtain an aircraft Certificate of Airworthiness & Noise Certificate	163b				
Are Statements of Conformity completed in accordance with Part 21 Appendix VII	App VII				
Is it ensured that each completed Aircraft conforms to the type design and is in a condition for safe operation before issuing a Statement of Conformity	165c	No 2 to 165c			
Is it ensured that the items listed in GM No 3 to 21.A.165(c) are in place prior to issue of a Statement of Conformity	165c	No 3 to 165c			
If the applicant has applied for the privilege to maintain a complete aircraft, after completion but prior to delivery, under their subpart G approval are appropriate procedures available.	163d 139b1	163d			

Activity Areas Audited	Part 21A	AMC21A	POE / Proc.	Comments	Result
Do the procedures clearly state the limitation of maintenance prior to operational rules requiring maintenance by an approved maintenance organisation	163d	163d			
Where a Certificate of Release to Service is issued is it determined that the aircraft has had all necessary maintenance and is in a condition for safe operation	165i				
If the applicant/holder has applied for the privilege to issue Permit to Fly and approval of associated flight conditions under their subpart G approval are appropriate procedures available?	163e	163e			
If the applicant/holder has not applied for privilege of approval of associated flight condition. Who is responsible for stating it? Are appropriate procedures/arrangements in place?	163e	163e			
Where PtoF issued, are Flight Conditions determined and approved?	163j 708, 710				
Where PtoF issued, is established compliance with 21.A711(b) and (d) before issuing PtoF to an aircraft? (Inspection of issued documents)	163k 711(b,d)				
Are changes and renewals of PtoF performed according to paragraphs 21.A.713 and 21.A.725?	713, 725	713			
What period is used for issued PToF? Is it in compliance with 21.A.723?	723				
Are all conditions and restrictions associated with the PtoF satisfied and maintained?	727				
Are all produced PtoF, flight conditions and associated supporting documents available to the Agency and retained?	729				

[Q] EASA FO.POA.00015-002 for Production Organization Exposition compliance checklist:

Part-21 SUBPART G PRODUCTION ORGANISATION EXPOSITION COMPLIANCE CHECKLIST

Applicant Name:		Tel No:	
Contact Person:		Approval Ref:	
POE Title:		POE Ref:	
Date of Review:		Reviewed by:	

This is the list of all the chapters, or subjects to be included in a Production Organisation Exposition (POE). It is not mandatory to follow the sequence of the chapters but it is mandatory to cover all the ones applicable. Some chapters can be added/merged according to organisation needs; the titles can be changed if appropriate.

	Reference to EASA Part 21 subpart G	**Ref to POE paragraph**	**Comment for applicant**	**Comment for Competent Authority**	
General information that should be in the first page					
Part 21 subpart G Production Organisation Exposition					
Name and address of the Organisation complying with official name (EF50 and business registration)					
Approval reference of the POA					
Reference of the Exposition with issue number					
Approval date					
General information for each page					
Name of the organisation					
POE identification					

	Reference to EASA Part 21 subpart G	Ref to POE paragraph	Comment for applicant	Comment for Competent Authority
Amendment/revision number of the POE				
Page number				

General chapters				
Table of content				
History of revision			Including status of the revision. Please ensure that the changes are somehow highlighted and that they are easy to identify.	
List of effectives pages				
Distribution list				
Terms and abbreviation			This can be removed from general chapters if any abbreviations is defined every time it is used in the document	
Introduction / Description of the Organisation			This is to present the organisation	

Management Procedures				
Signed corporate commitment by the Accountable Manager	21.A.143 (a) 1.		Shall confirm that the production organisation exposition and any associated manuals which define the approved organisation's compliance with this subpart will be complied with at all times.	
Nomination of Accountable Manager with reference to delegation letter when the AM is nominated by top management	21.A.143 (a) 2. 21.A.145 (c) 1.			
Management personnel	21.A.145 (c) 2. 21.A.143 (a)		Shall list the title and names of all the nominated persons in front of the POA with identification of EASA Form 4 holders	
Duties and responsibilities of :	21.A.143 (a) 3. 21.A.145 (c) 2.		Shall also include matters on which they may deal directly with the competent authority on behalf of the Organisation.	
- Accountable manager				

	Reference to EASA Part 21 subpart G	Ref to POE paragraph	Comment for applicant	Comment for Competent Authority
- Quality manager				
- Production manager				
- Any other manager related to POA				
Organisation chart	21.A.143 (a) 4. 21.A.145		The org chart shall identify the reporting lines and nominated managers	
List of Part 21 certifying staff	21.A.143 (a) 5. 21.A.145 (d)		This can also be an appendix	
General description of the man-power resources	21.A.143 (a) 6.			
General description of the facilities	21.A.143 (a) 7.		Containing the address and details of each facility included in the scope of the POA (in the production organisation's certificate of approval). A readable facility layout plan shall be included	
Scope of work	21.A.143 (a) 8. 21.A.151		The general scope of work relevant to the terms of approval shall be described here. Additionally it should refer to the full list of P/N (part number) produced under the production approval , the capability list or to the database that gives the list. For the products, it should refer to the type certificate number. In case of various DO/PO arrangements, a list of all DO/PO arrangements shall be included.	
Notification procedure of organisational changes to Competent Authority.	21.A.143 (a) 9. 21.A.147 (a) 21.A.148 21.A.149 21.A.153		Shall list all the changes identified as significant changes. Shall describe how each type (significant or not) of changes are managed. It includes change of accountable manager, change of other nominated managers, change of location of facility or change of activity (scope) etc…	
Amendment procedure of the exposition	21.A.143 (a) 10. 21.A.143 (b) 21.A.165 (a)		It shall describe how and by whom are the Exposition and the associated documents updated.	
Description of the quality system	21.A.143 (a) 11.		This is optional as it is covered by the next chapter but it can be useful to describe the structure of the documentation (pyramid)	

	Reference to EASA Part 21 subpart G	Ref to POE paragraph	Comment for applicant	Comment for Competent Authority
Supplier/subcontractor list	21.A.143 (a) 12		It shall include the main suppliers list plus the reference to the full suppliers list if the list is too big. A change of such a main subcontractor may be treated as a significant change (21.A.147 (a)). Can also be put as an appendix.	
Flight test operations manual defining the organisation's policies and procedures in relation to flight test	21.A.143 (a) 13		If flight tests are to be conducted	
Quality System				
Distribution of the documents	21.A.139 (a) 21.A.165 (a)			
Document issue, approval or change	21.A.139 (b) 1. (i)		The creation of document (by whom, to whom, numbering, document structure…) shall also be covered in this paragraph. How the changes are followed and highlighted shall also be covered.	
Vendor and subcontractor assessment audit and control	21.A.139 (b) 1. (ii) 21.A.157		Shall also include the evaluation and the acceptance criteria.	
Verification that incoming products, parts, materials, and equipment, including items supplied new or used by buyers of products, are as specified in the applicable design data	21.A.139 (b) 1. (iii)		It is the description of the incoming material inspection	
Identification and traceability	21.A.139 (b) 1. (iv)			
Manufacturing processes	21.A.139 (b) 1. (v) 21.A.145 (a) 21.A.163 (a) 21.A.165 (b)		Shall also include the management of the production documentation.	
Special processes	21.A.145 (d)		The special processes shall be mentioned and described if any.	
Inspection and testing, including production flight tests	21.A.139 (b) 1. (vi)			
Calibration of tools, jigs and test equipment	21.A.139 (b) 1. (vii)		Shall include the acceptance, the use, the control and the calibration of the tools and equipment	

	Reference to EASA Part 21 subpart G	Ref to POE paragraph	Comment for applicant	Comment for Competent Authority
Non-conforming items control	21.A.139 (b) 1. (viii)		Including concessions	
Airworthiness co-ordination with applicant for, or holder of, the design approval	21.A.139 (b) 1. (ix) 21.A.133 (b) (c) 21.A.165 (g)		This paragraph shall also refer to the DO/PO arrangement if any (unless this is included in the "scope of work" chapter).	
Records completion and retention	21.A.139 (b) 1. (x) 21.A.165 (d) 21.A.165 (h)		It is dealing with technical records and it shall include the management of electronic records if any.	
Personnel competence and qualification	21.A.139 (b) 1. (xi) 21.A.145 (d)		This should describe the general requirement for accepting anybody working in POA holder organisation. The training process of these persons shall be described (minimum training and also regular training). If there are special process or NDT in the scope, the specific requirements for training and qualification should also be described.	
Certifying staff qualification and training	21.A.145 (d)		This paragraph is specifically reserved for certifying staff, with qualification requirements, training needs, nomination, records and authorization.	
Issue of airworthiness release documents	21.A.139 (b) 1. (xii) 21.A.163 21.A.165 (c) 21.A.165 (i)			
Handling, storage and packing	21.A.139 (b) 1. (xiii)			
Internal quality audits and resulting corrective actions	21.A.139 (b) 1. (xiv) 21.A.139 (b) 2. 21.A.158			
- Quality audit of processes - Quality audit of product - Quality audit remedial action procedure - Quality audit personnel - Planning for POA compliance audits			The quality audit of processes shall cover also the audit of special processes if any. These are the audits procedures to cover the scope of Part 21 subpart G in order to prove the compliance with the regulation	

	Reference to EASA Part 21 subpart G	Ref to POE paragraph	Comment for applicant	Comment for Competent Authority
Work within the terms of approval performed at any location other than the approved facilities	21.A.139 (b) 1. (xv)		Also called outlocated work.	
Work carried out after completion of production but prior to delivery, to maintain the aircraft in a condition for safe operation	21.A.139 (b) 1. (xvi)		This is applicable only for complete aircraft.	
Issue of permit to fly and approval of associated flight conditions	21.A.139 (b) 1. (xvii) 21.A.165 (j) (k)		This is applicable only for complete aircraft.	
Occurrence reporting	21.A.139 (f) 21.A.165 (e) (f)			
Control of critical parts	21.A.139 (b) 1.			

Appendixes				
Capability List			If applicable	
Cross reference table between Part 21 subpart G requirements and internal documents.			This is not applicable in case there are no other internal POA documents than POE.	

Conclusion/Notes:

Reviewed by: Date:

Signed:

[R] EASA Form 4 on Details of Management Personnel:

European Union Aviation Safety Agency **Form 4**

EASA Foreign Approval - Part 145/Part 147/Part MG/Part MF	Ref# [chrono/record num.]

Competent authority: **European Union Aviation Safety Agency (EASA)**

1. Organisation name:

2. Approval Number relevant to the item (1):

3. First Name/ Surname:

4. Details of Management Personnel required to be accepted as specified in:

- (•) **Please choose one of the following:**
- ( ) **Part 145.A.30(b)**
- ( ) **Part M.A.606(b)**
- ( ) **Part M.A.706(c)**
- ( ) **Part 147.A.105(b)**

5. Position for the EASA approval:

6. Title within the Organisation:

7. Qualifications relevant to the position:

8. Work experience relevant to the position:

Date:

Signature:

[S] EASA Form 51 for Application of significant changes or variation of scope and terms of Part 21 Production Organization Approval:

Data protection: Personal data included in this application is processed by EASA pursuant to Regulation (EU) 2018/1725 on the protection of natural persons with regard to the processing of personal data by the Union institutions, bodies, offices and agencies and on the free movement of such data, and repealing Regulation (EC) No 45/2001 and Decision No 1247/2002/EC. It will be processed solely for the purposes of the performance, management and follow-up of the Application by the Agency, without prejudice to possible transmission to internal audit services, to the Court of Auditors, to the European Anti-Fraud Office (OLAF) for the purposes of safeguarding the financial interests of the European Union. The Applicant shall have the right of access to his personal data and the right to rectify any such data that is inaccurate or incomplete. Should the Applicant have any queries concerning the processing of his personal data, he shall address them to the Agency at the following address: dpo[at]easa.europa.eu. The Applicant shall have right of recourse at any time to the European Data Protection Supervisor.

1. APPLICANT'S REFERENCE

1.1 Your Reference	PLEASE PROVIDE A BRIEF, UNIQUE IDENTIFIER THAT WE WILL USE TO REFER TO YOUR APPLICATION

2. Applicant Address and Contact Data

2.1 Applicant Data

2.1.1 Name and Address (registered (business) name and address/legal seat of the company)	Applicant Number	**3XXXXX** (if known)	POA Number	**EASA.21G. XXXXX**
	Company Name			
	Trade Name	if different from legal name		
	Street / Nr			
	Post Code			
	City			
	Country			
2.1.2 Contact Person (responsible for this application)	Title	☐ Mr ☐ Ms		
	Name			
	First name			
	Job title			
	Phone/Fax			
	Email			

2.2 Billing Data (may be left blank, if same as 2.1 Applicant Data)

2.2.1 Billing Address	Company Name	Same as in section 2.1.1 (other name only in exceptional cases)

	Street / Nr	
	PO Box	
	Post Code	
	City	
	Country	
2.2.2 Contact Person (Responsible for ensuring the EASA terms of payment are honoured. An electronic invoice will be issued to the email address indicated here.)	Title	☐ Mr ☐ Ms
	Name	
	First name	
	Job title	
	Phone/Fax	
	Email	

3. Location(s) for which changes in the terms of approval are requested:		
3.1 Location Address	Street / Nr	
	Post Code	
	City	
	Country	

[please copy the above table to add further locations]

4. Brief summary of proposed changes at the addresses indicated under item 3	4.1 General:	
	4.2 Scope of approval:	
	4.3 Nature of privileges:	
5. DESCRIPTION OF ORGANISATIONAL CHANGES:		
6. (NOMINATED) ACCOUNTABLE MANAGER	NAME	
	POSITION	
Date/Location		Signature of the (nominated) Accountable Manager

Important Note: EASA cannot accept applications without signature. Please make sure that you sign the application. In case of an application for a change of the accountable manager the EASA Form 51 must be signed by the new nominee for this position. In all other cases the EASA Form 51 must be signed by the accountable

manager.

This Application should be sent by e-mail or regular mail to:

European Union Aviation Safety Agency
Applicant Services Department
Postfach 10 12 53
D-50452 Köln
Germany

E-mail: applicant.services@easa.europa.eu

Completion Instructions

Completion Instructions

Please double-click on the icon to access the completion instructions

[T] EASA Form 34 for ETSO Application:

Data protection: Personal data included in this application is processed by EASA pursuant to Regulation (EC) No 45/2001 on the protection of individuals with regard to the processing of personal data by the Community institutions and bodies and on the free movement of such data. It will be processed solely for the purposes of the performance, management and follow-up of the Application by the Agency, without prejudice to possible transmission to internal audit services, to the Court of Auditors, to the European Anti-Fraud Office (OLAF) for the purposes of safeguarding the financial interests of the European Union. The Applicant shall have the right of access to his personal data and the right to rectify any such data that is inaccurate or incomplete. Should the Applicant have any queries concerning the processing of his personal data, he shall address them to the Agency at the following address: dpo [at] easa.europa.eu. The Applicant shall have right of recourse at any time to the European Data Protection Supervisor.

1. APPLICANT'S REFERENCE

1.1 Your Reference	**PLEASE PROVIDE A BRIEF, UNIQUE IDENTIFIER THAT WE WILL USE TO REFER TO YOUR APPLICATION**

2. Applicant Address and Contact Data

2.1 Applicant Data

2.1.1 Name and Address (registered (business) name and address/legal seat of the company)	Applicant Number	**3XXXXX**	(A)DOA Reference	**if applicable**
	(Company) Name			
	Street / Nr			
	Post Code			
	City			
	Country			
2.1.2 Contact Person (responsible for this application)	Title	☐ Mr ☐ Ms		
	Name			
	First name			
	Job title			
	Phone/Fax			
	Email			

Important Note: First time applicants need to submit a copy of the company's **Business Registration** or similar legal document stating name and seat of the company together with the application. In case the applicant is not a company but a natural person, a copy of the person's **ID or passport** needs to be provided with the first application.

2.2 Billing Data (may be left blank, if same as 2.1 Applicant Data)

2.2.1 Billing Address (For the receipt of EASA	(Company) Name	Same as in section 2.1.1 (other name only in exceptional cases)

	Street / Nr	
	PO Box	
	Post Code	
	City	
	Country	
2 2.2.2 Contact Person (Responsible for ensuring the EASA terms of payment are honoured. An electronic invoice copy will be issued to the email address indicated here.)	Title	☐ Mr ☐ Ms
	Name	
	First name	
	Job title	
	Phone/Fax	
	Email	
2.3 Shipping Data (may be left blank, if same as 2.1 Applicant Data)		
4.18 2.3.1 Certificate Delivery Address (for the shipping of original EASA documents)	(Company) Name	
	Street / Nr	
	PO Box	
	Post Code	
	City	
	Country	
2.3.2 Contact Person (Shipping)	Title	☐ Mr ☐ Ms
	Name	
	First name	
	Job title	
	Phone/Fax	
	Email	

3. IDENTIFICATION OF ACTIVITY			
3.1 APPLICATION TYPE	☐ **Initial Approval of Equipment** ☐ **Minor Change to approved equipment which requires a change of the ETSOA*** (→ please complete 3.2 and 3.3)		
*Note: **Minor Changes to approved equipment will be charged the applicable fee for administrative re-issuance.**			
3.2 Approval N°		ISSUED ON	DD/MM/YYYY

(ONLY COMPLETE IN CASE OF MINOR CHANGE TO APPROVED EQUIPMENT)			
3.3 Description of Minor Change (only complete in case of Minor change to approved equipment)			

4. PRODUCT IDENTIFICATION

4.1 Kind of Equipment / Product in accordance with the Fees and Charges Regulation	
☐ Equipment – value above € 20,000	CS-ETSO.A
☐ Equipment – value between € 2,000 and € 20,000	CS-ETSO.B
☐ Equipment – value below € 2,000	CS-ETSO.C

4.2 Type/ Model		
4.3 Description		
4.4 Part Number(s)		
4.5 Equipment Category	Please enter the ID-Category according to the scheme in the Annex.	Annex I - Equipment Categories

5. CERTIFICATION BASIS

5.1 ETSO Standard(s)		
5.2 Deviations	☐ None	☐ Deviations (→ please specify below)

6. DATA REQUIREMENTS

6.1 Demonstration for Capability for Production (if applicable)	
6.2 Remarks (e.g. DDP in process)	

7. Part 21 demonstration of eligibility

I declare that this application is:

☐ Within the current approved scope of work of the applicant's (A)DOA.		
☐ Following an application for Design Organisation Approval (**FO.DOA.00080**) or Alternative Procedures to Design Organisation Approval (**FO.DOA.00081**).	Application Date	
	Project N°	if known
☐ Following an application for a change to the scope of work via	Application Date	

EASA Form **FO.DOA.00081** or **FO.DOA.00082.**	Project N°	if known

☐ Without an (A)DOA (only for organisations not located in an EASA member state).

8. APPLICANT'S DECLARATION AND ACCEPTANCE OF THE GENERAL CONDITIONS AND TERMS OF PAYMENT

I declare that I have the legal capacity to submit this application to EASA and that all information provided in this application form is correct and complete.

I have understood that I am submitting an application for which fees or charges will be levied by EASA in accordance with the Commission Regulation (EU) on the fees and charges levied by the European Aviation Safety Agency, as last amended and available from http://easa.europa.eu/ > Regulations > Fees & Charges.

I acknowledge that I have read and understood the Agency's Terms of Payment (see http://easa.europa.eu/ > the Agency > FAQs > Fees & Charges > Terms of Payment) and agree to abide by them. I declare to be aware that fees or charges, as well as all relevant travel costs must be paid whether or not the application is successful and that they might not be refundable. Moreover, I declare that I am aware of the consequences of non-payment.

Date/Place	Name	Signature

Important Note: EASA cannot accept applications without signature. Please make sure that you sign the application.

This Application and any additional documents should be sent by fax, e-mail or regular mail to:

European Aviation Safety Agency
Certification and Approval Support Department
Postfach 10 12 53
D-50452 Köln
Germany Fax:

E-mail: etsoa@easa.europa.eu

Completion Instructions

Completion Instructions

Please double-click on the icon to access the completion instructions

[U]List of Equipment Categories from the EASA Applicant Portal:

ID-Category	Category	Sub-Category
34	Aircraft tires, wheels and brakes	
37	Any other articles	
26	Autoflight and control systems and instruments	e. g. Autopilot
2	Avionics - Communication (VHF/HF/ELT)	VHF-Receivers
3	Avionics - Communication (VHF/HF/ELT)	VHF-Transmitters/Receivers
4	Avionics - Communication (VHF/HF/ELT)	HF-Transmitters/Receivers
5	Avionics - Communication (VHF/HF/ELT)	Emergency Locator Transmitters (ELT)
6	Avionics - Communication (VHF/HF/ELT)	Accessories to Airborne Communication Equipment
22	Avionics - Multisensorsystems	Multisensorequipment
23	Avionics - Multisensorsystems	Multifunctionequipment
38	Avionics - Multisensorsystems	Flight Management System
39	Avionics - Multisensorsystems	Multifunction-Display
7	Avionics - Navigation	Automatic Direction Finding Equipment (ADF)
8	Avionics - Navigation	VHF-Navigation Receivers (VOR)
9	Avionics - Navigation	VHF-Receivers (ILS, Marker)
10	Avionics - Navigation	UHF-Navigation Receivers (ILS)
11	Avionics - Navigation	Radio Distance Measuring Equipment (DME)
12	Avionics - Navigation	LORAN- and Decca-Receivers
13	Avionics - Navigation	Very Low Frequency Systems
14	Avionics - Navigation	Supplementary Equipment for Navigation Equipment
15	Avionics - Navigation	Microwave Landing System (MLS)
16	Avionics - Navigation	GPS
17	Avionics - Navigation	MMR
46	Avionics - Navigation	Other Navigation Systems
18	Avionics - Radar and Transponder	ATC Transponders

19	Avionics - Radar and Transponder	Doppler-Radar
20	Avionics - Radar and Transponder	Weather Radar Systems
21	Avionics - Radar and Transponder	Radar Altimeters
30	Avionics - Warning Systems	TAWS / EGPWS / GPWS
40	Avionics - Warning Systems	ACAS / TCAS
41	Avionics - Warning Systems	Stormscopes
36	Cabin equipment	Seats
42	Cabin equipment	Safety belts
43	Cabin equipment	Berths
35	Cargo equipment	Pallets
44	Cargo equipment	Containers
45	Cargo equipment	Tie-down equipment
28	Electrical systems equipment	
25	Flight and navigation instruments	
27	Power plant instruments	
29	Recording equipment contributing to accident/incident investigation	
24	Survival and safety equipment	Parachutes
31	Survival and safety equipment	Oxygen equipment
32	Fire and Smoke detection/extinguisher equipment	
33	Survival and safety equipment	Rafts/Life Jackets
47	Cabin equipment	Galley equipment & Trolleys

[V] DDP for ETSOA Application:

AMC 21.A.608 Declaration of Design and Performance

STANDARD FORM

DDP No. .....

ISSUE No. .....

1. Name and address of manufacturer.
2. Description and identification of article including:

   Type No .....

   Modification Standard

   Master drawing record

   Weight and overall dimensions
3. Specification reference, i.e., ETSO No. and Manufacturer's design specification.
4. The rated performance of the article directly or by reference to other documents.
5. Particulars of approvals held for the equipment.
6. Reference to qualification test report.
7. Service and Instruction Manual reference number.
8. Statement of compliance with the appropriate ETSO and any deviations therefrom.
9. A statement of the level of compliance with the ETSO in respect of the ability of the article to withstand various ambient conditions or to exhibit various properties.

The following are examples of information to be given under this heading depending on the nature of the article and the specifications of the ETSO.

(a) Environmental Qualification
   - i. Temperature and Altitude
   - ii. Temperature Variation
   - iii. Humidity
   - iv. Operational Shocks and Crash Safety
   - v Vibration
   - vi. Explosion Proofness
   - vii. Waterproofness
   - viii. Fluids Susceptibility
   - ix. Sand and Dust
   - x. Fungus Resistance
   - xi. Salt Spray
   - xii. Magnetic Effect
   - xiii. Power Input
   - xiv. Voltage Spike
   - xv. Audio Frequency Conducted Susceptibility - Power Inputs
   - xvi. Induced Signal Susceptibility

xii. Radio Frequency Susceptibility(Radiated and Conducted)

xiii. Emission of Radio Frequency Energy

xix. Lightning Induced Transient Susceptibility

xx. Lightning Direct Effects

xxi. Icing

xxii. Electrostatic Discharge

xxiii. Fire, Flammability

(Note: The manufacturer should list environmental categories for each of the sections of the issue of EUROCAE ED-14/RTCA DO-160 that was used to qualify the article.)

(b) For radio transmitters the transmitting frequency band, maximum transmitting power, and emission designator.

(c) Working and ultimate pressure or loads.

(d) Time rating (e.g., continuous, intermittent) or duty cycle.

(e) Limits of accuracy of measuring instruments.

(f) Any other known limitations which may limit the application in the aircraft e.g., restrictions in mounting attitude.

10. A statement of the software level(s) used or 'None' if not applicable.

(Note: Software levels (software development assurance levels (DAL)) are those defined in the industry document referred in the latest edition of AMC 20-115)

11. A statement of design assurance level for complex hardware or a statement indicating whether complex hardware is embedded or not in the product.

(Note: Complex hardware design assurance levels are those defined in the applicable issue of EUROCAE ED–80/RTCA DO-254.)

12. The declaration in this document is made under the authority of

.....(name of manufacturer)

(Manufacturer's name) cannot accept responsibility for equipment used outside the limiting conditions stated above without their agreement.

Date: .....Signed.....(Manufacturer's authorised representative)